From graded ratings to binary decisions: A case study on argument alternations in German

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Starting point

People are able to give gradient judgments on grammaticality.
(see Fanselow et al., 2006, for an overview of experimental research)

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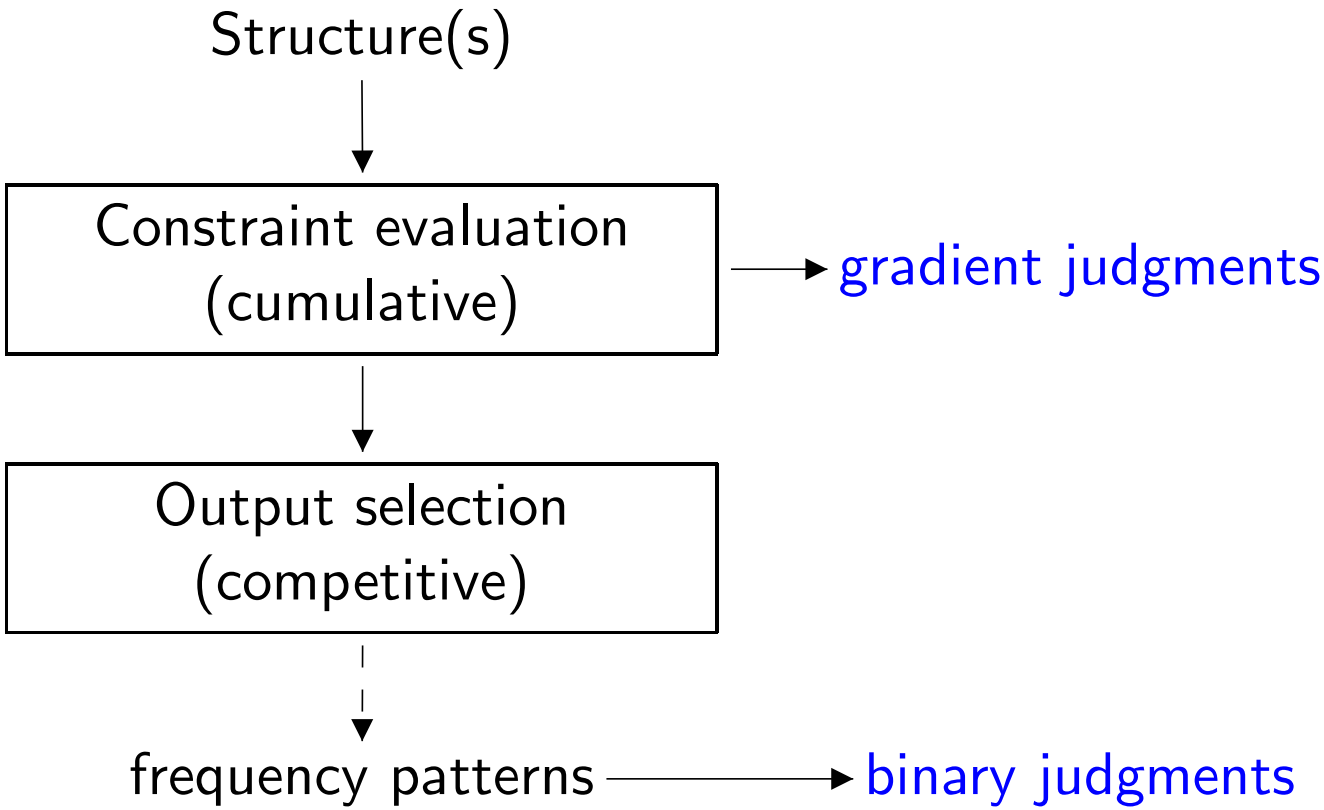
- language production?
- binary grammaticality judgments?

The Decathlon Model

(Featherston, 2005)



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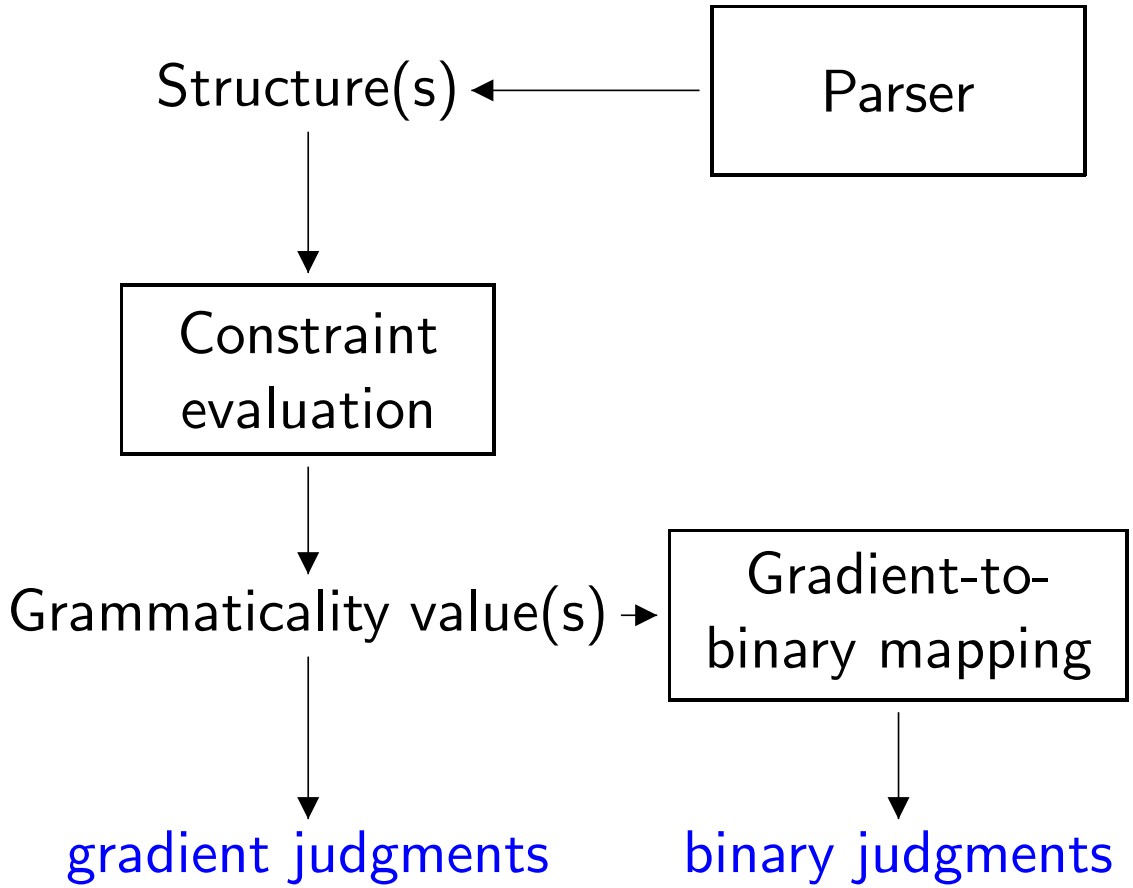

