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A review of some experimental methods

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Overview

- A “cookbook” of different kinds of experiments
- Some standard designs in psycholinguistics
- Examples of applications
- Different types of data, different ways of measuring them

Behavioral data

- Two types of behavioral data in psycholinguistics
- Offline data: output of language processing
  - Productions: words, sentences, etc.
  - Grammaticality ratings
- Online data: course of language processing
  - Reaction time (one of the main foci today)
  - Eye movements (not dealt with today)
- Also, neurophysiological data: patterns of brain activation

On the menu today…

- Offline tasks

  Grammaticality rating task, sentence completion task, picture naming task

- Online techniques: reaction time studies

  Lexical decision task, self-paced reading task

- Common type of manipulation: priming

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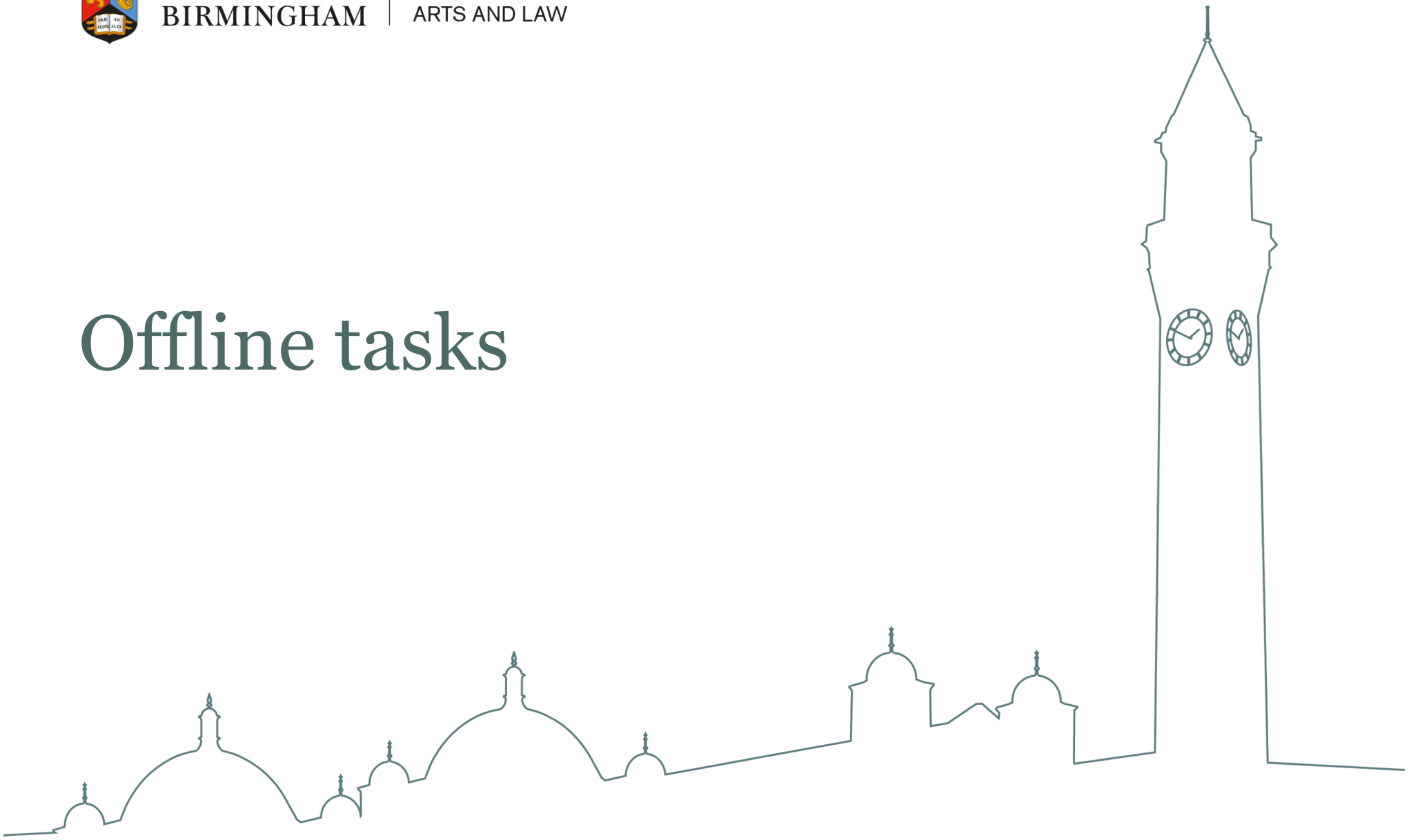
Offline tasks



