A-maze of Natural Stories:

Texts are comprehensible using the Maze task

Veronica Boyce, Roger Levy

AMLaP 2020

Incremental processing methods

Incremental processing methods

Common ways to measure RT

Incremental processing methods
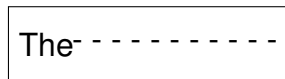
Common ways to measure RT

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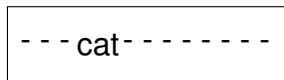
Common ways to measure RT

Eye-tracking

Self-paced reading

The- - - - - - - - - -

Incremental processing methods

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- - - cat - - - - - - - -

Incremental processing methods

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- - - - - - drank - - - -

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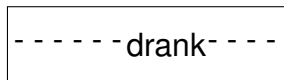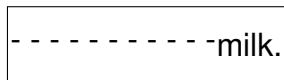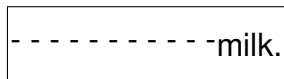
Different methods have different trade-offs

An alternative: Maze

The   x-x-x

An alternative: Maze

The x-x-x

An alternative: Maze

upon   dog

An alternative: Maze

upon (dog)

An alternative: Maze

revise   chased

An alternative: Maze

revise (chased)

An alternative: Maze

the   wish

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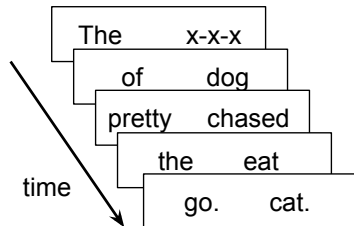mitigate. squirrel.

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(Forster et al. 2009; Witzel et al. 2012)

G-maze
'Grammatical' choices

The	x-x-x
of	dog
pretty	chased
the	eat
go.	cat.

time

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G-maze 'Grammatical' choices	**L-maze** 'Lexical' choices

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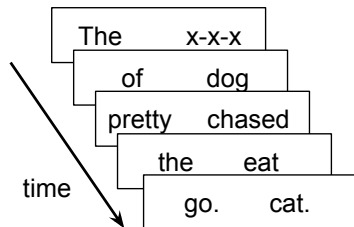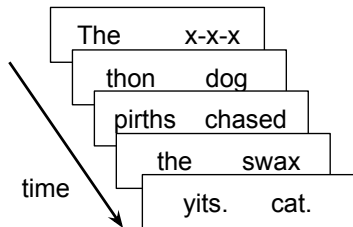
Sentence ends if a mistake is made.
Claim: forces incremental processing (no spillover)

Maze Made Easy

Can we use Maze instead of web SPR?

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- Work for multi-sentence items

Run on web

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Wrote an Ibex module

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Words so far: 8

hotter   rested

| e | | i |

Run on web

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e i

Replicated Witzel et al. (2012) results (Boyce et al. 2020)

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Generating distractors

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Goal: Find a word that can't continue a partial sentence

- Ex. *The dog chased*

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Can we use Neural Language Models?

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Run items through LM, choose high surprisal words as distractors

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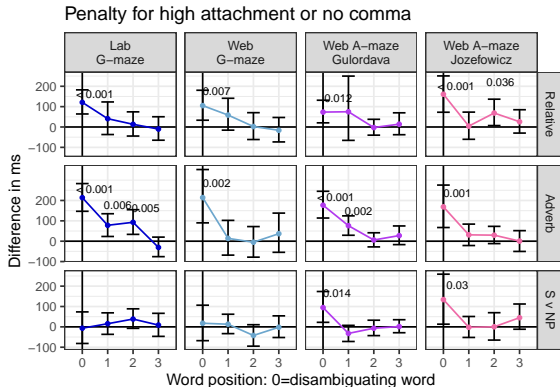# Does it work?

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Penalty for high attachment or no comma

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- Treat whole story as a unit: Few participants make it to the end.
- Treat each sentence as a unit: Some participants miss key context.

What if after an error, participants corrected errors and the sentence continued?

Maze with Error Correction

The   x-x-x

Maze with Error Correction

$$\left(\text{The}\right) \quad \text{x-x-x}$$

Maze with Error Correction

upon   dog

Maze with Error Correction

upon (dog)

Maze with Error Correction

revise   chased

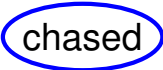# Maze with Error Correction

revise chased

Maze with Error Correction

revise   chased

Incorrect. Please try again.