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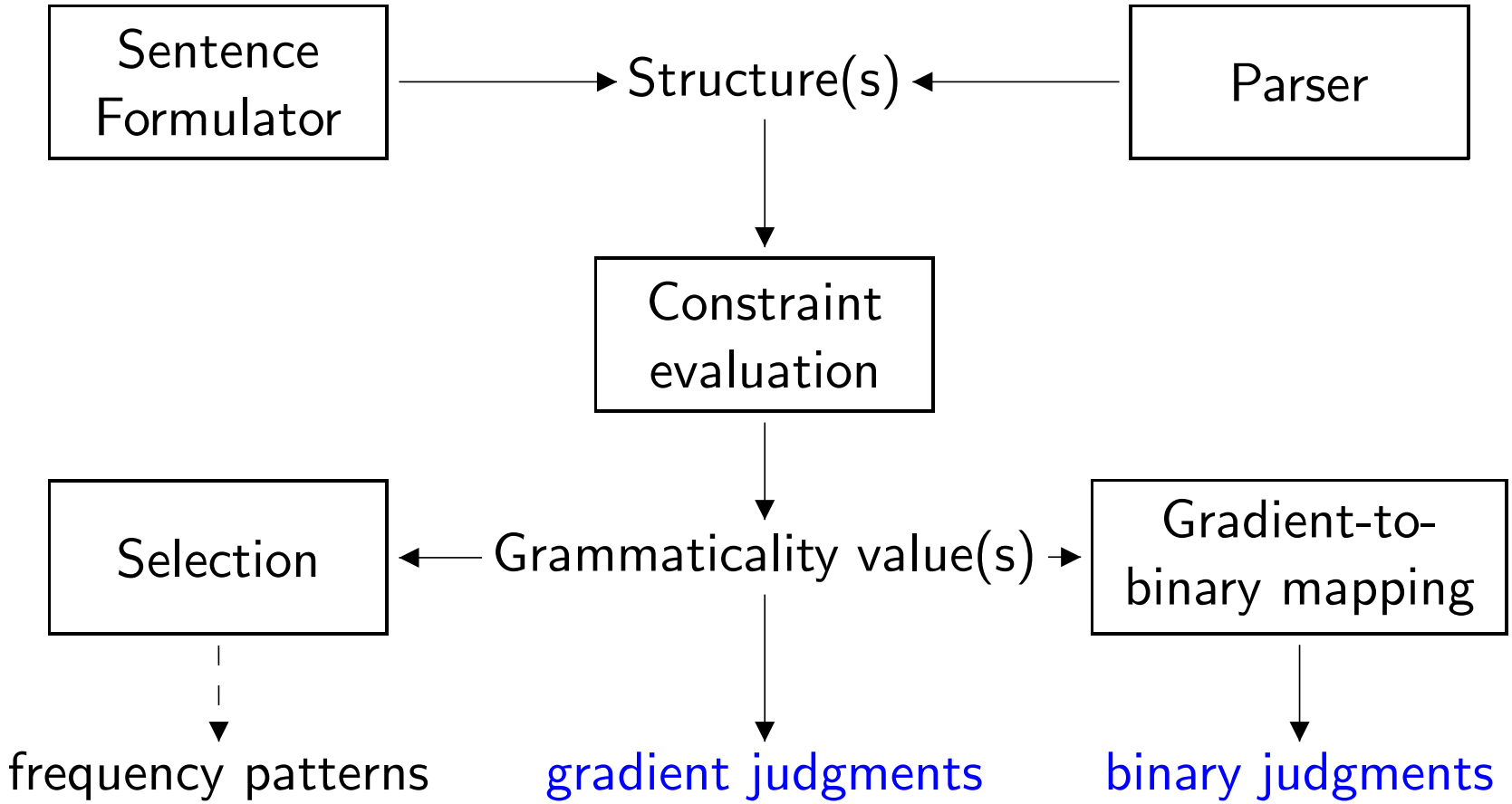

Outline

Ditransitive verbs in German

(1) . . . dass er dem Mann ein Buch schickte.
that he.NOM the.DAT man a.ACC book sent
'. . . that he sent a book to the man.'

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Ditransitive verbs are suitable because . . .
argument alternations are subject to verb-specific restrictions in a gradual way:

- Optionality of the dative object
- Compatibility with the so-called *bekommen* passive

Ditransitive verbs in German

Dropping the dative object:

(2) … dass er ~~dem Mann~~ ein Buch schickte.
that he.NOM ~~the.DAT man~~ a.ACC book sent
'…that he sent a book.'

