



Repeated measures ANOVA

Pronoun interpretation
in direct and indirect speech

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Overview

1. Experimental design
2. Statistical tests
3. Results
4. Discussion



1. Experimental design



Introduction to direct and indirect speech

Direct speech	Aap zei "Ik krijg de auto". Monkey said, "I get the car".
Indirect speech	Aap zei dat hij de auto krijgt. Monkey said that he gets the car.

Syntactic cues:

- Direct speech: verb-second word order
- Indirect speech: dat-complementizer, verb-final word order

Phonetic cues:

- Direct speech: pause between reporting clause and report, change of voice



Introduction to direct and indirect speech

Direct speech	Aap zei "Ik krijg de auto". Monkey said, "I get the car".
Indirect speech	Aap zei dat hij de auto krijgt. Monkey said that he gets the car.

Perspective:

- Direct speech: shift from actual to original speaker's perspective
- Indirect speech: actual speaker's perspective



Experimental design

Experimental subjects must interpret the deictic pronouns *ik* ('I'), *jij* ('you') and *hij* ('he'). Pronouns are either not embedded (no report baseline) or embedded in direct or indirect speech.

Independent variables:

1. reporting type (no report, direct speech, indirect speech)
2. type of pronoun (1p, 2p, 3p singular pronouns)

Dependent variables:

1. accuracy
2. reaction time



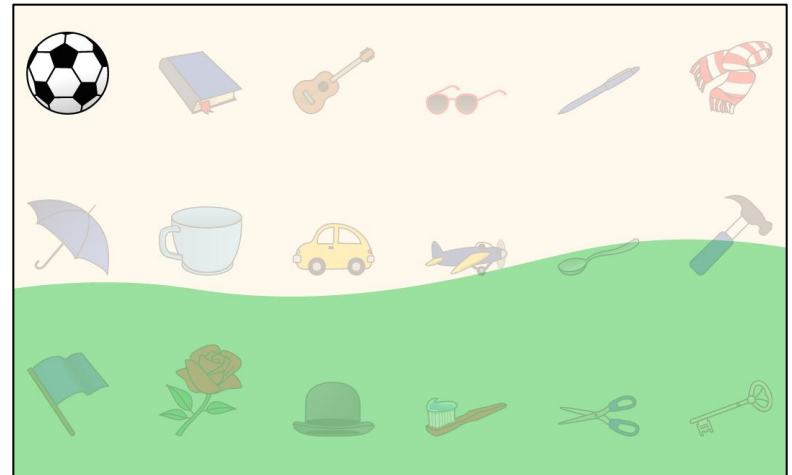
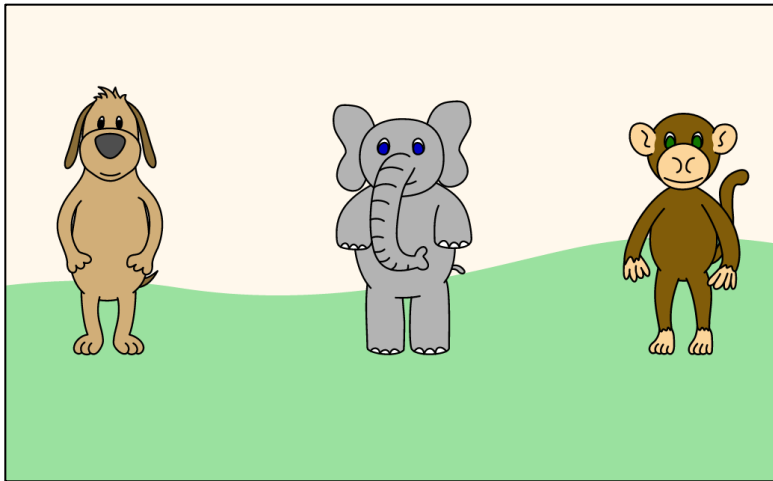
Test items

For test materials see following link:

