Cognitive Mechanisms of Semantic Disambiguation

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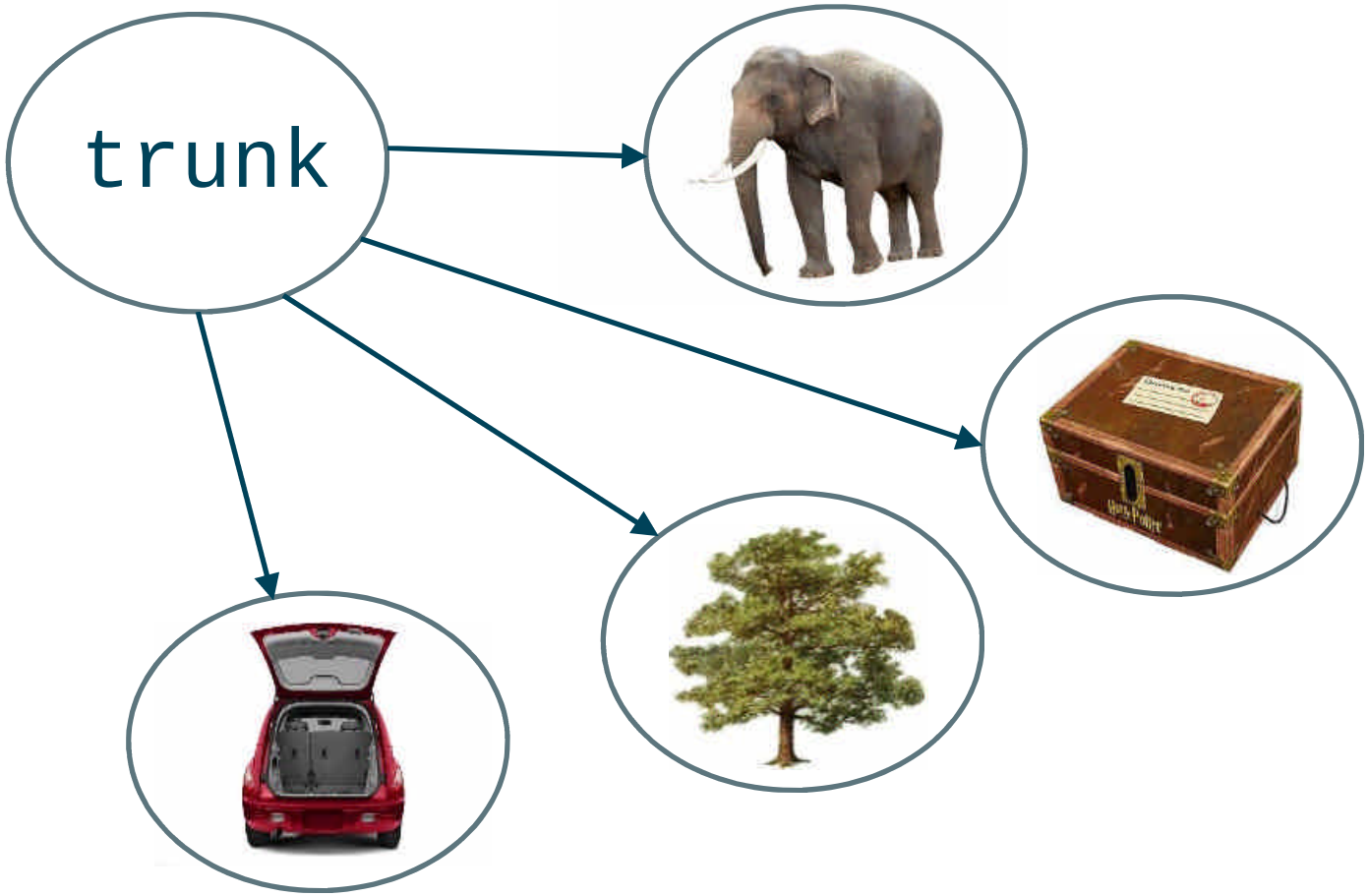
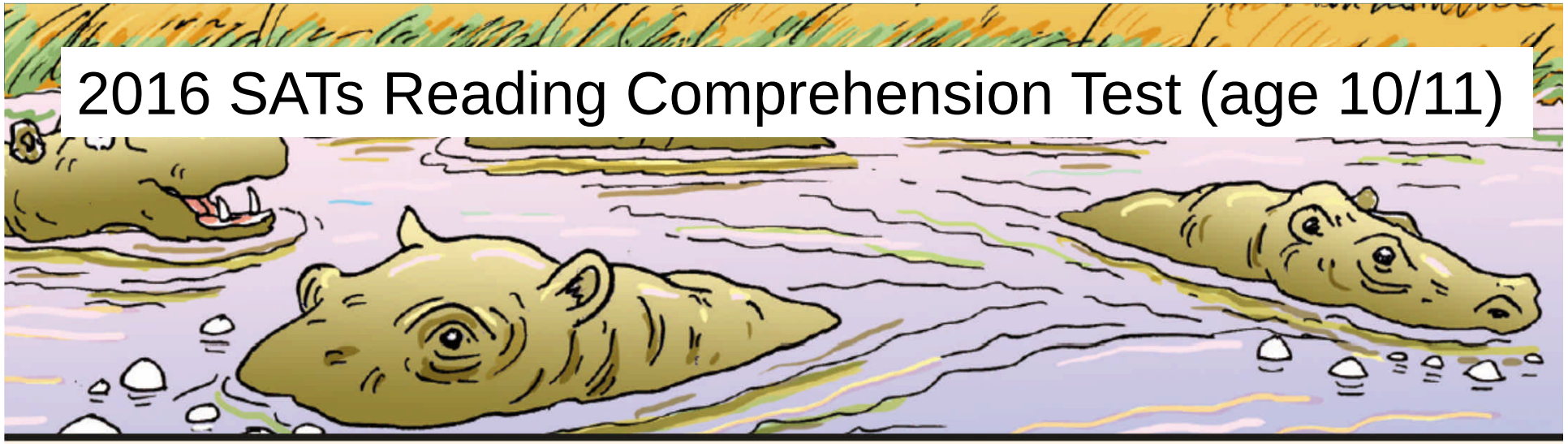
How do we know what words mean?



2016 SATs Reading Comprehension Test (age 10/11)



Dawn was casting spun-gold threads across a rosy sky over Sawubona Game Reserve as Martine Allen took a last look around to ensure there weren't any witnesses. She leaned forward like a jockey on the track, wound her fingers through a silver mane, and cried, 'Go, Jemmy, go.'

The white giraffe sprang forward so suddenly that she was almost unseated, but she recovered and, wrapping her arms around his neck, quickly adjusted to the familiar rhythm of Jemmy's rocking-horse stride. They swept past the dam and a herd of bubble-blowing hippos, past a flock of startled egrets lifting from the trees like white glitter, and out onto the open savannah plain. An early morning African chorus of doves, crickets and go-away birds provided a soundtrack.

Most words are ambiguous

Being able to select appropriate word meanings is vital for comprehension.

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RIGHT

Adjective

1. morally good, justified, or acceptable: "I hope we're doing the right thing"
2. true or correct as a fact: "I'm not sure I know the right answer"
3. in a satisfactory, sound, or normal state: "that sausage doesn't smell right"
4. on, towards, or relating to the side of a human body or of a thing which is to the east when the person or thing is facing north: "my right elbow"
5. complete; absolute (used for emphasis): "I felt a right idiot"
6. relating to a person or group favouring conservative views: "are you politically right?",

Adverb

1. to the furthest or most complete extent or degree: "the car spun right off the track"
2. correctly: "he had guessed right"
3. on or to the right side: "turn right off the B1269"

Noun

1. that which is morally correct or honourable: "the difference between right and wrong"
2. a moral or legal entitlement : "she had every right to be angry"
3. the right-hand part, side, or direction: "take the first turning on the right"
4. a group or party favouring conservative views: "the Right got in at the election"