Ditransitive verbs in German

Dropping the dative object:

(2) . . . dass er ~~dem Mann~~ ein Buch schickte.
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(3) ?. . . dass er ~~dem Mann~~ ein Buch anvertraute.
that he.NOM ~~the.DAT man~~ a.ACC book entrusted
'. . . that he entrusted a book.'

Ditransitive verbs in German

Bekommen passive:

(4) . . . dass der Mann das Buch geschickt *bekam*.
that the.NOM man the.ACC book sent got
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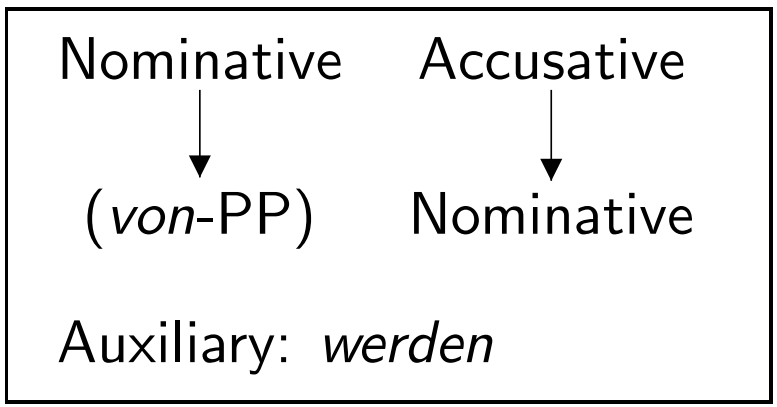
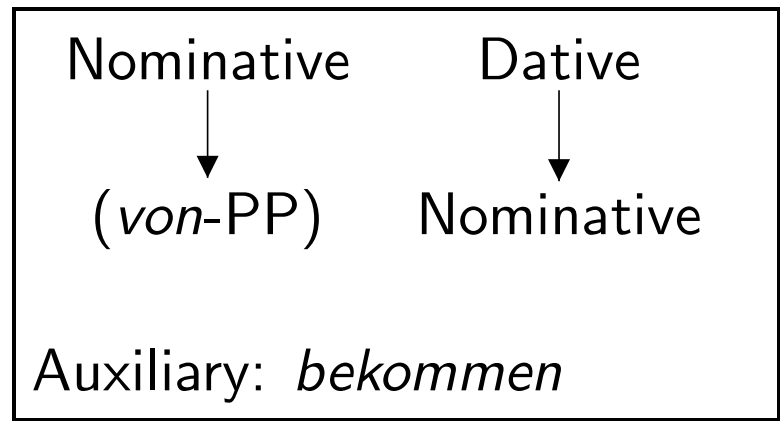


Bekommen passive



Ditransitive verbs in German

Bekommen passive:

(5) . . . dass der Mann das Buch geschickt *bekam.*
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Outline

Experiments 1 & 2

(9) *Active*

dass der Vermieter letztes Jahr (dem Sohn) das Haus vererbte.
that the landlord last year the son the house left
'that the landlord left the house (to the son) last year.'

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- 36 participants in each experiment

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- First, a reference item is presented to which the participant assigns an arbitrary numeric value (> 0).
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Experiment 2: Speeded Grammaticality Judgments

- Word-by-word presentation in the middle of the screen
- Presentation time for each word: ca. 300–400 ms
- End-of-sentence judgments with a deadline of 2000 ms

Experiment 1 & 2

Mean ME scores in Experiment 1 (log ratios).

	Active	Regular passive	*Bekommen* passive
3 Args.			
2 Args.			

Mean percentages of judgments 'grammatical' in Experiment 2.

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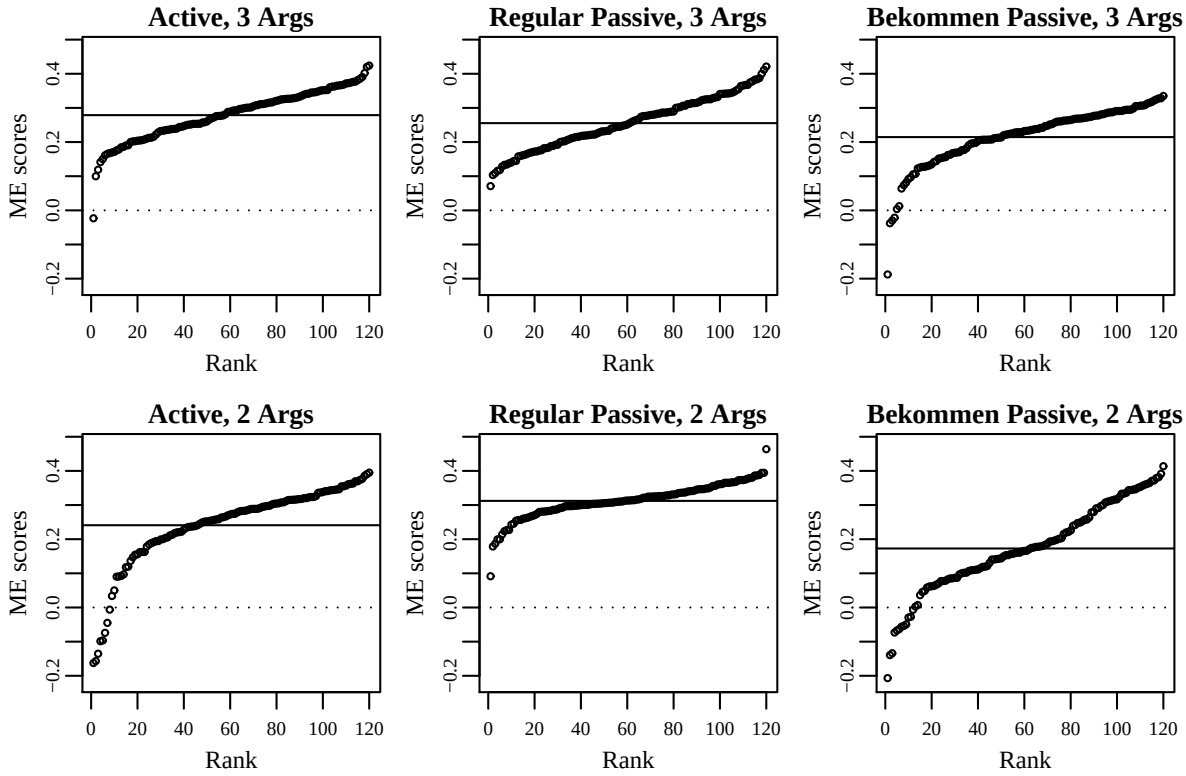