<http://test.jelmervanderlinde.nl/franziska/>

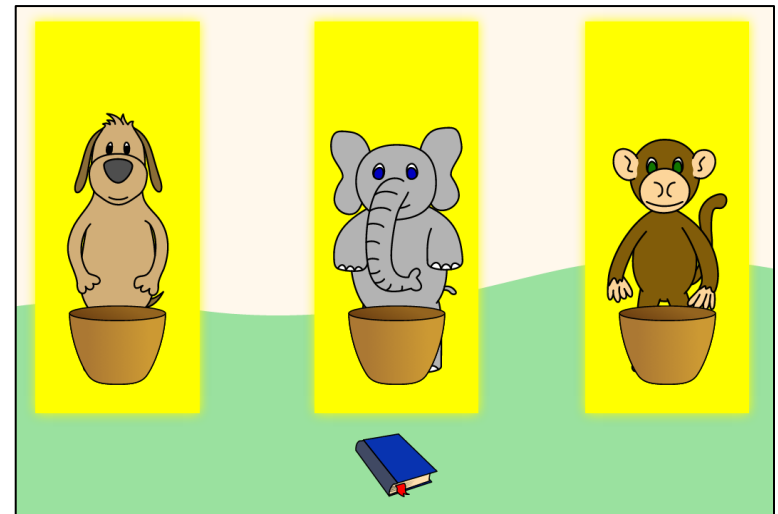
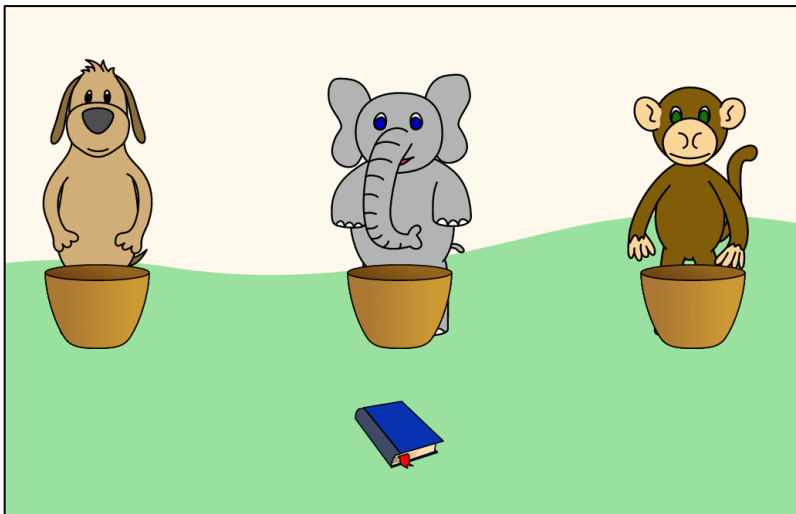
(Google Chrome or Chromium browser required)

Introduction of protagonists and objects



- The protagonists (Dog, Elephant and Monkey) introduce themselves
- Test, whether subjects know the names of the protagonists
- 18 objects are named

Practice items



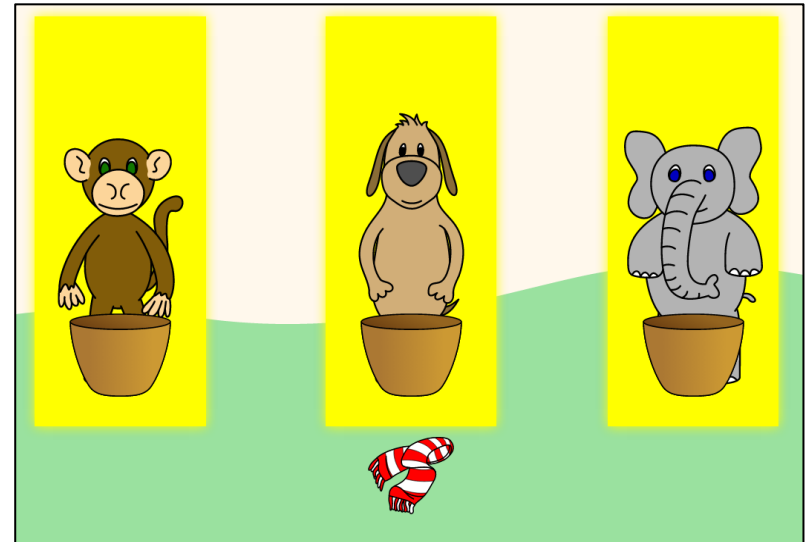
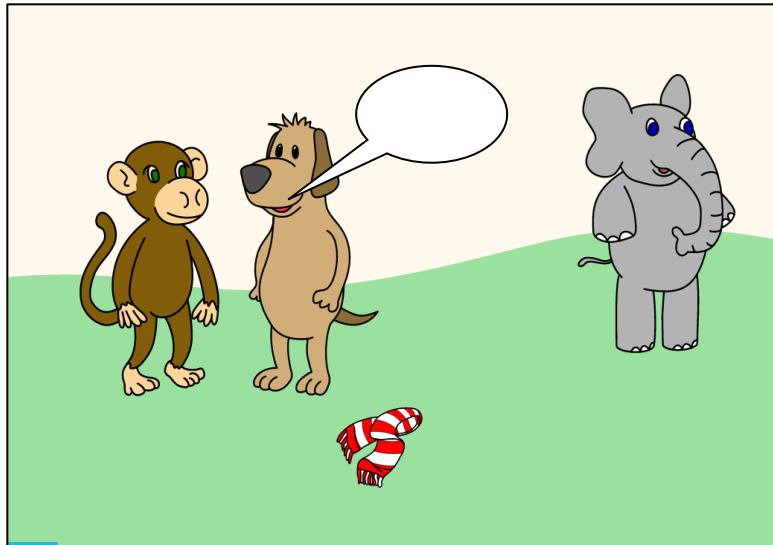
Example:

Olifant: Hond krijgt het boek.

Elephant: Dog gets the book.

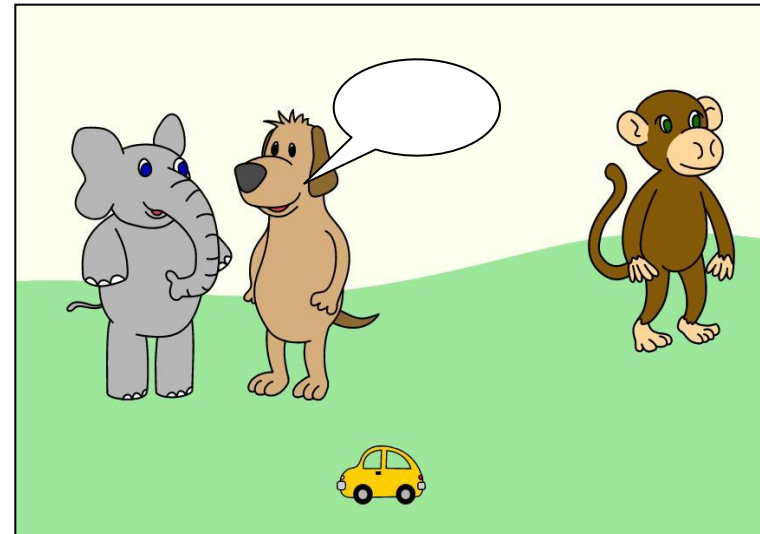
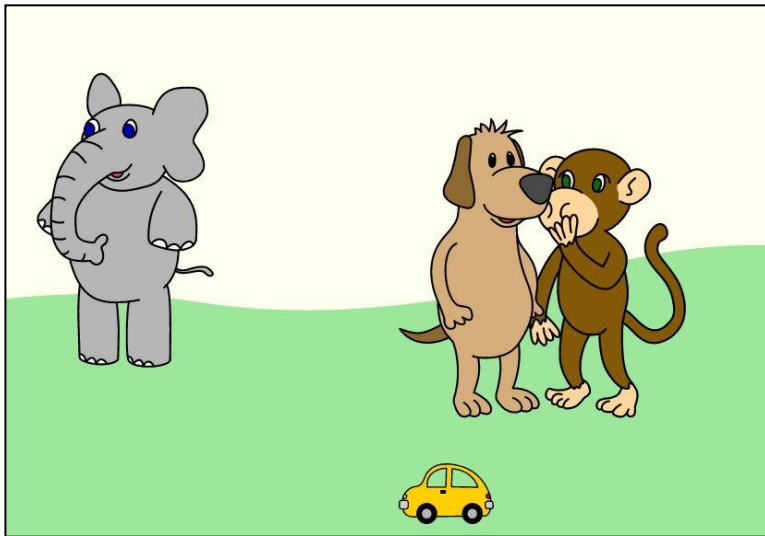
- With proper names instead of pronouns
- Purpose: familiarize subjects with procedure

Part 1: no-report condition



Example: Hond: Ik/ Jij/ Hij krijg(t) de sjaal.
 Dog: I/ You/ He get(s) the scarf.