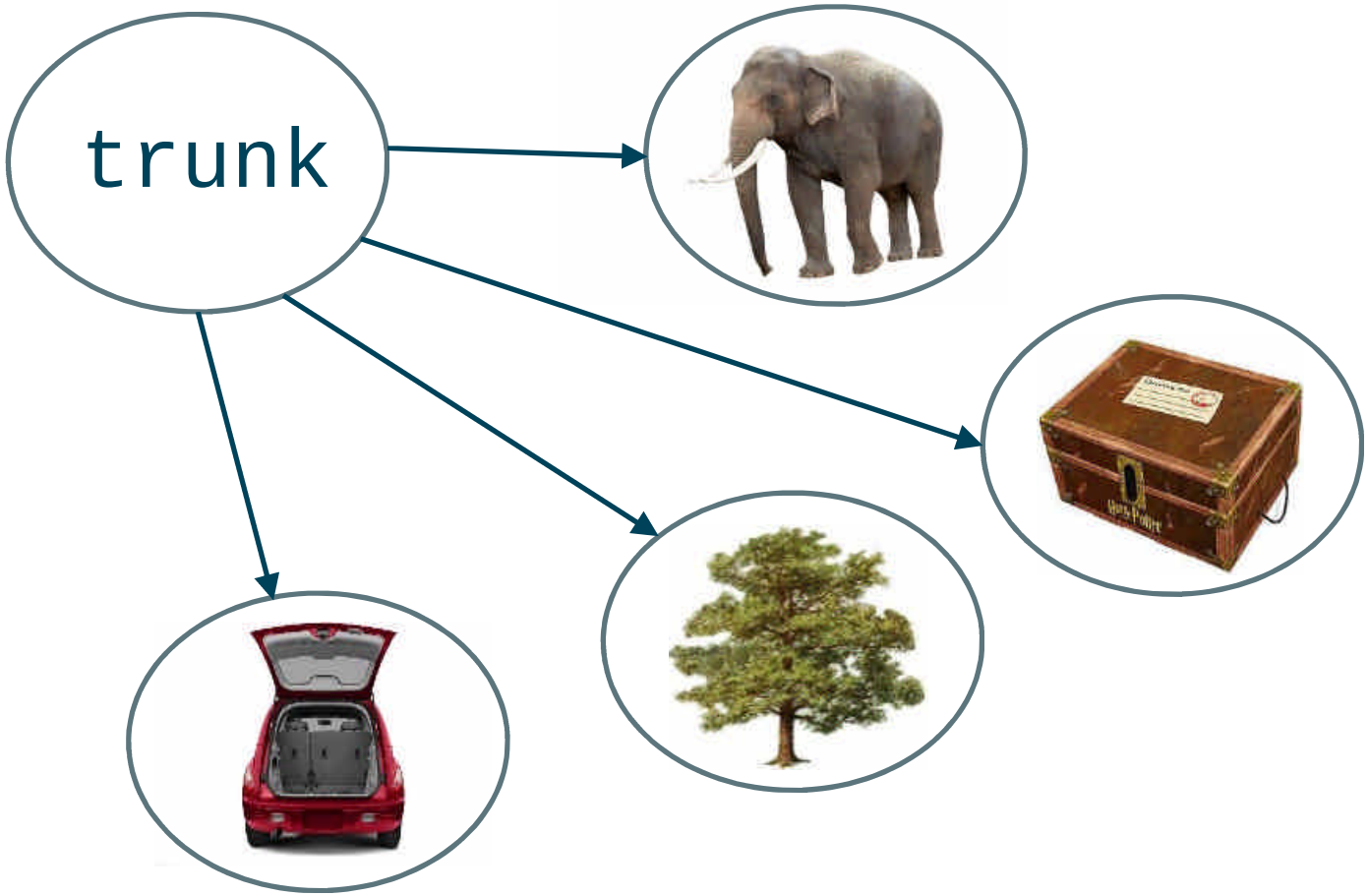
Verb

1. restore to a normal or upright position: "we righted the capsized dinghy"
2. restore to a normal or correct state: "righting the economy"

Exclamation

1. used to indicate agreement : "'Oh, right'"

How do we know what words mean?



Cognitive Mechanisms – an overview

Consensus that:

- Automatic retrieval of multiple meanings in parallel
- Rapid selection of single meaning
- Occasional need for subsequent reinterpretation

See Vitello & Rodd (2015) for review

Conventional view is that two factors determine:

- How readily available meanings are
- Which meaning is ultimately selected

(i) Sentence context

(ii) Dominance (relative frequency)

Reordered Access Model: Duffy & Colleagues

Cognitive Mechanisms – my view

Rapid, fluent access requires integration of many different statistical cues

1) SENTENCE CONTEXT

e.g., “The BARK of the TREE/DOG”

2) Recent experience with the word

3) Long-term experience with the word

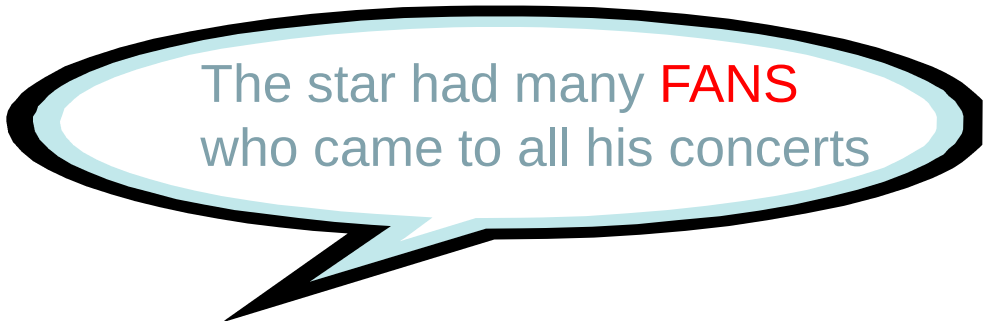
4) Knowledge about the speaker/writer

Etc etc etc…

Cue 2: Recent Experience
Word Meaning Priming: Method

Three Stages

1. Prime phase : Semantic relatedness task



music?

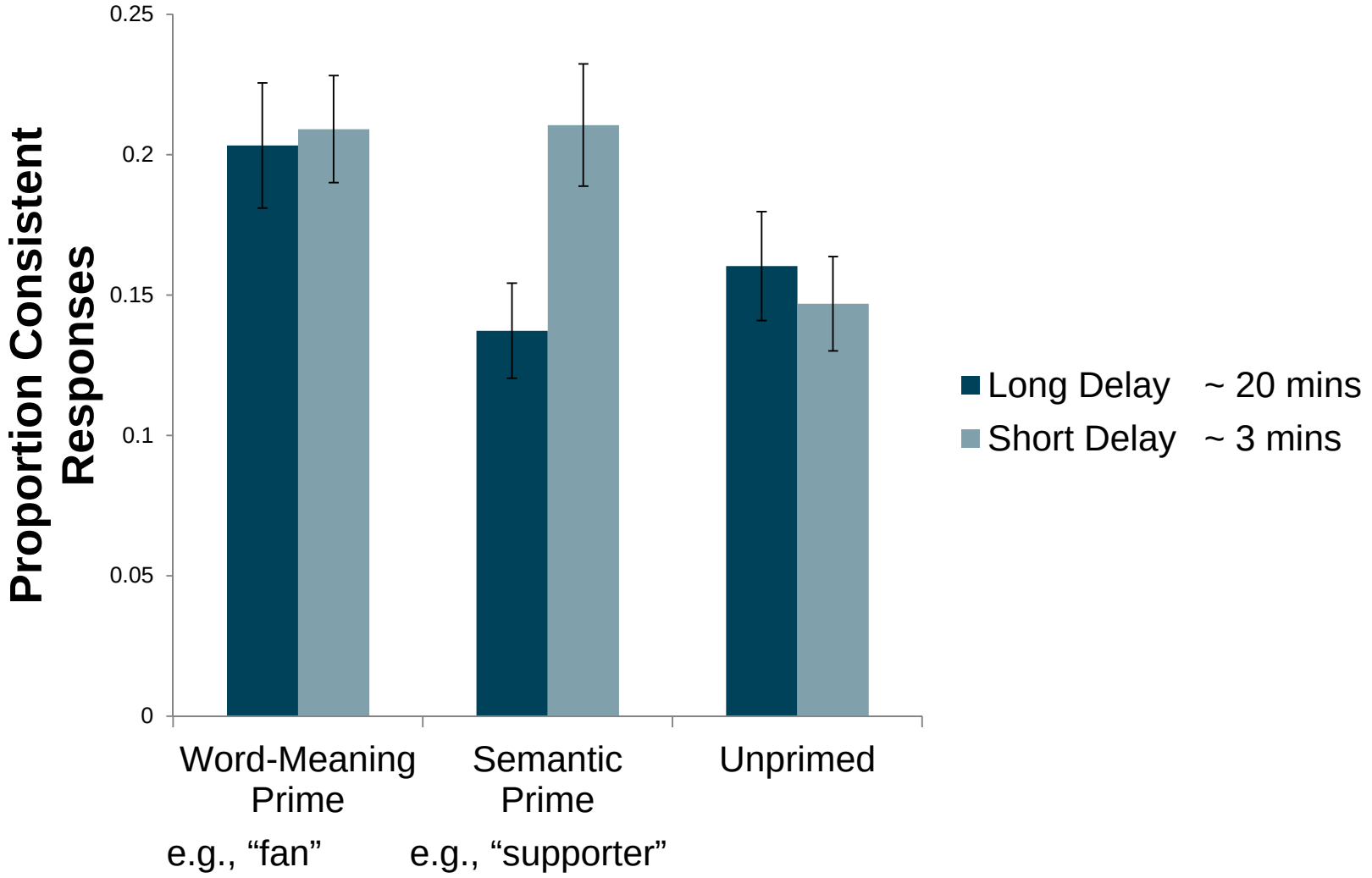
(2. Filler task: Digit span)

3. Test phase: Word association task

?