Grammaticality rating task

- Typical type of data in linguistics
- Subjects are shown sentences and asked to rate them in terms of their well-formedness
- Typically rated on a scale (1-5 or 1-7) rather than binarily
- Likert scale: originally used to represent attitude

  "very good / good / neutral / bad / very bad"
- Replaces linguists' intuitions with a more intersubjective measure of grammaticality
- Can be used to investigate the factors influencing grammaticality for naive speakers

Sentence completion task

- Subjects have to complete some linguistic input that contains missing parts
- Either a sentence prompt (sentence continuation)

  The crook was arrested by …

  The teacher gave …

- Or gaps in sentences to fill with words (cloze test)

  Today, I went to the _____ and bought some milk and eggs. I knew it was going to rain, but I forgot to take my _____, and ended up getting wet on the way.

- Useful to study grammatical preferences of lexical items, or vice versa

Sentence completion task

- An example: Gries et al. (2005)
- Study of the verbs occurring in the *as*-predicative construction (e.g., *They see the problem as unsolvable*)
- They compare raw frequency of occurrence with collostruction strength (association measure)

	FREQUENCY: *high*	FREQUENCY: *low*
COLLSTRENGTH: *high*	*define, describe, know, recognize, regard, see, use, view*	*acknowledge, class, conceive, denounce, depict, diagnose, hail, rate*
COLLSTRENGTH: *low*	*keep, leave, refer to, show*	*build, choose, claim, intend, offer, present, represent, suggest*

Gries, S., B. Hampe, and D. Schönefeld (2005). Converging evidence: bringing together experimental and corpus data on the association of verbs and constructions. *Cognitive Linguistics* 16(4), 635–676.

Sentence completion task

- Experimental validation of collostructional analysis
- They presented participants with sentence prompts containing one of the *as*-predicative verbs, e.g.:

  The biographer depicted the young philosopher ...

- They looked at how likely participants were to complete the prompt with an *as*-PP
- *As*-predicative more likely to be produced with verbs with high collostruction strength than with high frequency

Picture naming task

- Subjects are presented with pictures
- They are asked to provide a description of each picture in a word or a sentence
- Can be used to investigate competition between lexical or grammatical variants
- Can also be used as an online technique of naming latency is measured (more precise for words than sentences)

Picture naming task

- Example: Ferretti et al. (2001)
- Subjects heard sentence fragments, e.g.:

  She arrested the (active fragment)

  She was arrested by the (passive fragment)
- Followed by a picture naming task
- Naming was faster if the picture showed a typical agent (for passives) or patient (for actives)
- Form of semantic priming

Ferretti, T., K. McRae, and A. Hatherell (2001). Integrating verbs, situation schemas, and thematic role concepts. *Journal of Memory and Language* 44, 516–547.