Rank-ordered distribution of mean ME scores for the 120 verbs.

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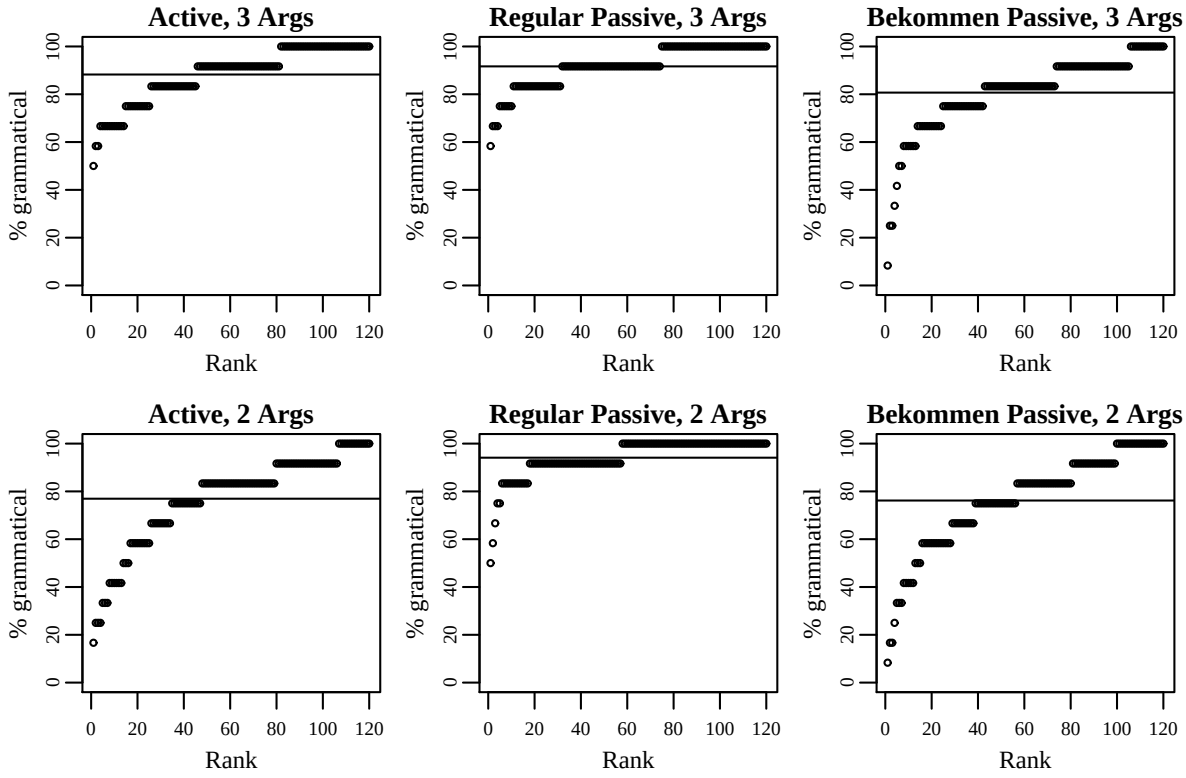

Rank-ordered distribution of mean percentages of judgments 'grammatical' for the 120 verbs used in Experiment 2.

From gradient to binary judgments

Do gradient grammaticality scores predict binary judgments?

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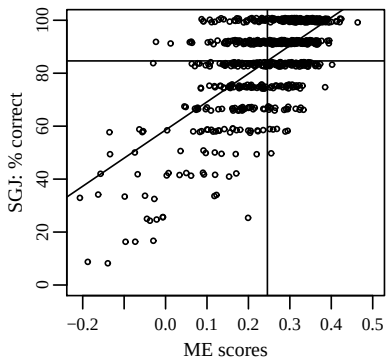
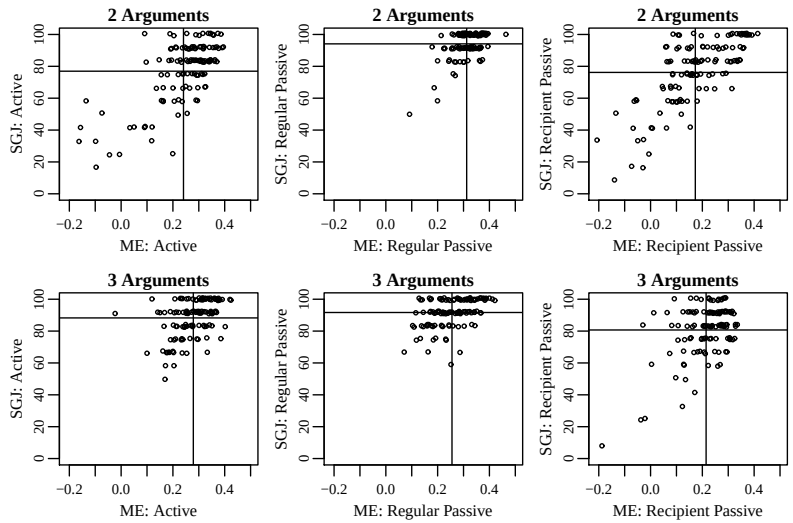
All 720 data points
(120 verbs in 6 conditions;
Kendall's $\tau = 0.42$)