Part 2: Direct and indirect speech condition



Direct speech Hond: Aap zei "Ik/ Jij/ Hij krijg(t) de auto".
 Dog: Monkey said, "I/ You/ He get(s) the car".

Indir. speech: Hond: Aap zei dat ik/ jij/ hij de auto krijg(t).
 Dog: Monkey said that I/ you/ he get(s) the car.

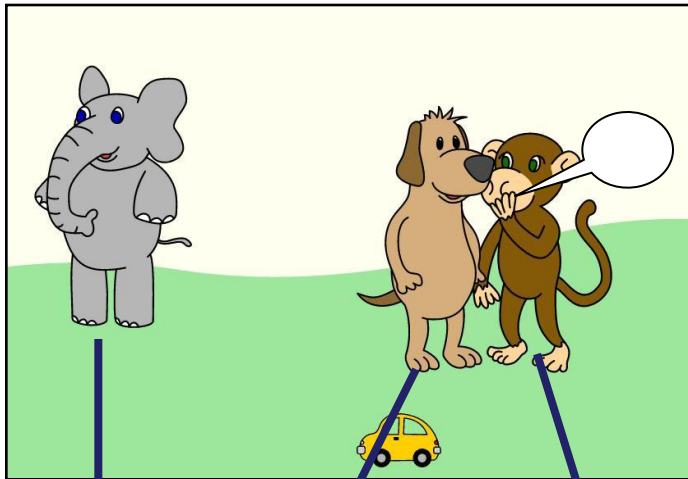


Overview of test items

- Number of test items: 45, presented in random order
- Counterbalanced:
 - Participant roles of protagonists
 - Sentence type a protagonist utters
 - Spatial position of protagonists (left, right, middle)
 - Association of 18 objects to scenes

	No-report	Direct speech	Indirect speech
1p	5	5	5
2p	5	5	5
3p	5	5	5

Original speech context (whispering)

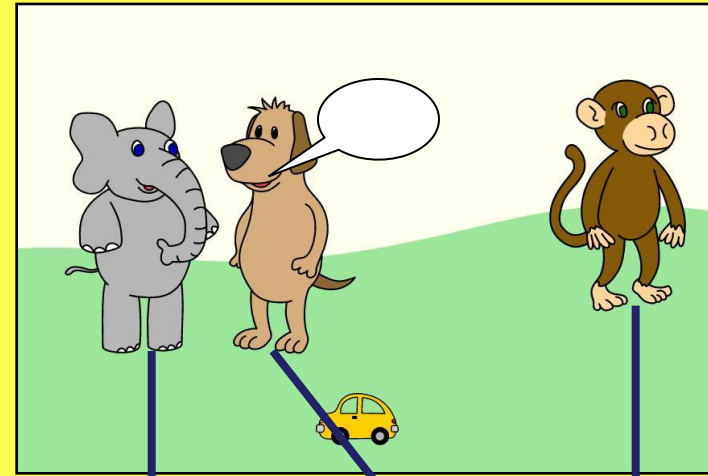


Other

Addressee

Speaker

Actual speech context (report)



Addressee

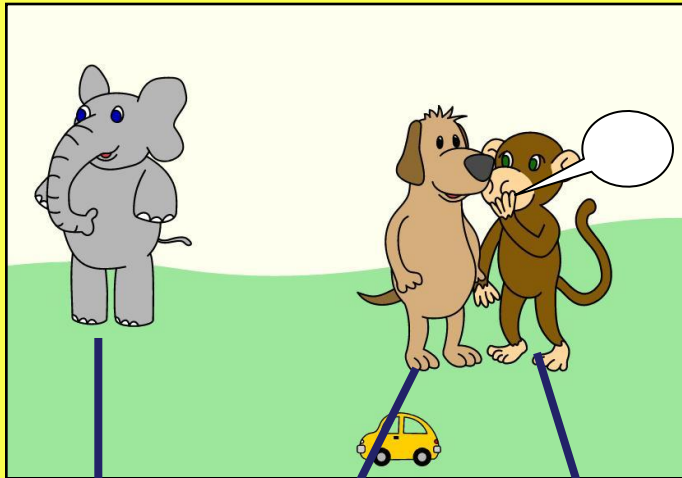
Speaker

Other

Indirect speech: Aap zei dat **ik** **jij** **hij** de auto krijgt(t).

Monkey said that I/ you/ he get(s) the car.