Picture naming task

She was arrested by the +  (cop)

faster than

She arrested the +

She arrested the +  (crook)

faster than

She was arrested by the +

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Reaction time studies

Reaction time studies

- Reaction time (RT) = the main source of behavioral data in psycholinguistics
- Time it takes to carry out a certain task
- Assumption: the complexity of the mental process involved is reflected in the response latency
- Usually measured in a computerized task
- I will mention two types of reaction time studies:
  - Lexical decision task
  - Self-paced reading task

Lexical decision task

- Participants are presented with character strings, some of which are words, some are not
- They have to decide as quickly as possible if the string is an actual word or not
- Non-words tend to follow the phonotactics of the language (e.g., in English: *moop*, but not *kfep*)

Lexical decision task

- Provides a measure of how easily different words are retrieved from memory
- Words in the stimuli would typically differ in terms of some variable(s) of interest: frequency, length, complexity, etc.
- Variants of the task make use of other kinds of decision about the word, e.g., animacy (Ferretti et al. 2001)

Ferretti, T., K. McRae, and A. Hatherell (2001). Integrating verbs, situation schemas, and thematic role concepts. *Journal of Memory and Language* 44, 516–547.

Self-paced reading task

- Subjects are presented with sentences that they have to read one word at a time, at their own pace
- When they have read one word, they press a key to advance to the next word
- Reaction time for each word is recorded
- Taken as a measure of incremental sentence processing

Self-paced reading task

- Self-paced reading is especially appropriate when there are strong expectations on initial parsing decisions
- E.g., garden-path effects:

  The horse raced past the barn fell.

  - The initial parse is likely to treat *raced* as the main verb
  - This analysis is invalidated at the word *fell*
  - Reanalysis must occur, resulting in longer processing
- Cf. *lead someone down the garden path*: give someone misleading cues or signals

Self-paced reading task

- Example: verbs taking clause or NP complement

  The student knew [the answer] by heart. (NP)

  The student knew [the answer was correct]. (clause)

- Temporary ambiguity: both analyses are available until after the NP (disambiguating region)
- Higher reaction time at the disambiguation region if the sentence differs from the expected analysis

Self-paced reading task

Clifton, C., L. Frazier, and C. Connine (1984). Lexical expectations in sentence comprehension. *Journal of Verbal Learning and Verbal Behavior* 23, 696–708.

Garnsey, S., N. Pearlmutter, E. Myers, and M. Lotocky (1997). The contribution of verb bias and plausibility to the comprehension of temporarily ambiguous sentences. *Journal of Memory and Language* 37, 58–93.

Hare, M., K. McRae, and J. Elman (2003). Sense and structure: Meaning as a determinant of verb subcategorization preferences. *Journal of Memory and Language* 48, 281–303.

Pickering, M., M. Traxler, and M. Crocker (2000). Ambiguity resolution in sentence processing: Evidence against frequency-based accounts*. Journal of Memory and Language* 43, 447–475.

Trueswell, J., M. Tanenhaus, and C. Kello (1993). Verb-specific constraints in sentence processing: Separating effects of lexical preference from garden-paths. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 19 (3), 528–553.

Wilson, M. P., and S. M. Garnsey. (2009). Making simple sentences hard: Verb bias effects in simple direct object sentences. *Journal of Memory and Language* 60, 368–392.