120 data points (verbs) per condition
(Kendall's τ from 0.19 to 0.55)



SGJ results plotted against ME results

From gradient to binary judgments

Logistic regression with mixed-effect modeling:

- results of Experiment 2 (SGJ) as predicted variable
- results of Experiment 1 (ME) as predictor variable
- participants and items as random effects

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Results of logistic regression:

- ME scores are a highly significant predictor of SGJ results
- Somers' C $= 0.82$ (n $= 8640$)

Outline

Corpus Analysis

deWaC (cf. Baroni et al., 2009)

- German part of Wacky
- built by web crawling
- 1.7 billion tokens of text
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For comparison:
Tiger Treebank (Release 2): about 880,000 tokens in ca. 50,000 sentences
For 29 out of the 120 verbs, it does not even contain the past participle form
(*http://www.ims.uni-stuttgart.de/projekte/TIGER*)

Corpus Analysis

Raw corpus counts:

- verb frequencies: lemma frequencies based on the lemma information contained in DeWac
- bigram frequencies:
  - regular passive: past participle + *werden* (lemma)
  - *bekommen* passive: past participle + *bekommen* (lemma)
  - active: finite or non-finite verbform in clause-final position
    past participle + *haben* (lemma)
    infinitive + modal verb (lemma)

Grammaticality and frequency

Frequency counts for active, regular passive and *bekommen* passive bigrams

Verb frequencies	Mean	Range	Total
	85,214	30–2,596,534	10,225,623

Bigram frequencies	Mean	Range	Unseen bigrams	Rank Correlations (Lemma-Bigram)
Active				
Regular passive				
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Bekommen passive	91			

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Regular passive	4530	3–58169		
Bekommen passive	91	0–2502		

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Bigram frequencies	Mean	Range	Unseen bigrams	Rank Correlations (Lemma-Bigram)
Active	16549	1–427714	0	.84**
Regular passive	4530	3–58169	0	.74**
Bekommen passive	91	0–2502	15	.28**

Grammaticality and frequency

Rank correlations (Kendall's tau) between experimental grammaticality scores and different relative frequency measures.

		Active		Regular passive		*Bekommen* passive	
	All	3 Args	2 Args	3 Args	2 Args	3 Args	2 Args
Bigram ratios	.23**	-.07	.05	-.01	.12	.31**	.36**

Grammaticality and frequency

(12) expected construction frequency for v_n

$$= f(lemma_n) \times p(construction)$$

$$= f(lemma_n) \times \frac{f(construction_{total})}{f(lemma_{total})}$$

(13) Probability of a verb to occur in the *bekommen* passive

$$= \frac{f(bekommen_{total})}{f(lemma_{total})} = 10{,}929/10{,}225{,}623 = 0.00107$$

(14) observed-to-expected-ratio for v_n

$$= \frac{observed\ bigram\ frequency(v_n)}{expected\ bigram\ frequency(v_n)}$$

Grammaticality and frequency

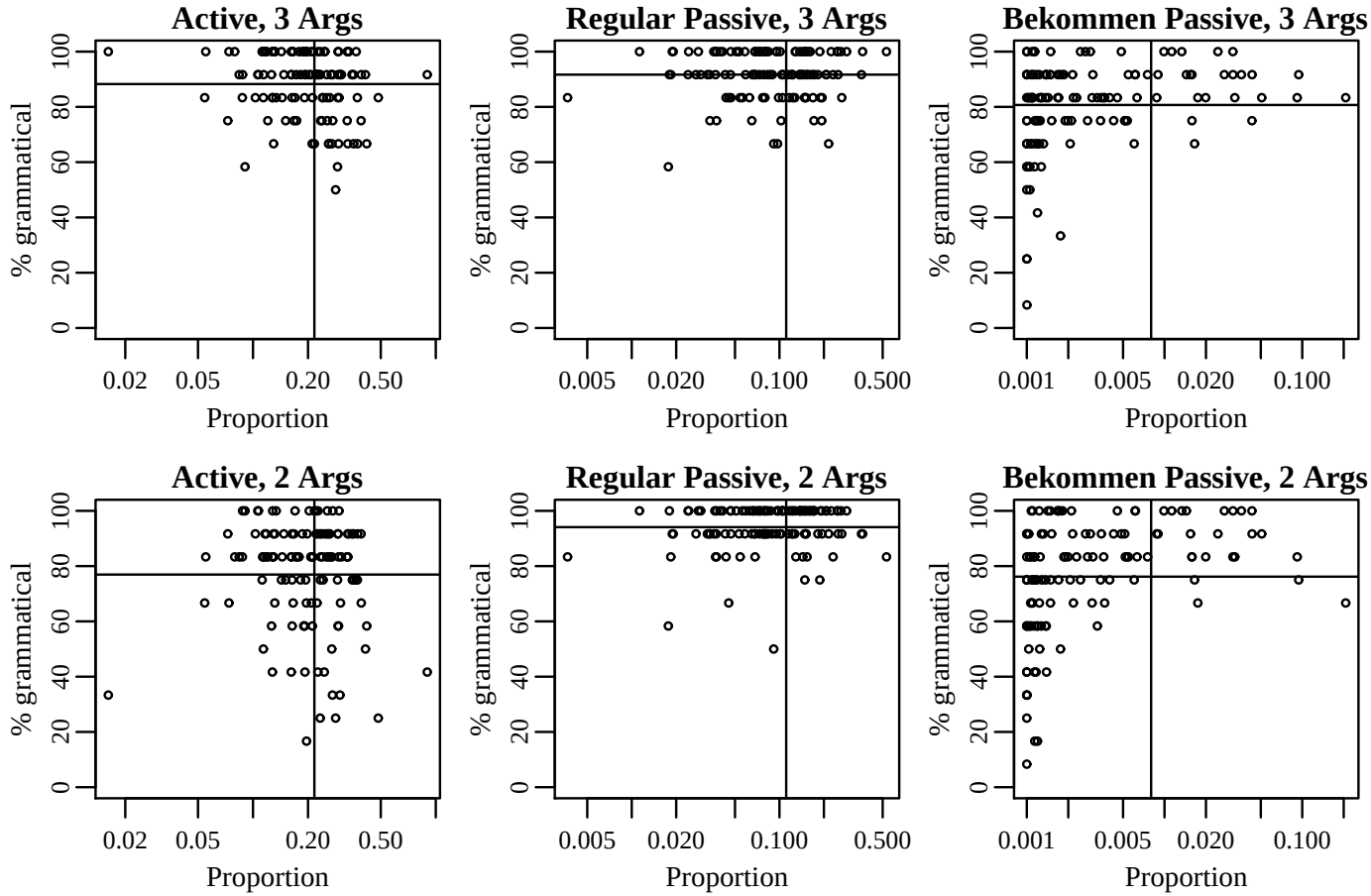
(15) a. expected bigram frequency for *schicken*
$= 0.00107 \times 78443 = 84$