Maze with Error Correction

revise (chased)

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Maze with Error Correction
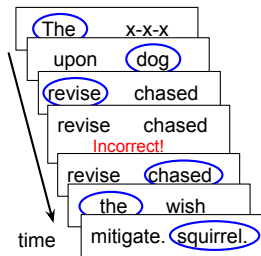
the   wish

Maze with Error Correction

the wish

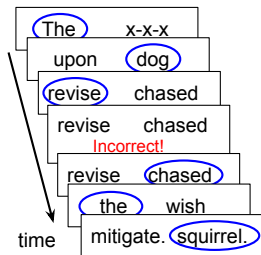# Maze with Error Correction

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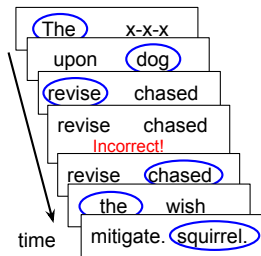the   wish
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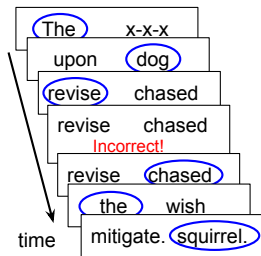# Maze with Error Correction

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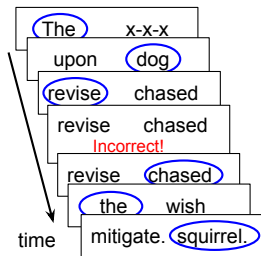
- Can be toggled in Ibex Maze
- Long materials feasible
- Have all the data
- Compensates for bad distractors

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Current experiment

Various open questions to address

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Various open questions to address

- Will people read long texts in Maze?
- Will they comprehend what they read?
- Does error correction Maze work?
- Do we get predictability effects?

Natural Stories

Natural stories corpus (Futrell et al. 2017)

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- 10 stories, each about 1000 words

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- 10 stories, each about 1000 words
- 6 comprehension questions per story

Natural Stories

Tulip mania was a period in the Dutch Golden Age during which contract prices for bulbs of the recently introduced tulip reached extraordinarily high levels and then suddenly collapsed. At the peak of tulip mania in February sixteen thirty-seven, tulip contracts sold for more than ten times the annual income of a skilled craftsman. It is generally considered the first recorded economic bubble. [...]

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Q: When did tulip mania reach its peak?
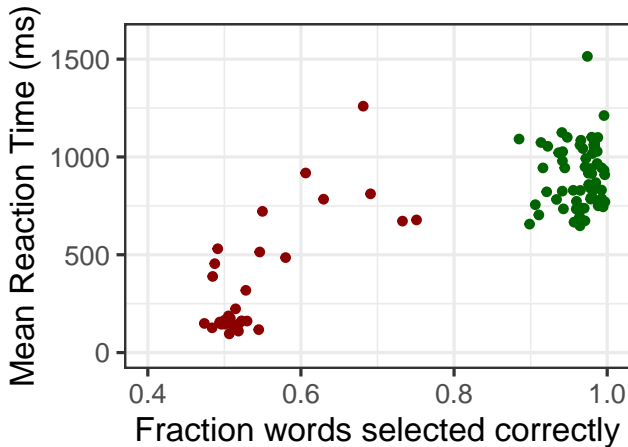A: 1630's   1730's

Participant accuracy

100 participants from MTurk each read 1 story (20 minutes)
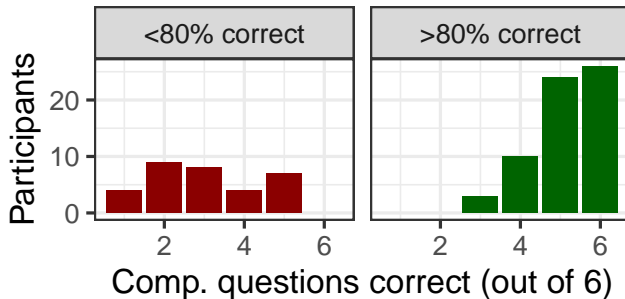
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Is RT linear in terms of surprisal?

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Estimate surprisal from 3 models:

- smoothed 5-gram
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Surprisal Effects

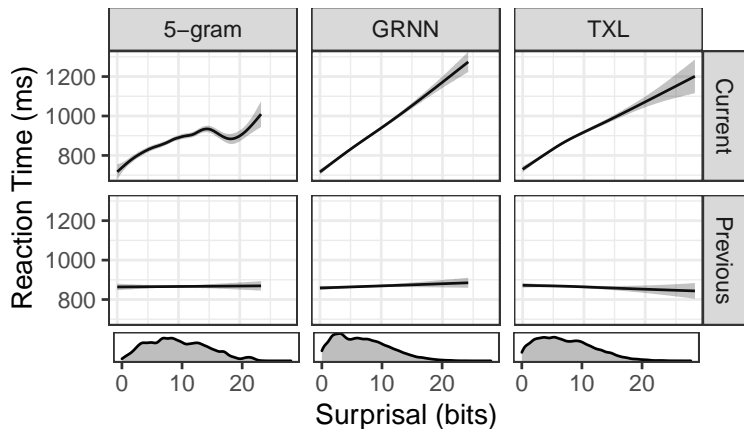Is RT linear in terms of surprisal?