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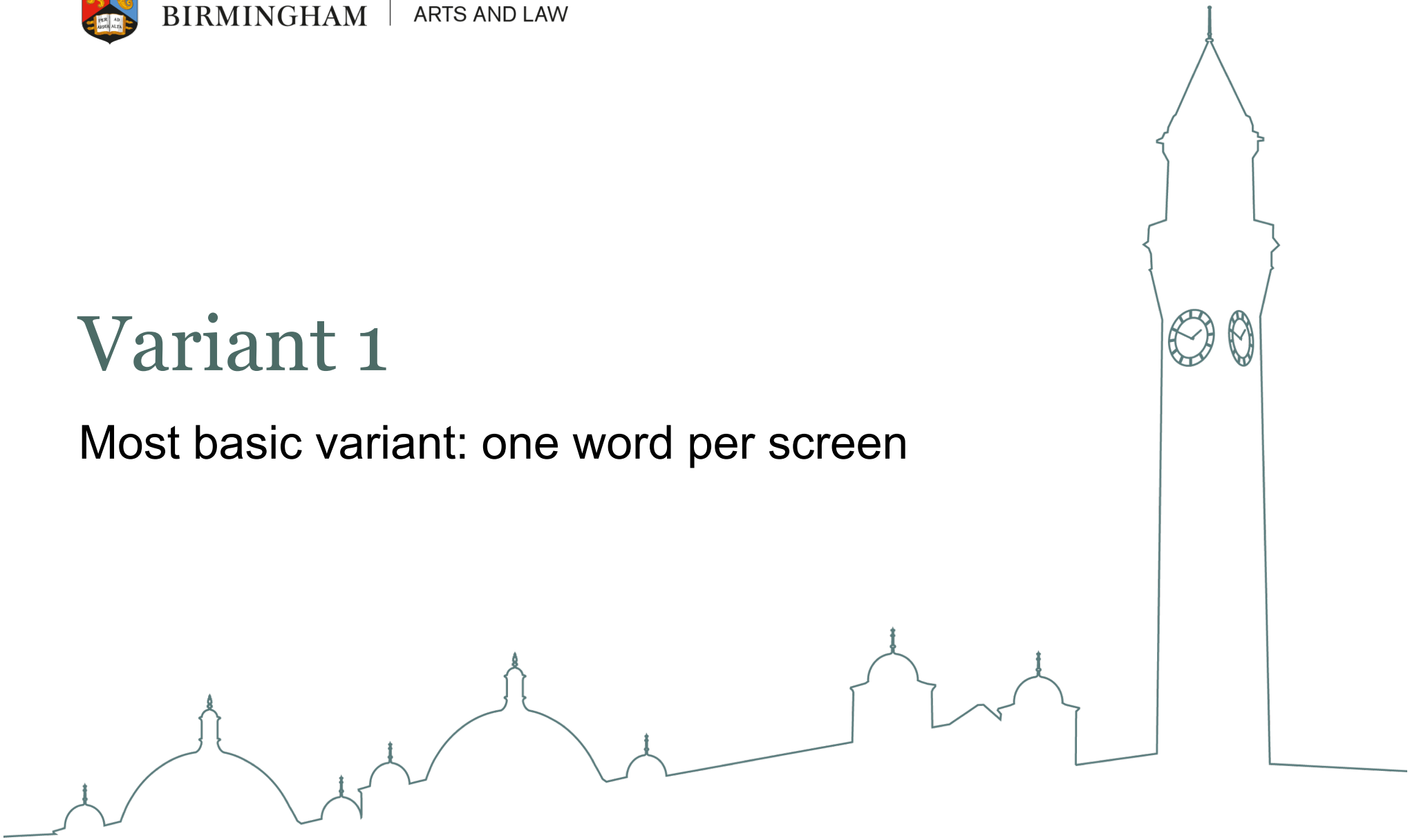
Variant 1

Most basic variant: one word per screen



The

student

knew

the

answer

was

correct.

Self-paced reading task

- Comprehension questions are often added after some or all of the sentences

  e.g., Was the answer right? (yes/no)

- This is to make sure that participants actually read and process the sentences and do not simply tap through
- Participants or trials can be left out of the analysis if performance with the questions is not satisfactory

Self-paced reading task

- Limitation: very unnatural way to read text
- Tendency for participants to “whizz through” the sentences without processing each word individually
- Problem reduced by comprehension questions, but not fully avoided
- “Wait and see” strategy: processing by chunks, resulting in rapid tapping followed by a pause
- “Overspill” effect: differences in reaction time can spread after the critical region