b. expected bigram frequency for *stehlen*
$= 0.00107 \times 20463 = 22$

(16) a. observed-to-expected ratio for *schicken* $= 235/84 = 2.8$

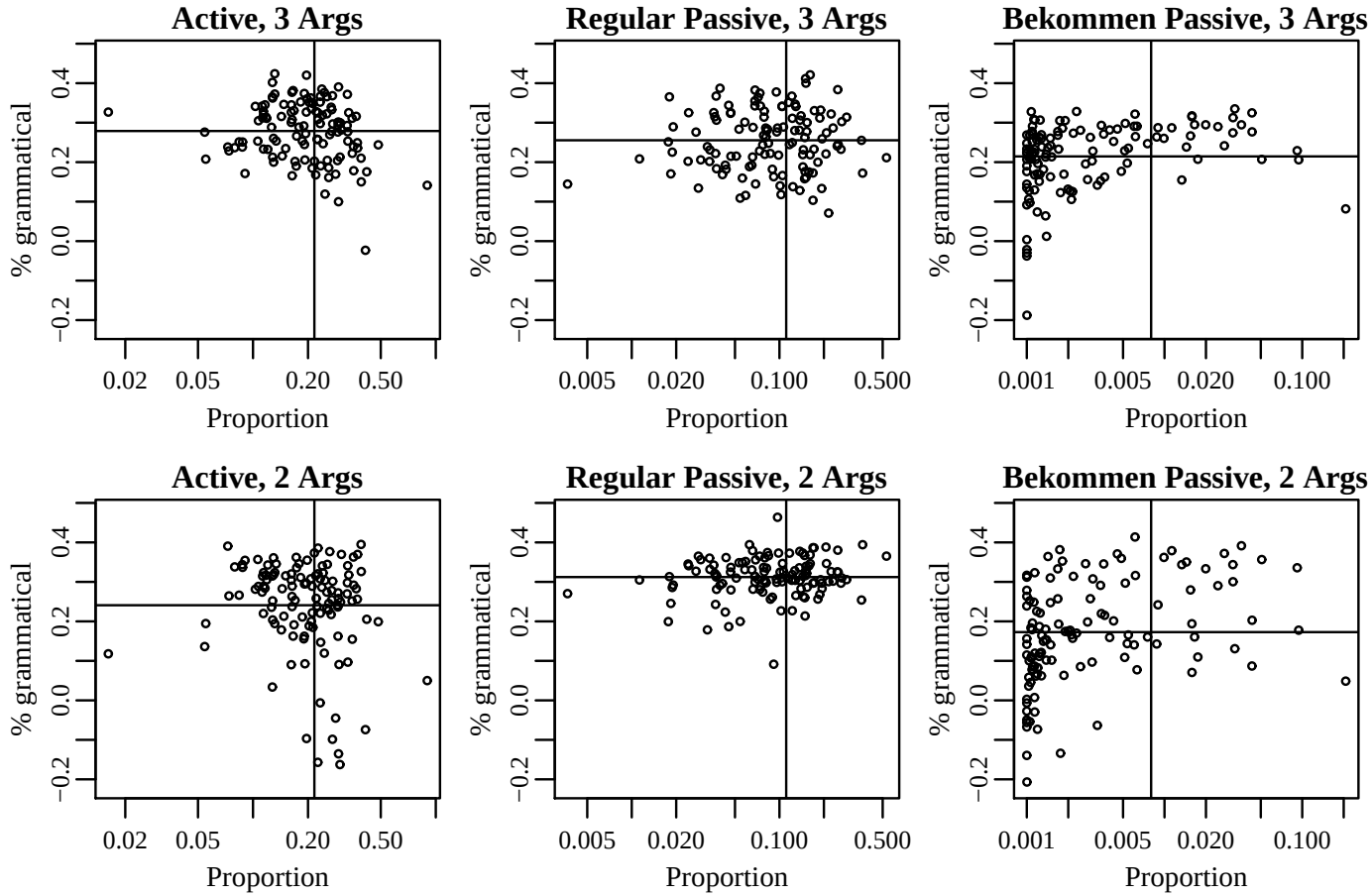
b. observed-to-expected ratio for *stehlen* $= 4/22 = 0.18$

Grammaticality and frequency



Experimental grammaticality scores (SGJ) plotted against observed-to-expected ratios. The 120 data points in each plot represent the 120 verbs investigated in the experiment.