Does Prime influence responses at Test?

Word-Meaning Priming (Rodd et al., 2013; Expt 3)



Word Meaning Priming: On the radio…

BBC Radio 4: “The Human Zoo”

1) Listeners heard personal descriptions that included 28 Ambiguous words

> Mark hopes to become a professional tennis player. He practises on court at his club with his coach most days. His strongest weapon on court is his serve. He regularly gets out of trouble in a match with an ace on his serve. In his last match Mark saved three set points with an ace.

Spoken by two well known radio presenters (male, female)

2) Web-based word association task

Are responses primed by having listened to the radio primes?

N=2525

Stage 1: Word Association

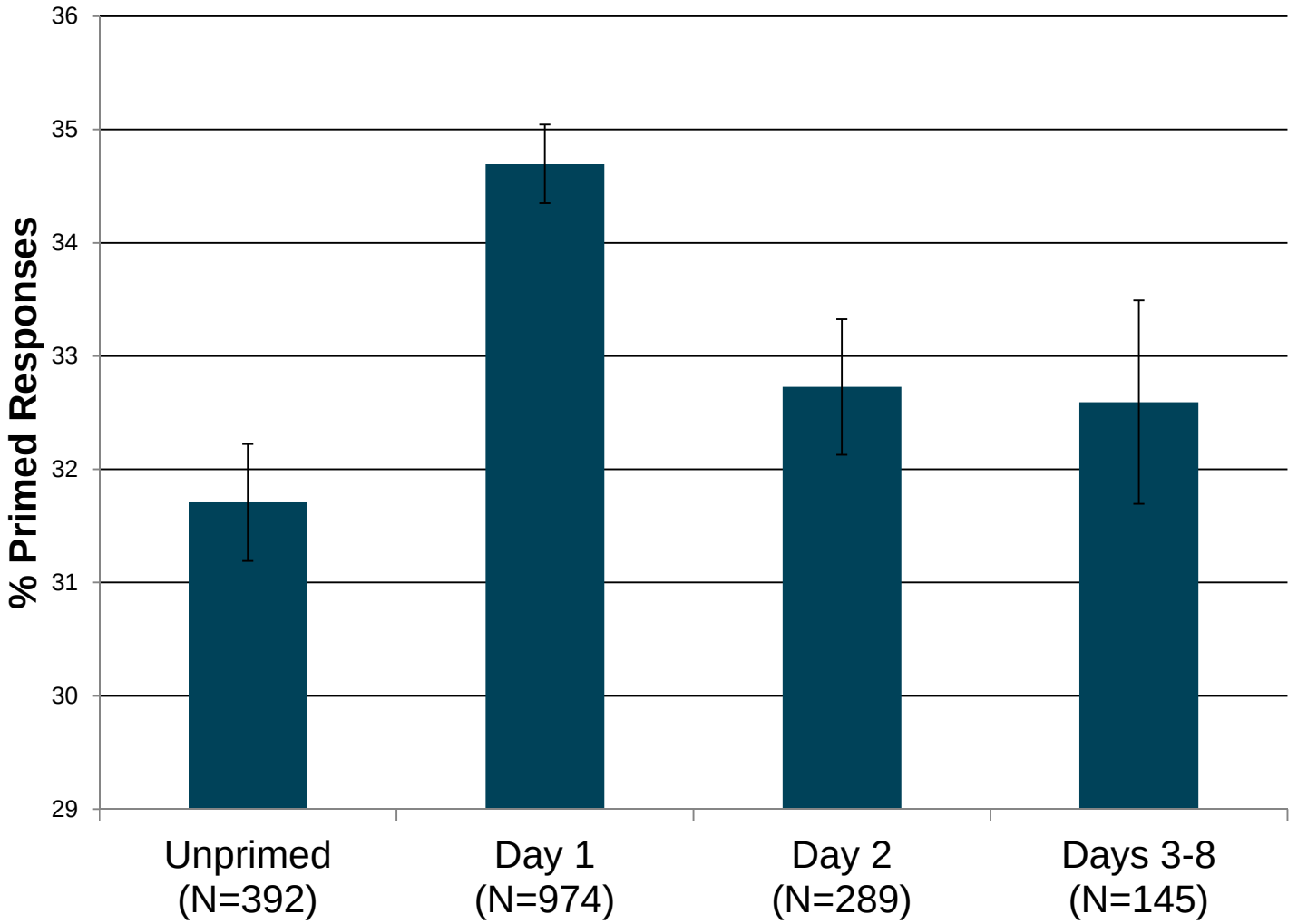
… bus

Stage 2: Meaning Clarification

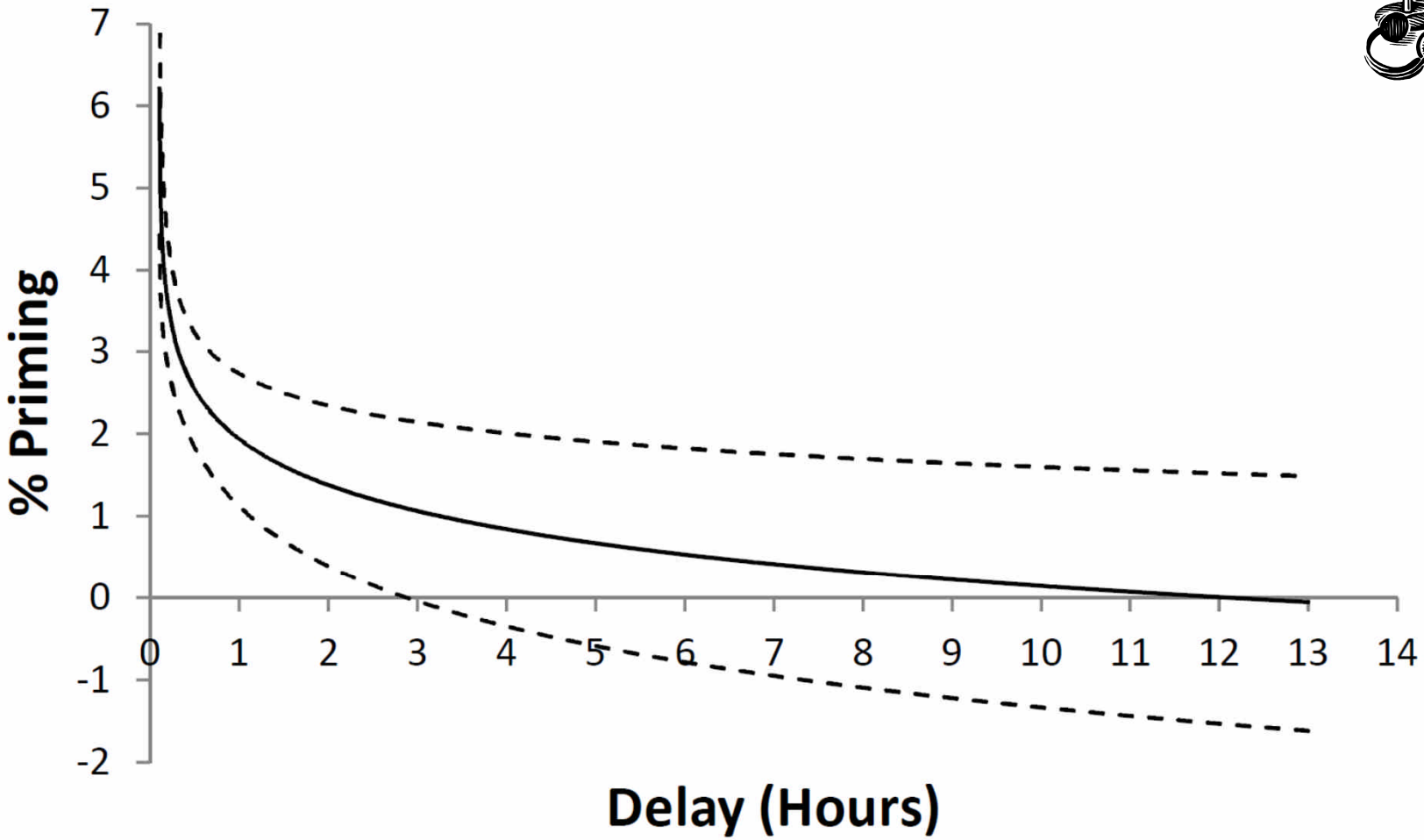
You heard “coach”. You responded “bus”.
Which meaning were you thinking of:

1) Bus, usually used for longer journeys
2) Sports trainer
3) Other meaning
4) Error