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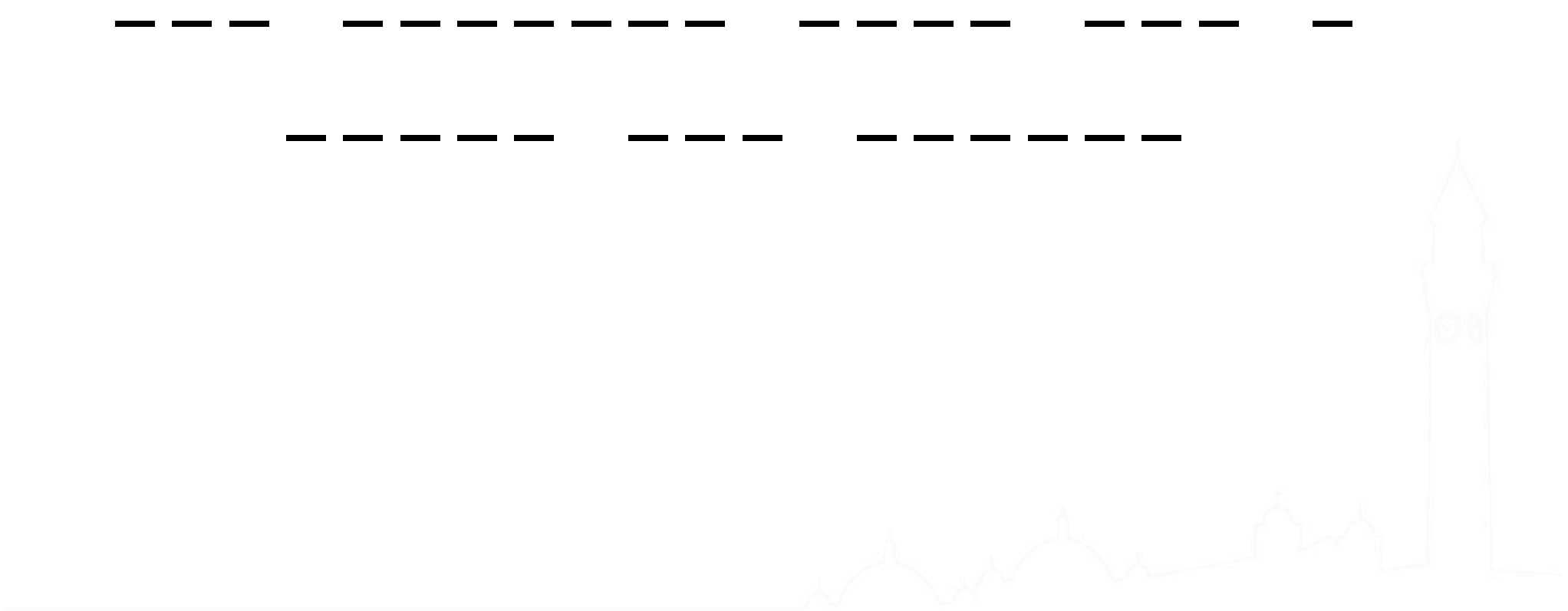
Variant 2

Moving window

Self-paced reading: moving window

- All words in the sentence are initially replaced by “masks” made of the same nondescript character (e.g., ‘-’, ‘*’)
- Each word is shown individually one at a time in its actual position in the sentence
- With each key press, the next word is displayed and the current word reverts to the mask



The ------- ----- --- -

----- --- ------

--- student ---- --- -
----- --- ------

--- -------- knew --- -

----- --- ------

--- -------- ---- the -
----- --- ------

--- ------- ---- ---

answer --- ------

--- -------- ----- --- -

----- was ------

--- -------- ---- --- -

----- --- wrong.

Self-paced reading: moving window

- More natural way of reading
- The “windowing” forces incremental processing
- Comprehension questions are still necessary
- Spillover effects can still be found
- Currently the most popular variant

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Variant 3

Sentence maze

Self-paced reading: sentence maze

- Proposed by Forster (2010)
- In each trial, participants are presented with two words
- Only one of these words makes a well-formed continuation of the sentence
- They must select the right continuation in order to advance in the sentence
- If they pick the wrong word, the current trial ends

Forster, K. (2010). Using a maze task to track lexical and sentence processing. *The Mental Lexicon* 5(3), 347–357.
Forster, K., C. Guerrera, and L. Elliot (2009). The maze task: Measuring forced incremental sentence processing time. *Behavior Research Methods* 41(1), 163–171.