Grammaticality and frequency



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Grammaticality and frequency

Summary:

- There are systematic correlations between grammaticality and frequency:
  - Degraded grammaticality implies low frequency
  - High frequency implies high grammaticality
- There are also systematic mismatches:
  - High grammaticality does not imply high frequency.
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- 'High grammaticality and low frequency' occurs often.
- 'High frequency and low grammaticality' occurs rarely.

(for similar results see Arppe & Järvikivi, 2007)

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From grammaticality to language use

Hypothesis:

Grammaticality determines language use, not the other way round.

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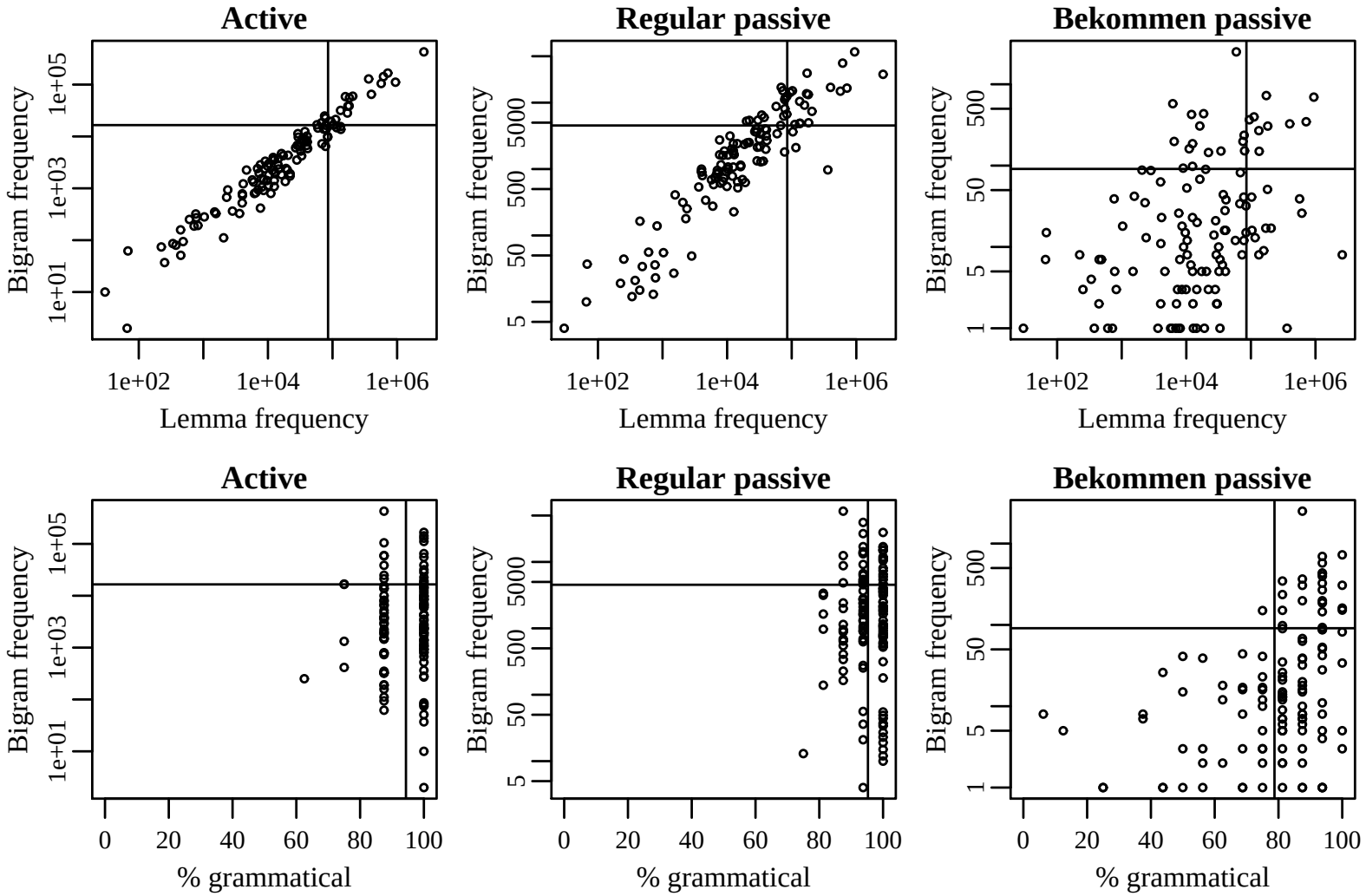

Bigram frequency plotted against verb frequency (upper row) and against experimental grammaticality scores (lower row).

From grammaticality to language use

Results of Poisson regression with bigram frequency as predicted variable and either grammaticality alone, verb frequency alone or grammaticality and verb frequency together. The columns labeled 'Reduction' gives the reduction in deviance achieved by the respective model.

	Active		Regular passive		*Bekommen* Passive	
Null deviance	5701182		959280		19741	
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Grammaticality	2505	.00	8016	.00	5907	.19

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Frequency	5492666	.95	734056	.57	3567	.12

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Frequency	5492666	.95	734056	.57	3567	.12
Grammaticality & Frequency	5493190	.95	734365	.56	10508	.47

Outline

Experiment 3

Was gibt es Neues von Robert? ('What's new about Robert?')