Original speech context
(whispering)

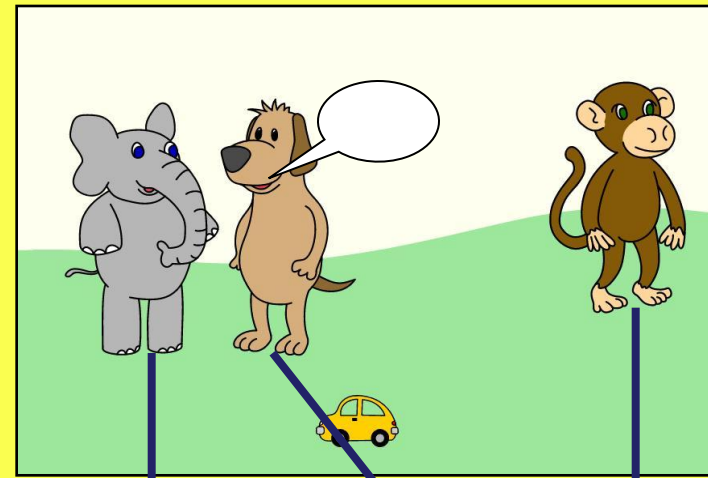


Other

Addressee

Speaker

Actual speech context
(report)



Addressee

Speaker

Other

Direct speech:

Aap zei “ **ik** **jij** **hij** krijg(t) de auto”.

Monkey said, “I/ You/ He get(s) the car”.



Hypotheses

1. Increasing difficulty: no report < indirect speech < direct speech
 - a. more mistakes
 - b. longer reaction times
2. Systematic mistakes: Choice of indirect speech interpretation of pronouns in direct speech.
3. Increasing difficulty: 1p < 2p < 3p
 - a. more mistakes
 - b. longer reaction times



Experimental subjects

Current study

- **Adult native speakers of Dutch: 29 participants**

Prospective studies

- Typically developing Dutch learning children, age: 4-7
- Dutch-Frisian bilinguals vs. Dutch monolinguals (Jens van der Meer)
- Change of voice manipulation in direct speech (Koen Brinks)



2. Statistical tests



Repeated measures ANOVA

- within-subjects: all subjects are measured under all conditions

Assumptions of ANOVA:

1. Independence of observations (does not apply to repeated measures ANOVA)
2. Homogeneity of variance (Homoscedasticity): smallest SD $\geq 0.5 \times$ largest SD
3. Normality: For each level of the within-subjects factor, the dependent variable must have a normal distribution

Normality (Reaction time)

Group	Shapiro-Wilk test (W)	p -value
No - Ik	0.2192	2.2e-16
No- Jij	0.192	2.2e-16
No - Hij	0.4682	2.2e-16
Direct - Ik	0.1292	2.2e-16
Direct - Jij	0.2215	2.2e-16
Direct - Hij	0.2491	2.2e-16
Indirect - Ik	0.5359	2.2e-16
Indirect - Jij	0.8129	2.8e-12
Indirect - Hij	0.4356	2.2e-16

➤ Normality assumption is violated



Violation of normality assumption

- Violation of normality assumption is to be expected with reaction time data
- Possible ways to deal with it: inverse transformation ($1/RT$) or log transformation ($\log RT$)

Research questions

1. Does reporting type influence reaction time/accuracy?
2. Does pronoun type influence reaction time/accuracy?
3. Do reporting type and pronoun type interact?

Null Hypothesis	Alternative Hypothesis
H0: μ no report = μ direct speech = μ indirect speech	H1: Not H0
H0: μ 1 st person = μ 2 nd person = μ 3 rd person	H1: Not H0
H0: no interaction between the two factors	H1: Not H0



Post-hoc analysis: Tukey's HSD test

- ANOVA answers the question whether groups differ significantly, but with more than 2 levels per factor it is unclear which groups differ.
- Post-hoc test: Tukey's HSD (honestly significant differences) test, performed after an ANOVA
- Pair-wise comparison of means to test which differ significantly from each other



3. Results



Reaction time explained by condition and pronoun

Error: ID

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Residuals	28	186.3	6.655		

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Condition	2	11.0	5.493	15.518	2.2e-07 ***
Pronoun	2	3.3	1.661	4.693	0.00932 **
Condition: Pronoun	4	4	1.858	5.250	0.00034 ***
Residuals	1268	448.8	0.354		