The --

and student

ocean knew

the dress

answer

must

organic was

bottle.

wrong.

Self-paced reading: sentence maze

- Less natural way of reading, stimuli harder to design
- But forces subjects into strictly word-by-word processing
- No need for comprehension questions, since they can't advance without actually reading the sentence
- "Clean" data with little noise, better able to detect the subtlest differences in RT than the other variants
- (although some data can be lost due to trial failures)

Self-paced reading: sentence maze

- Variant: alternative words are non-words (e.g., *moop*) instead of ungrammatical continuations
- Equivalent to a sentence-long lexical decision task
- Easier to design but less tied to sentence processing

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Priming

Priming experiments

- Technically not a type of experiment, but rather a type of manipulation
- Priming = effect of the exposure to one type of stimulus (the **prime**) on the subsequent processing of another type of stimulus (the **target**)
  - Positive priming: prime facilitates processing of target
  - Negative priming: prime hinders processing of target

Priming experiments

- Often interpreted as revealing some kind of relationship between the mental representations of prime and target
- Positive priming suggests that the representations of prime and target have something in common
- Negative priming suggests some conflict between the representations of prime and target
- Two types of priming effects:
  - Increase/decrease in the likelihood of producing a particular kind of response
  - Shorter/longer reaction times to a certain kind of target

Priming in lexical decision tasks

- The stimuli list can be manipulated so that consecutive words are related in some way
- Does recognizing the first word facilitate recognizing the second, related word?
- Semantically related words: *hospital* - *nurse*
- Collocations: *cause* - *problems*

Syntactic priming

- Bock (1986): syntactic structures can be primed as well
- In each trial, participant heard a sentence that they had to repeat (prime)
- They then were presented with a picture that they had to describe in a sentence (target)
- Participants were more likely to describe the picture using the same structure as the prime than another variant

Bock, K. (1986). Syntactic persistence in language production. *Cognitive Psychology* 18(3), 355–387.

Syntactic priming

- Transitive primes

  Active: *One of the fans punched the referee.*

  Passive: *The referee was punched by one of the fans.*

- Ditransitive primes

  Prepositional: *The lifeguard tossed a rope to the struggling child*.

  Double object: *The lifeguard tossed the struggling child a rope*.

Syntactic priming

- Transitive pictures: could be described by either an active or passive sentence

  The lightning struck the church.

  The church was struck by the lightning.

  Preceded by a transitive prime

- Ditransitive pictures: could be described by a prepositional object or double object sentence

  The man reads a story to the child.

  The man reads the child a story.

  Preceded by a ditransitive prime

Syntactic priming

- Both pictures types were more likely to be described with a sentence matching the prime than the alternative
- It could just be a parallelism between sentence types rather than priming of syntactic structure
- Bock & Loebell (1990) report evidence in favor of the latter

Bock, J. K., and H. Loebell. (1990). Framing sentences. *Cognition* 35, 1–39.

Syntactic priming

- Prepositional dative vs. *to*-locative primes:

  The wealthy widow gave an old Mercedes to the church.

  The wealthy widow drove an old Mercedes to the church.