Influence of primes as function of delay

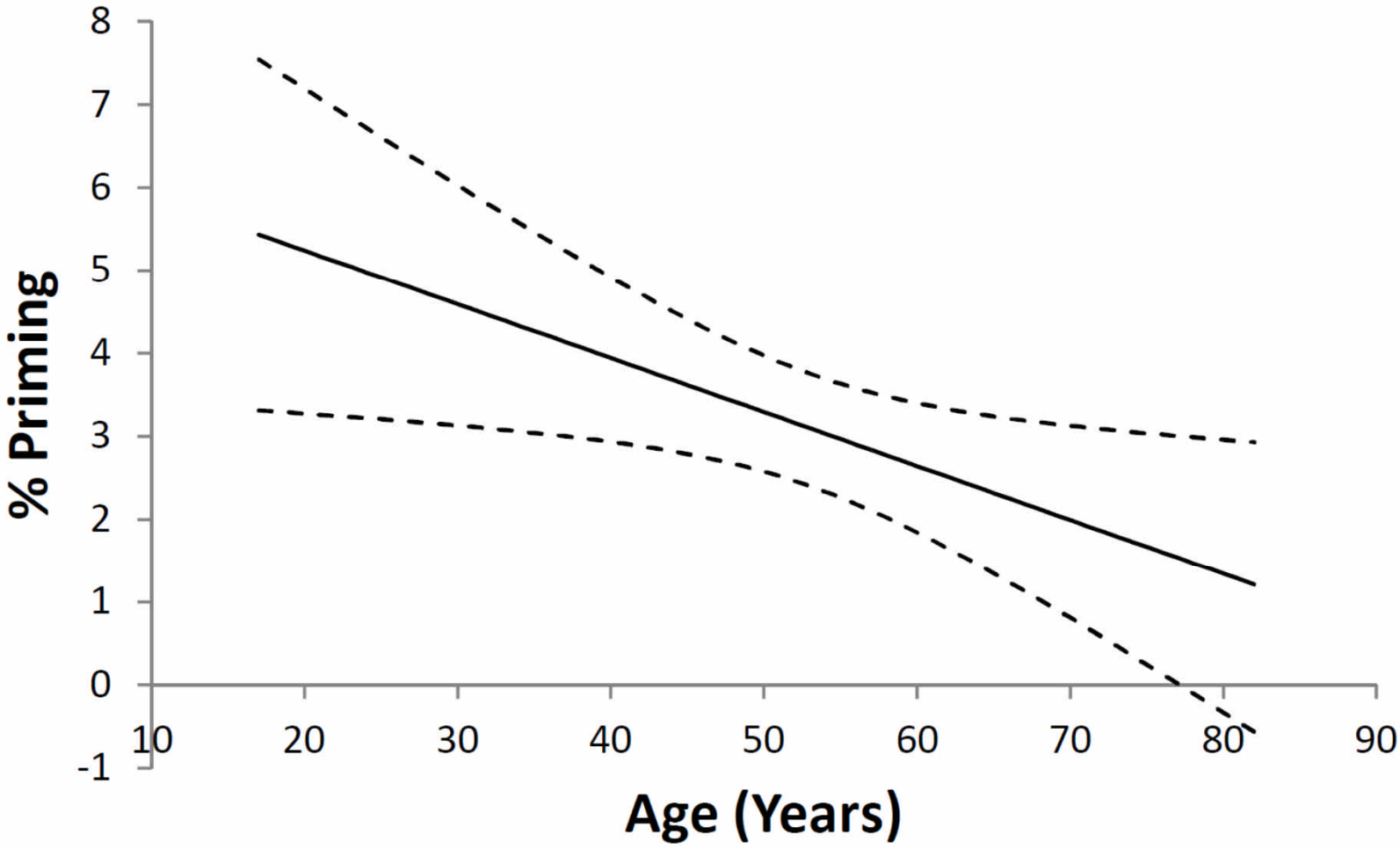


Influence of primes as function of delay:

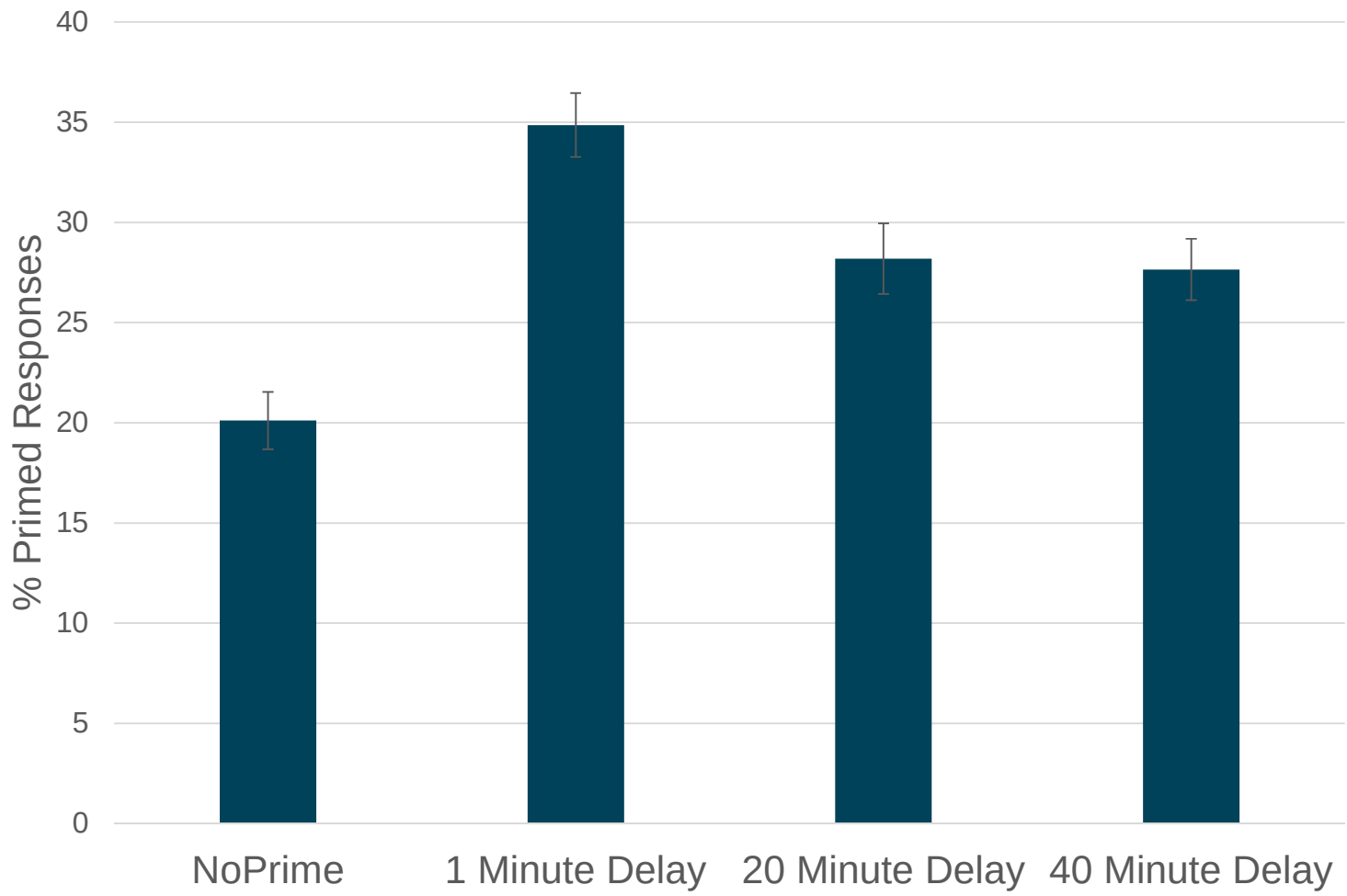


Best Fit: Logarithmic Function

Influence of primes as function of age: Regression analysis



Back in the lab…



Cross-language Priming

Three Stages

1. Prime phase : Semantic relatedness task in Dutch

Hij nam elke dag de BUS naar school. music

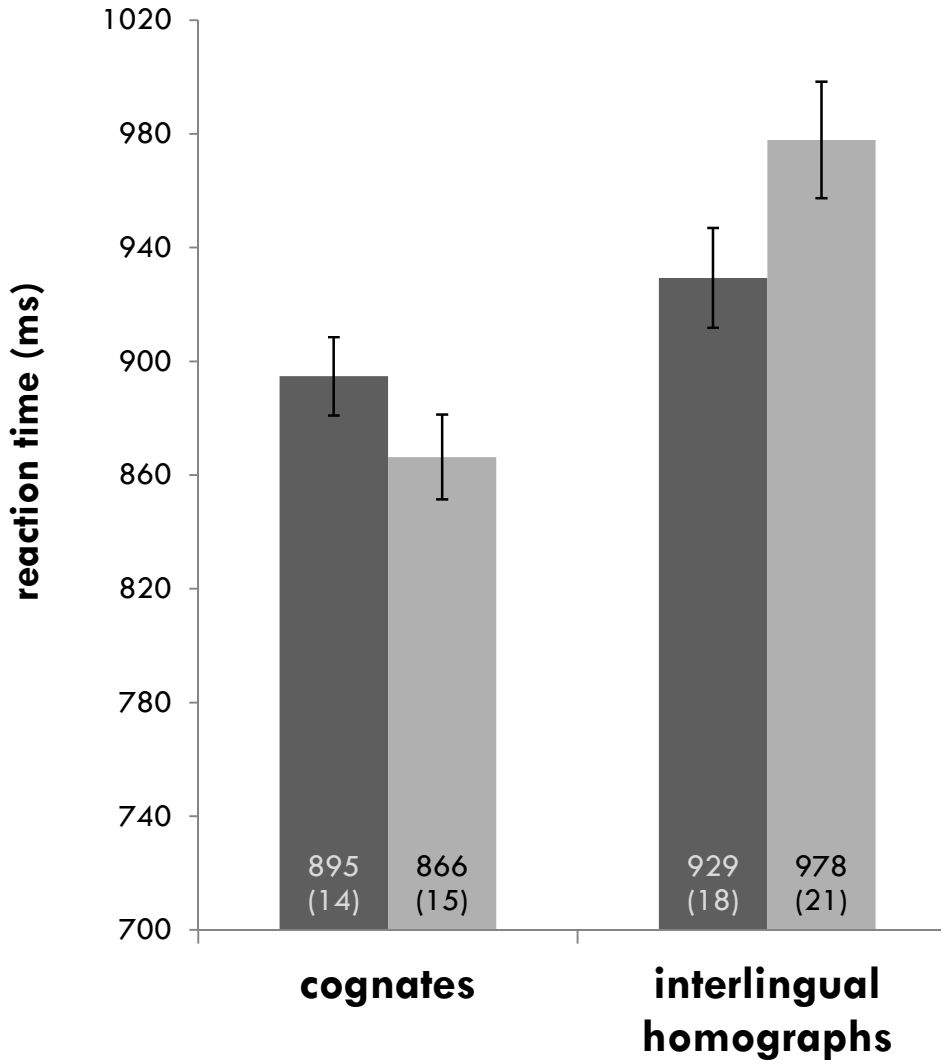
(2. Filler task: Digit span)

3. Test phase: Lexical Decision BUS

Does Prime influence responses at Test?

Cognates (e.g., BUS) vs. Interlingual Homographs (ROOM)

Cross-language Priming



Poort, Warren & Rodd, 2016

Cue 3: Long-term experience

Meaning Preferences in Rowers

- Rowers acquire additional meanings for common words: “square”, “feather”, “catch”…
- What factor determine their relative preferences for these meanings?
- Web-based word association task
- Two experiments (Total N=213)

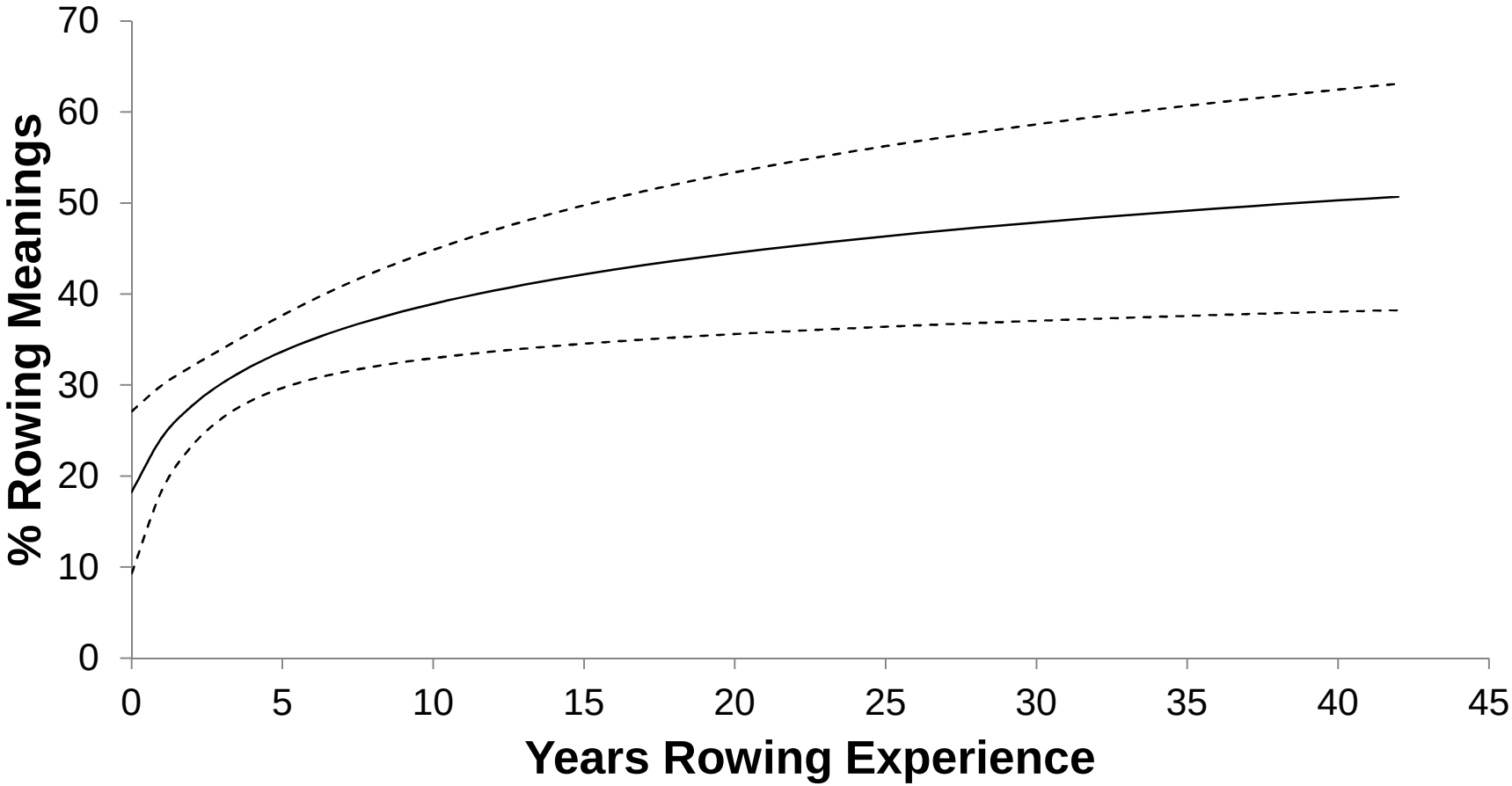
Multiple Regression Analyses

%rowing responses predicted by:

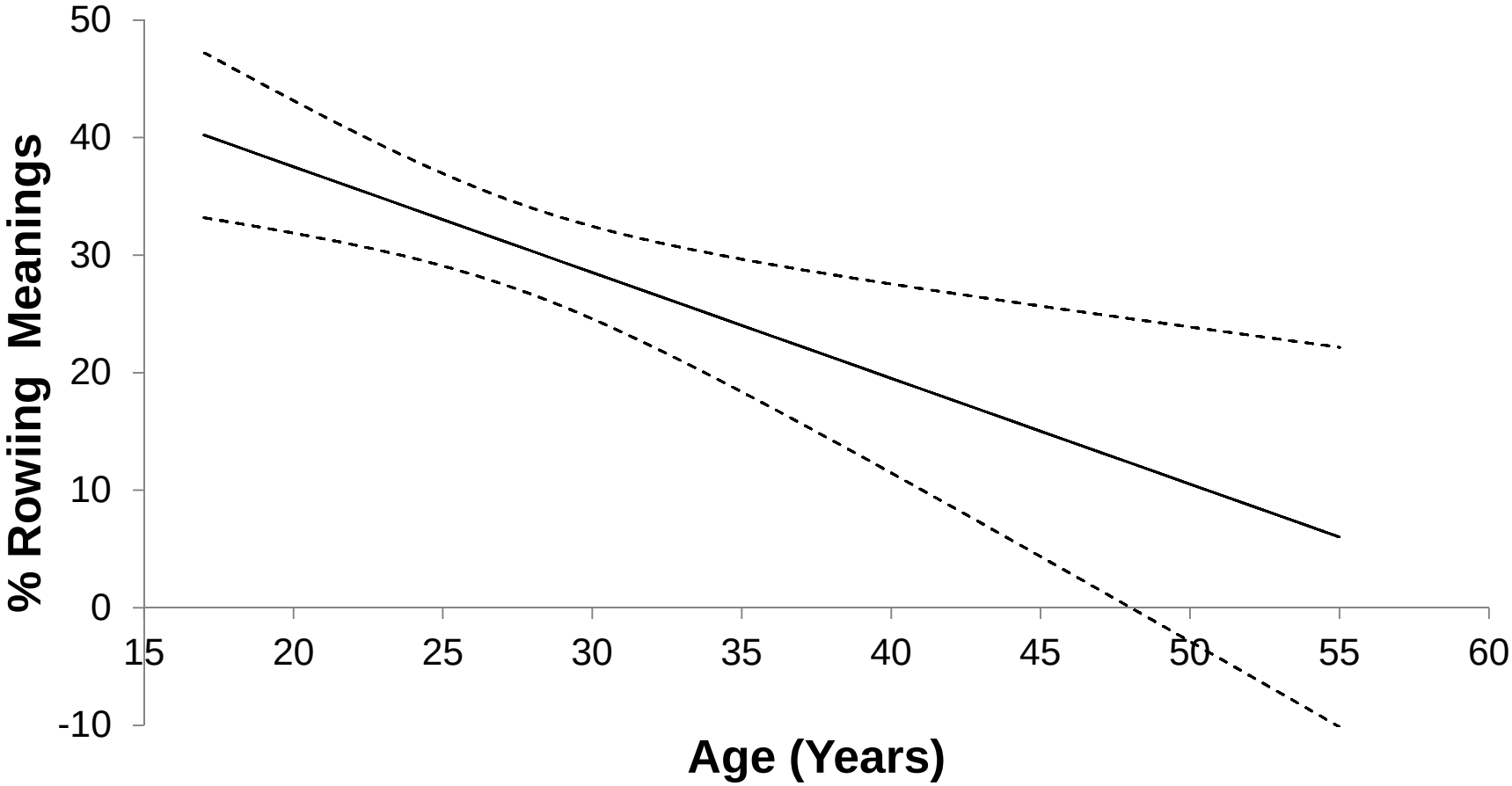
- number of years rowing experience (+)
- Age (-)
- Same-day rowing experience (+)