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Fit GAMs

- Fit to both current and past word surprisal
- Include frequency, length as predictors

Surprisal Effects

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Linear Models

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Linear Models

	5-gram	GRNN	TXL
Intercept	**865.3**	**871.1**	870.8
Surprisal	**11.7**	**23.7**	**18.5**
Frequency	-2.9	2.9	0.4
Length	**20.5**	**18.5**	**21.4**
Surprisal:Length	**-2.0**	**-1.8**	**-1.4**
Freq:Length	-1.0	-0.1	0.2
Past Surprisal	1.6	**2.7**	0.8
Past Freq	2.6	1.9	1.2
Past Length	**-4.8**	**-6.6**	**-5.2**
Past Surp:Length	-0.2	**-0.9**	-0.6
Past Freq:Length	-1.0	**-1.8**	**-1.5**

Surprisal in bits, Length in characters,
Frequency in log_2 occurrences/billion words

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Bayesian reader framework: Look at words long enough
to ID with some threshold of certainty
Possible mechanisms for difference:

- Higher threshold
- Fewer available resources for processing
- Presence of second word

Conclusion

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Consider A-maze!

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- Documentation: vboyce.github.io/Maze

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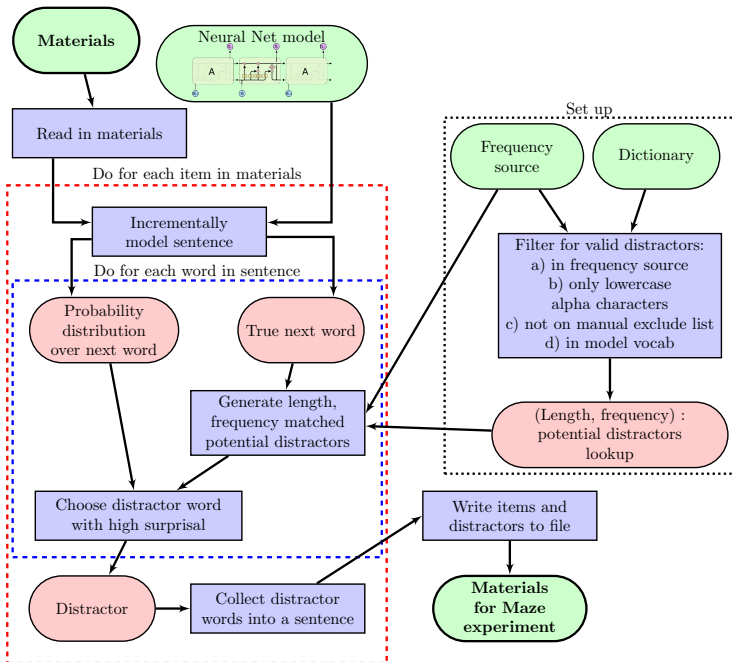
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Natural Stories A-maze:
- Participants comprehend what they read
- Find linear, large surprisal effects

Caveats

Definitely some bad distractors

	Prefix	Correct	Distractor	Error Rate
Gulordava				
	The	niece	cooks	44%
	The swimmer	disappointed	propositions	30%
	The	semester	steroids	29%
Jozefowicz				
	The	husband	authors	46%
	Jim	listened	survived	43%
	The	uncle	roads	42%
	The	knight	saints	40%

Surprisal Effects

GAM if we only exclude mistakes (all participants, post-mistake data)
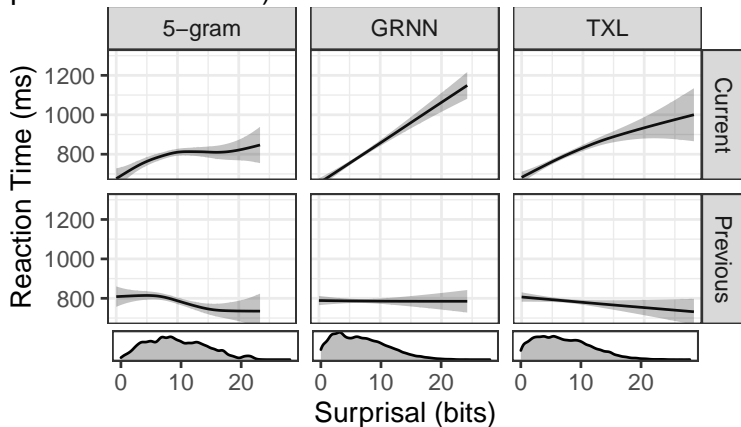
Links

Documentation: vboyce.github.io/Maze
with links to the following:

- A-maze code: github.com/vboyce/Maze
- Web-maze code: github.com/vboyce/Ibex-with-Maze
- Sample task: syntaxgym.org:666
- Paper: psyarxiv.com/b7nqd/

Matching distractors

If unspecified: Match by position

- The son of the lady who politely introduced <mark>herself</mark> / <mark>himself</mark> was popular at the party.

Can specify labels for each word to pair (within item)

- The cat who the dog scared hid in a box.
  pre-1 pre-2 who art noun verb main-verb post-1 post-2 post-3

- The dog who scared the cat sniffed around the couch.
  pre-1 pre-2 who verb art noun main-verb post-1 post-2 post-3