  … equally prime prepositional datives

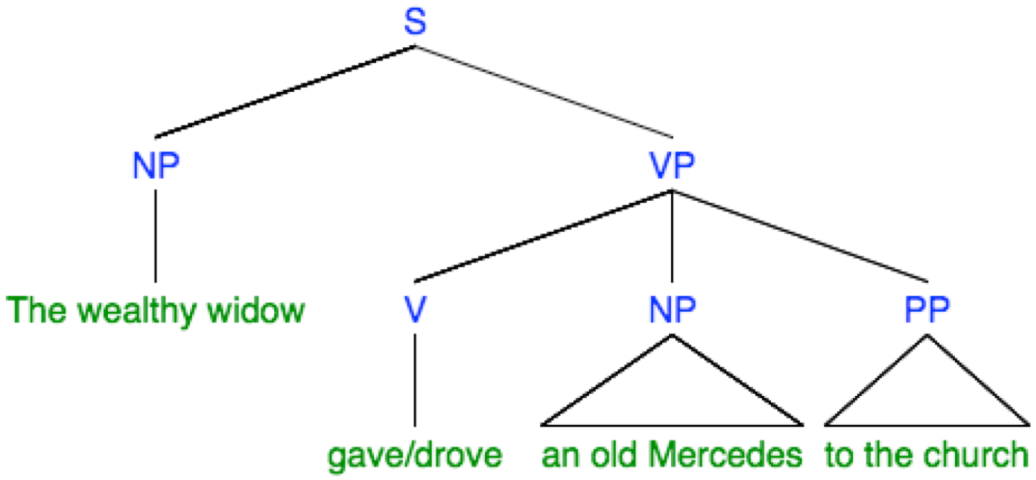
- Passives vs. *by*-locative primes:

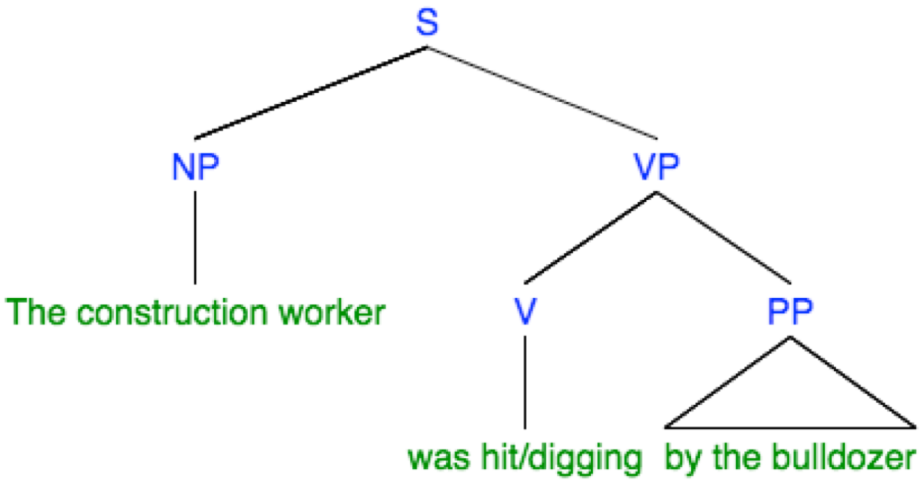
  The construction worker was hit by the bulldozer.

  The construction worker was digging by the bulldozer.

  … equally prime passives

Syntactic priming





- Same syntactic structure, different meaning/construction
- Syntactic structure triggers priming regardless of meaning

Purely syntactic priming?

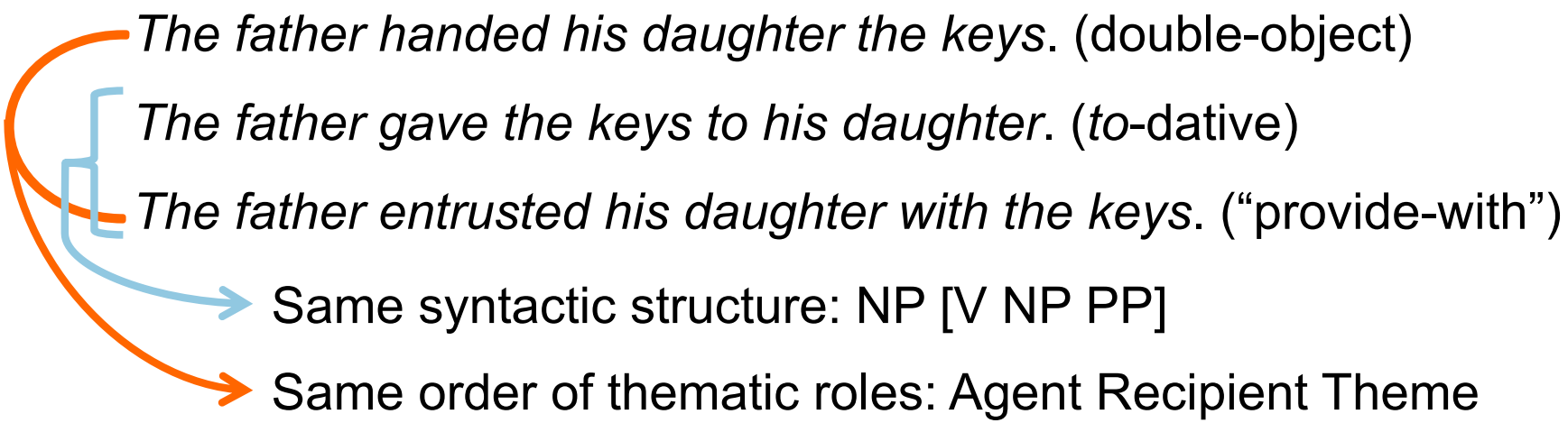
- But prepositional datives can be shown to be semantically related to locative uses of *to* (cf. Goldberg 1995)
- Some of their *to*-locative primes could actually be considered datives