But not by measures of rowing experience over preceding days/weeks/months

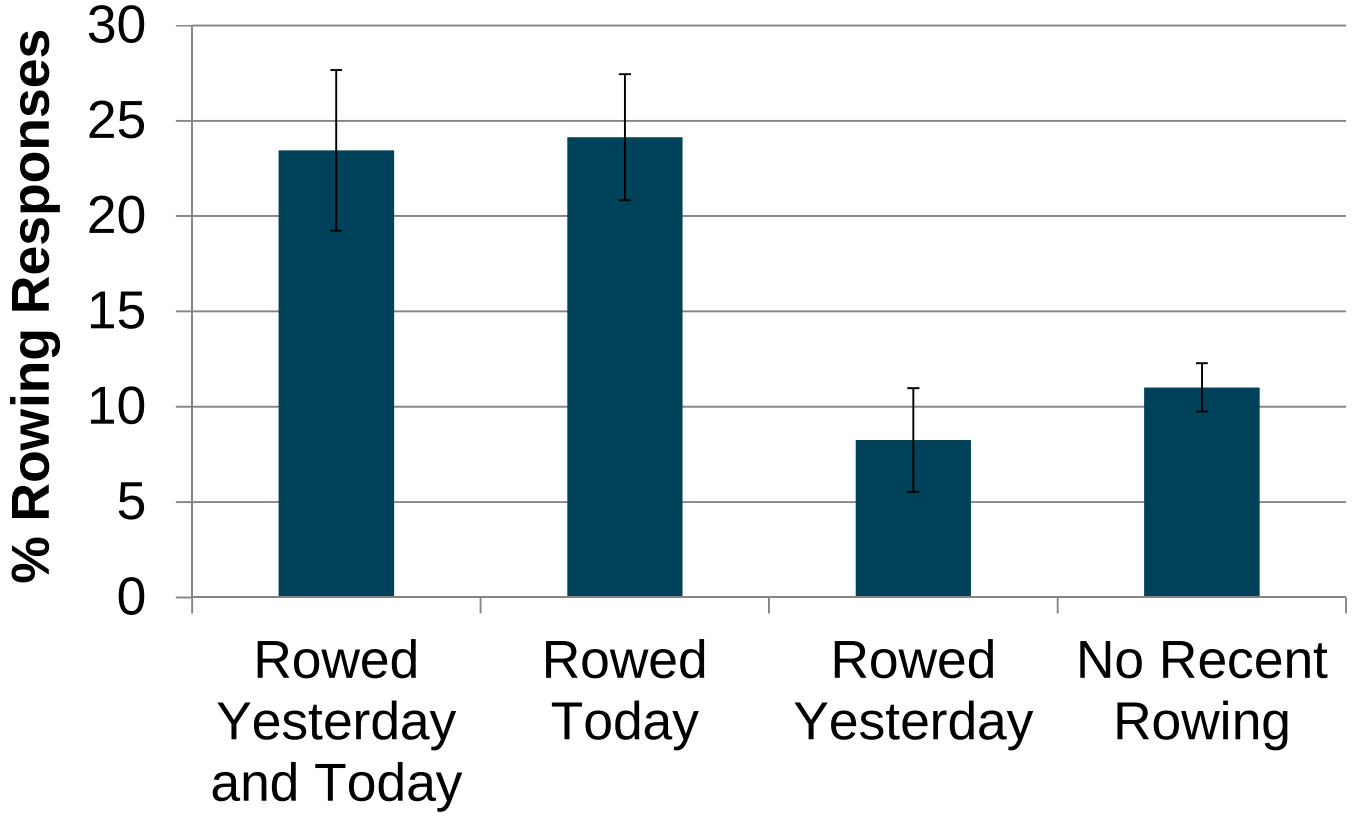
Multiple Regression Analyses



Multiple Regression Analyses



Effect of recent rowing experience



Median delay between rowing and experiment: 8 hours

Interim Summary

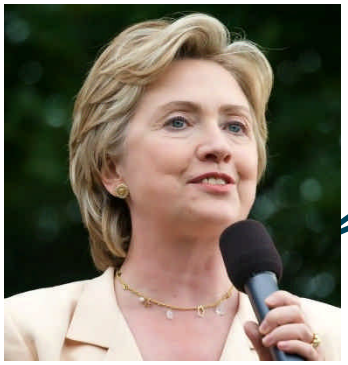
1. Meaning preferences for familiar words are HIGHLY flexible, even in adults
   - Recently encountered meanings more readily available
   - Priming from single exposures relatively modest
   - Large priming from multiple natural exposures

2. Effect of individual encounters decay relatively fast

3. Repeated encounters with any given word meaning have long-term cumulative effect on preferences
   (aka “dominance effects”)

This flexibility improves ease of comprehension

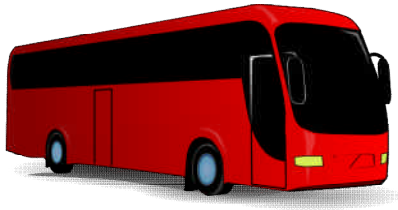
Cue 4: Speaker Characteristics:



COACH

?

COACH



?

Stimuli Pretesting

- 44 potential ambiguous words
  - GAS a gaseous form of a substance.
  - GAS a fuel for motor vehicles.

- US/UK participants rated meaning familiarity

- Selected 22 ambiguous words with different dominant meanings in BE and AE

e.g., FALL, FLAT, GUTTED, PLASTER, TUBE

Stage 1: Word Association

… bus

Stage 2: Meaning Clarification

You heard “coach”. You responded “bus”.
Which meaning were you thinking of:

1) Bus, usually used for longer journeys
2) Sports trainer
3) Other meaning
4) Error

Experiment 1

- Online word association task
- Run using Qualtrics

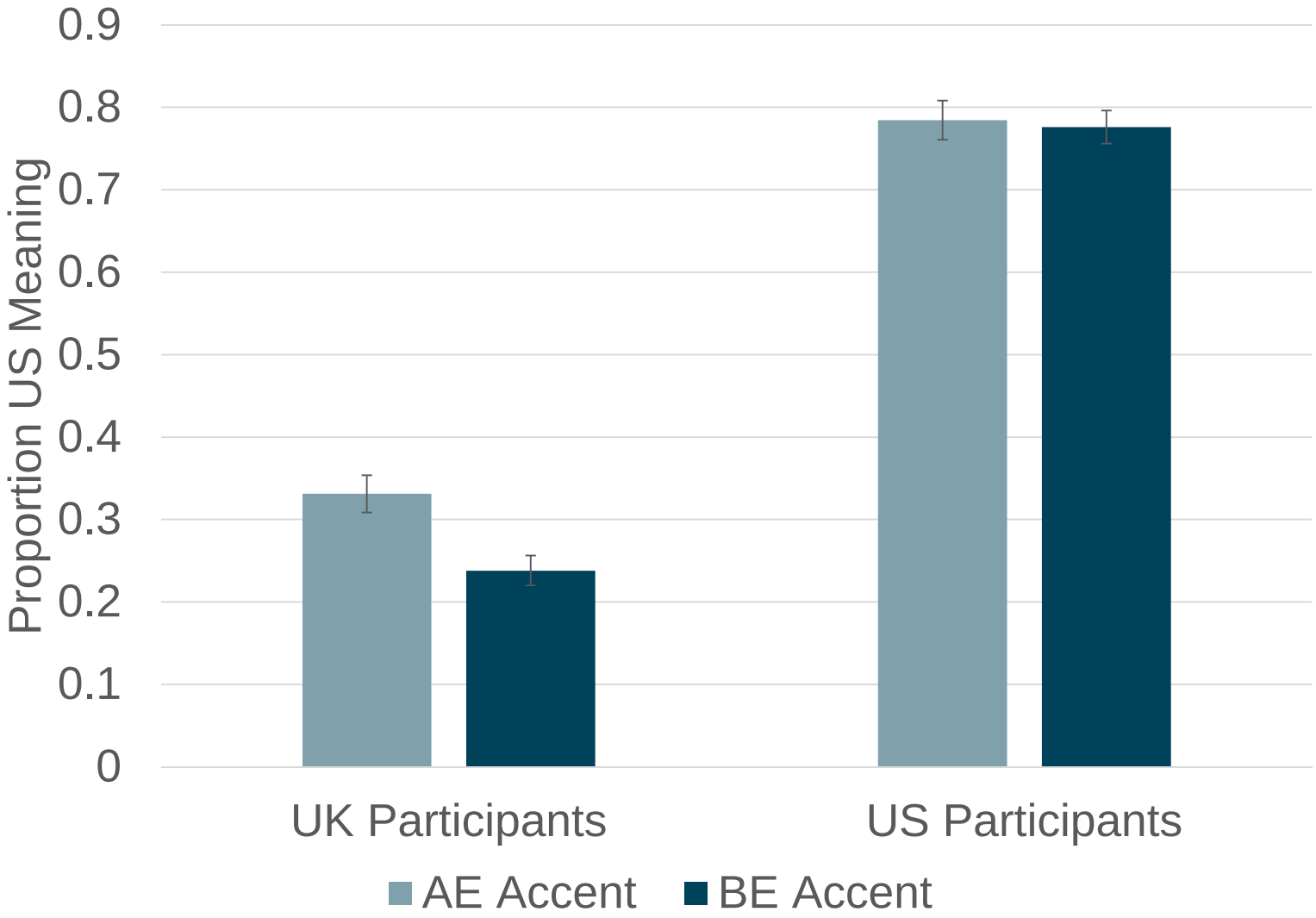
US participants (via MTURK)