☐ Robert hat unserem Opa einen Rasenmäher überreicht.
R. has our.DAT grandpa a lawnmower handed-over
'Robert handed over a lawnmower to our grandpa.'

☐ Von Robert hat unser Opa einen Rasenmäher überreicht bekommen.
By R. has our.NOM grandpa a lawnmower handed-over got
'By Robert, our grandpa was handed over a lawnmower.'

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- forced-choice selection
  (cf. Rosenbach, 2005; Bresnan, 2007; Arppe & Järvikivi, 2007)
- choice btw active sentence and *bekommen*-passive sentence
- order of the two answers was systematically varied
- context question establishes a topic (Agent or Recipient)

Experiment 3

Was gibt es Neues von eurem Opa? ('What's about your grandpa?')

☐ Unserem Opa hat Robert einen Rasenmäher überreicht.
our.DAT grandpa has R. a lawnmower handed-over
'To our grandpa, Robert handed over a lawnmower.'

☐ Unser Opa hat von Robert einen Rasenmäher überreicht bekommen.
our.NOM grandpa has by R. a lawnmower handed-over got
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  (cf. Rosenbach, 2005; Bresnan, 2007; Arppe & Järvikivi, 2007)
- choice btw active sentence and *bekommen*-passive sentence
- order of the two answers was systematically varied
- context question establishes a topic (Agent or Recipient)

Experiment 3

Was gibt es Neues von eurem Opa? ('What's about your grandpa?')

☐ Unserem Opa hat Robert einen Rasenmäher überreicht.
our.DAT grandpa has R. a lawnmower handed-over
'To our grandpa, Robert handed over a lawnmower.'

☐ Unser Opa hat von Robert einen Rasenmäher überreicht bekommen.
our.NOM grandpa has by R. a lawnmower handed-over got
'Our grandpa was handed over a lawnmower by Robert.'

- forced-choice selection
  (cf. Rosenbach, 2005; Bresnan, 2007; Arppe & Järvikivi, 2007)
- choice btw active sentence and *bekommen*-passive sentence
- order of the two answers was systematically varied
- context question establishes a topic (Agent or Recipient)
- 24 sentences (24 verbs)
- 48 participants

Experiment 3

Topic = Agent

active sentence	**SU** Vfin IO DO V
bekommen passive	by-phrase Vfin **SU** DO V

Topic = Recipient

active sentence	IO Vfin **SU** DO V
bekommen passive	**SU** Vfin by-phrase DO V

Experiment 3

Topic = Agent

active sentence	**SU** Vfin IO DO V
bekommen passive	by-phrase Vfin **SU** DO V

Topic = Recipient

active sentence	IO Vfin **SU** DO V
bekommen passive	**SU** Vfin by-phrase DO V

(18) Prominence hierarchies

a. Syntactic Function Hierarchy: Subject $\succ$ Object
b. Semantic Role Hierarchy: Agent $\succ$ Recipient
c. Thematic (discourse) Hierarchy: Topic $\succ$ $\neg$Topic

Experiment 3

Topic = Agent

active sentence	**SU** Vfin IO DO V
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(18) Prominence hierarchies

a. Syntactic Function Hierarchy: Subject $\succ$ Object
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- The topic may preferentially be realized as the subject:
  - Active voice for agent topics
  - *Bekommen* passive for recipient topics

Experiment 3

(19) -grammatical, - frequent
geben, glauben, stehlen, klauen, beschaffen, besorgen, kaufen ersparen

(20) +grammatical, - frequent
hinterlegen, zeigen, absprechen, zubereiten, schildern, erzählen, vorlegen, vorsingen

(21) +grammatical, +frequent
verschreiben, zustecken, zurückbezahlen, zuspielen, bewilligen, spendieren, zusenden, erstatten

- The probability of choosing the *bekommen* passive may depend on the verb's grammaticality score and or the bigram frequency

Experiment 3

. Percentages of choice 'topic=subject' (preliminary results, n = 40)

	Verb in the bekommen passive		
Topic	+ grammatical, + frequent	+ grammatical, - frequent	- grammatical, - frequent
Agent	95	96	97
Goal	85	72	43

Experiment 3

. Percentages of choice 'topic=subject' (preliminary results, n = 40)

	Verb in the bekommen passive		
Topic	+ grammatical, + frequent	+ grammatical, - frequent	- grammatical, - frequent
Agent	95	96	97
Goal	85	72	43

- strong preference for realizing the topic as subject:
  - Agent topics: 96%
  - Recipient topics: 65%
- The probability of choosing the *bekommen* passive depends on the verb's grammaticality score and its frequency properties

Outline

Conclusions

How do graded grammaticality ratings relate to . . .

1. language comprehension?
2. language production?
3. binary grammaticality judgments?

Conclusions

How do graded grammaticality ratings relate to . . .

1. language comprehension?
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ad ①

- The grammar is gradient itself, i.e. gradient judgments are not a mere epiphenomenon caused by language comprehension mechanisms. (see also Pater, 2009)
- We observe gradient judgments even when the material is controlled for performance factors
  Note. The experimental sentences are closely matched for length, complexity etc.

Conclusions

How do graded grammaticality ratings relate to . . .

1. language comprehension?
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ad ②

Conclusions

How do graded grammaticality ratings relate to . . .

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ad ②

- Grammaticality and frequency do not always go hand in hand.
- Production frequencies do neither predict gradient judgments nor binary judgments.
- Grammaticality is one of the factors determining by frequency.

Conclusions

How do graded grammaticality ratings relate to . . .

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Conclusions

How do graded grammaticality ratings relate to . . .

1. language comprehension?
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ad ③

- Gradient judgments are highly predictive for binary judgments.
- Binary grammaticality judgments can be derived directly from gradient judgments. (cf. Bader & Häussler, 2010)

Thank you

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