  e.g., The hospital returned the bill to the patient by mistake.
- All the *by*-locative primes had the same lexical make-up, parallel to that of the passives: *was* V *by*
- Maybe these factors explain the lack of difference in priming effects
- Syntactic priming may not be purely syntactic after all

Goldberg, A. (1995). *Constructions: a construction grammar approach to argument structure*. Chicago: University of Chicago Press.

Purely syntactic priming?

- Can semantics also be involved in priming sentences?
- Hare & Goldberg (2000): three kinds of primes



- Picture description task à la Bock (1986)
- "Provide-with" sentences prime double-objects as much as double-objects themselves

Hare, M. L., & Goldberg, A. E. (2000). Structural priming: purely syntactic? In M. Hahn, & S. C. Stones (Eds.), (pp. 208 – 211). Proceedings of the twenty-first annual meeting of the Cognitive Science Society, Mahwah, NJ: Lawrence Erlbaum Associates.

Purely syntactic priming?

- Chang, Bock & Goldberg (2003) report similar findings using rapid serial visual presentation (RSVP)
- RSVP (Potter & Lombardi 1998):
  - Participants had to read a sentence word by word silently
  - Distractor task: array of digits shown briefly, asked to say if a certain digit was in it (e.g., 4 5 2 9 1, “was ‘two’ in it?”)
  - They were asked to repeat the sentence out loud
- Priming effects: participants change the sentence using the structure of the previous sentence (if possible)

Chang, F., K. Bock, and A. Goldberg. (2003). Do thematic roles leave traces of their places? *Cognition* 90, 29–49.
Potter, M. C., and L. Lombardi. (1998). Syntactic priming in immediate recall of sentences. *Journal of Memory and Language* 38(3), 265–282.

Purely syntactic priming?

- Potter & Lombardi (1998) found priming effects in RSVP task: participants sometimes changed the sentence using the structure of the previous sentence (if possible)
- Chang et al.'s (2003) stimuli
  - Pairs of prime and target exemplifying two constructions

    The chef sprayed oil onto the pan. (theme-location)

    The chef sprayed the pan with oil. (location-theme)
  - Same syntactic structure, different thematic roles
  - If priming is purely syntactic, both types of sentences should equally prime targets of both kinds

Purely syntactic priming?

- This is not what Chang et al. found
- Thematic role overlap significantly increased priming
- Semantic aspects of sentences can also trigger priming
- Taken as evidence for form-meaning pairs in sentence representation (Goldberg & Bencini 2005)

Goldberg, A. and G. Bencini. (2005). In Tyler, A., Takada, M., Kim, Y., & Marinova, D. (eds.), *Language in Use: Cognitive and Discourse Perspectives on Language and Language Learning* (pp. 3-18). Washington, D.C.: Georgetown University Press.