- 32 AE accent
- 31 BE accent

UK participants (via social media)

- 25 AE accent
- 32 BE accent

RESULTS


0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Proportion US Meaning
UK Participants
US Participants
AE Accent
BE Accent

Experiment 1: Conclusions

- UK participants take speaker accent into account when interpreting words
- No significant accent effect in US participants
  - Presumably due to lack of BE Experience

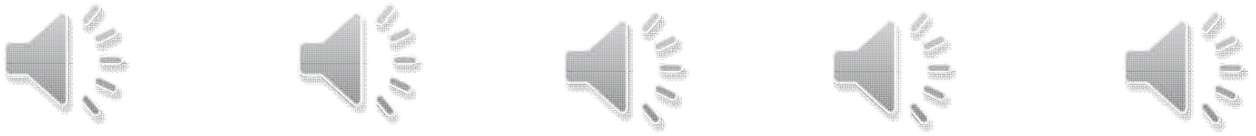
But what is the mechanism?

1) Accent context
2) Detailed acoustic/phonetic information in individual tokens (cf Episodic accounts)

Experiment 2: Question

Does the accent effect transfer to non-accented other words in the block?

Experiment 2: Morphed Speech



- Created using *Straight* (Rogers, J. C. & Davis, M. H. (2009)
- Decomposes speech into different constituent components
- Averages components in different proportions to create intermediate tokens

Experiment 2: Morphed Speech

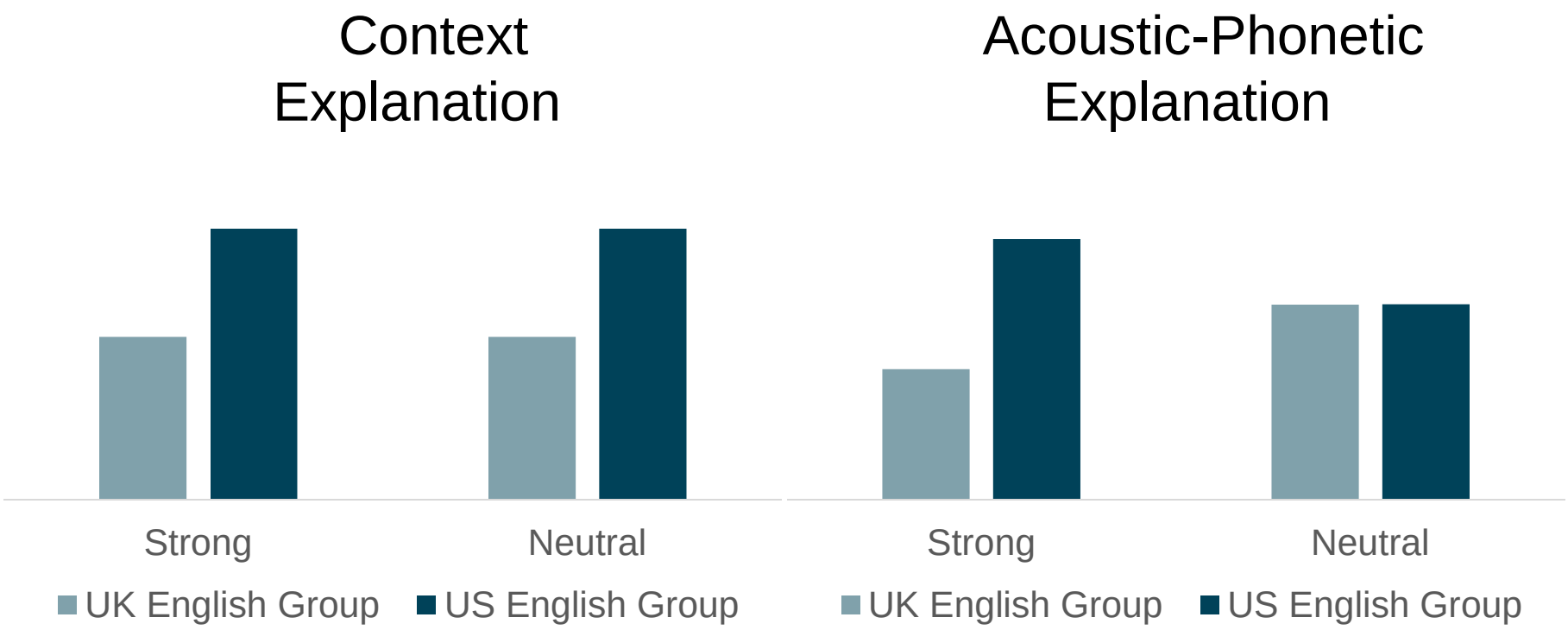
Strong US Weak US Neutral Weak UK Strong UK

Experiment 2: Design

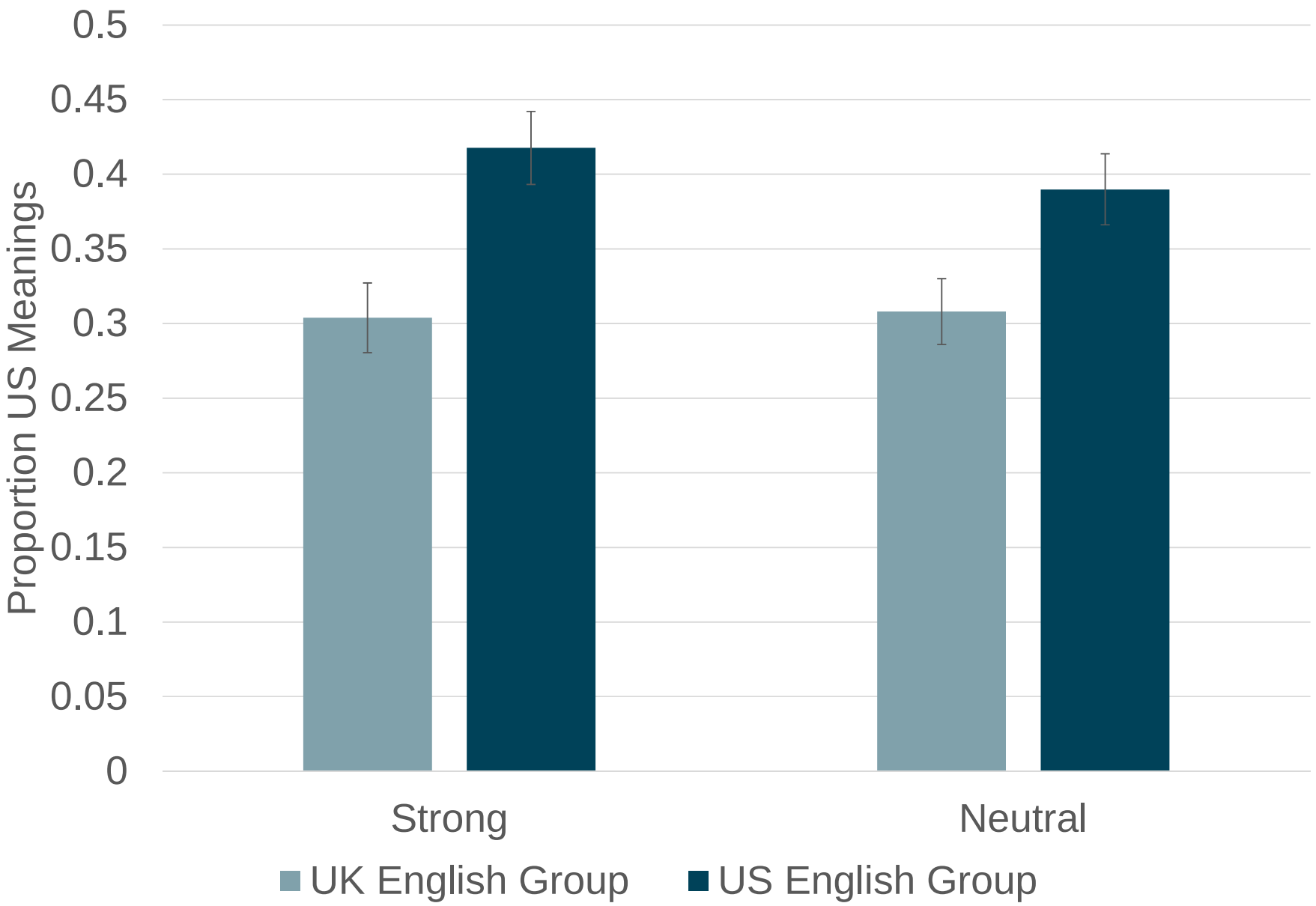
Two participant Groups:

1) US English	2) UK English
25% Strong US Accent	25% Strong UK Accent
25% Neutral	25% Neutral
50% Weak US Accent (fillers)	50% Weak UK Accent (fillers)

Experiment 2: Predictions



RESULTS


0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Proportion US Meanings
Strong
Neutral
UK English Group
US English Group

Experiment 2: Caveats

- Most participants were aware of ambiguity
- Most participants were aware of US meanings

- But
- 80% perceived the speech as coming from a single speaker
- very few participants reported being aware of variation in pronunciation

Experiment 2: Conclusions

- Accent effect transfers to non-accent spoken items

- Accent effect most likely driven by general accent context, not properties of individual words

Experiment 3: Question

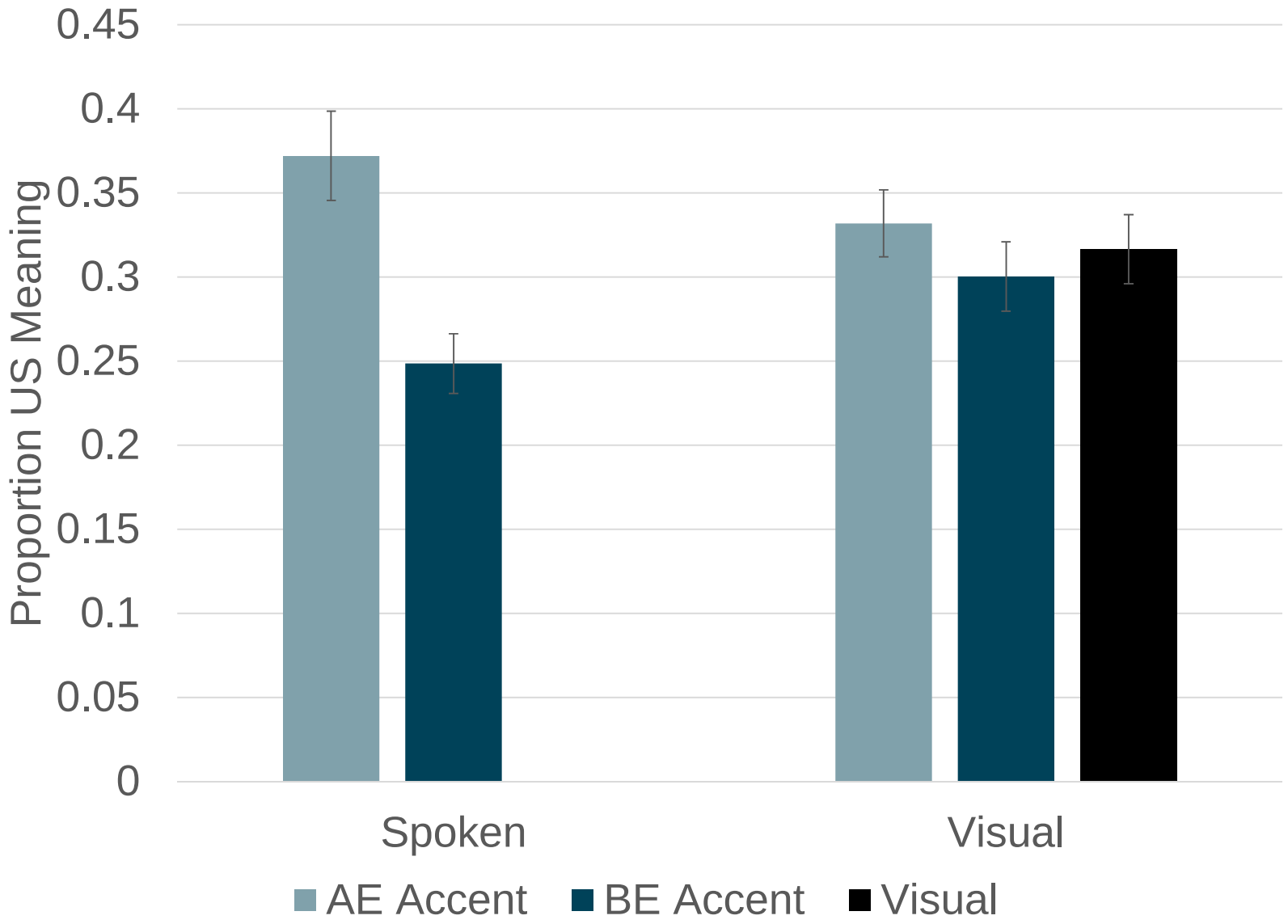
Does the accent effect transfer to visual words in the block?

Experiment 3: Stimuli

3 participant groups:

- 50% AE Spoken, 50% visual
- 50% BE Spoken, 50% visual
- 100% visual

RESULTS


0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Proportion US Meaning
Spoken
Visual
AE Accent
BE Accent
Visual

Experiment 3: Conclusions

Accent effect does NOT transfer to visual words

Either:

accent can only modulate spoken words

OR:

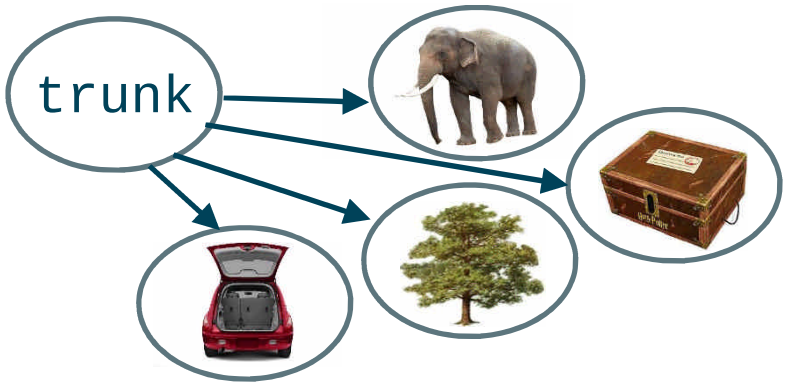
accent context only applies to items perceived as coming from the same speaker

Interim Summary

- Speaker accent modulates access to word meanings.
  - sufficient exposure to accents to acquire distributional statistics about lexical meanings.

- No direct influence of phonetic details.
  - Accent strength (strong vs. neutral) in Exp 2.
  - Effect not reduced for items with similar US/UK pronunciation (e.g., mate vs. quarter) in Exp 1.

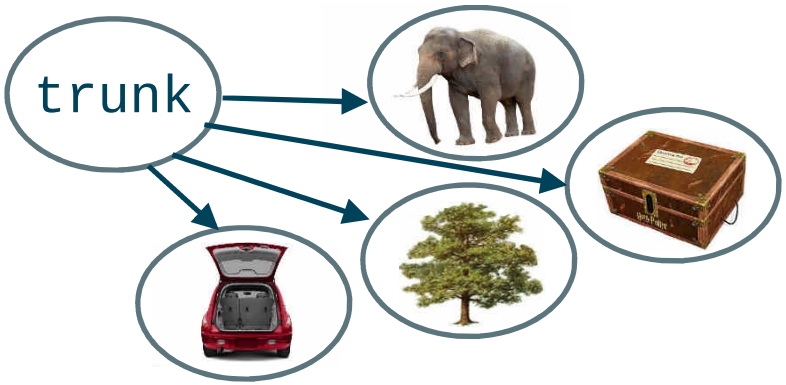
- Context effect may reflect use of a ‘speaker model’



Context is KING!

Fluent comprehension requires utilising multiple cues:

- Recent Experience
- Long-term Experience
- Speaker Characteristics
- etc etc etc…



Thank You!

Links to papers:

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