Tukey's HSD test (reaction time)

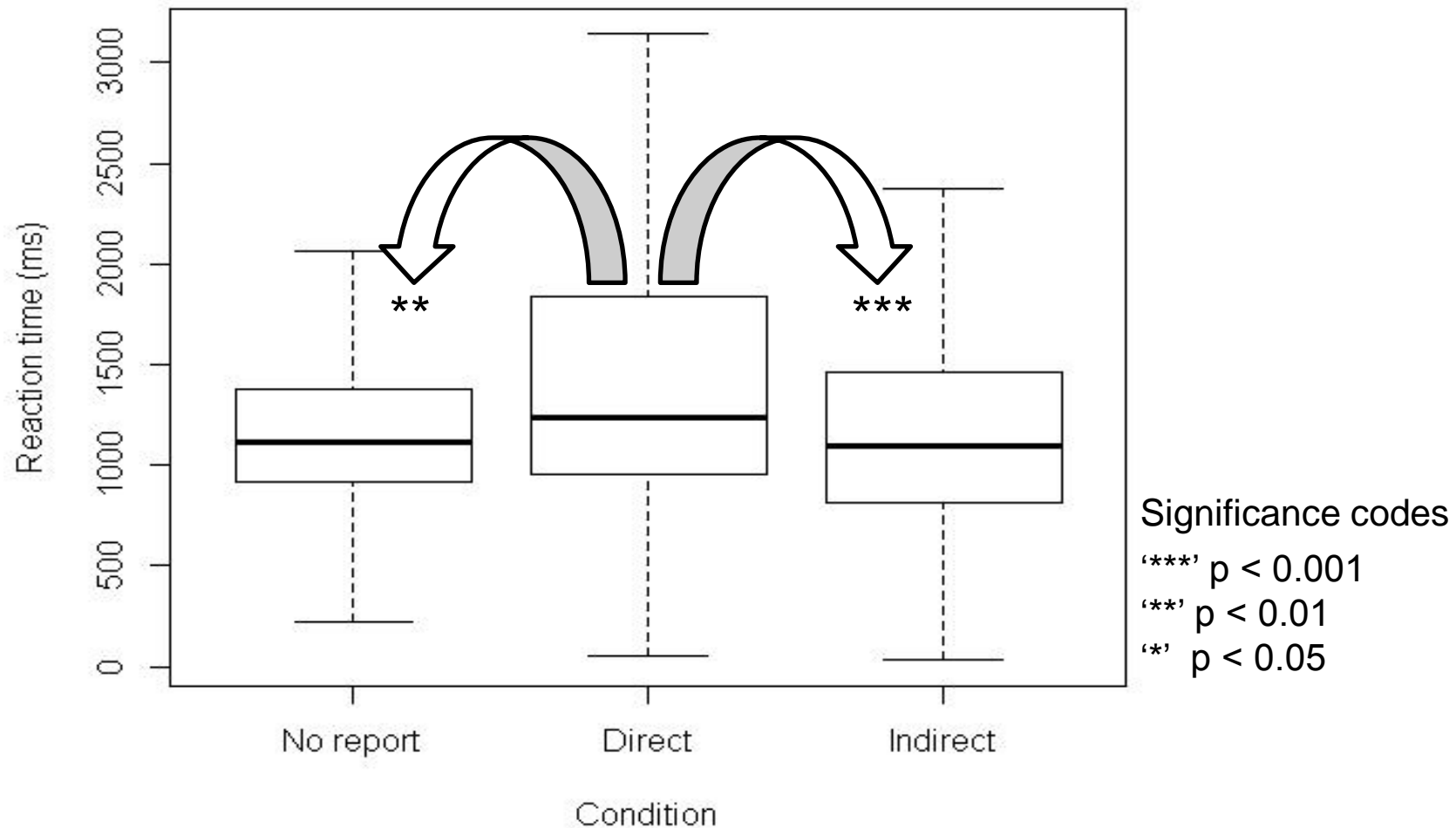
Condition

	diff	lwr	upr	p adj
Ind-Dir	-0.2190815	-0.33046422	-0.10769868	0.0000129
No-Dir	-0.1529670	-0.26434972	-0.04158419	0.0037251
No-Ind	0.0661145	-0.04526827	0.17749727	0.3449593

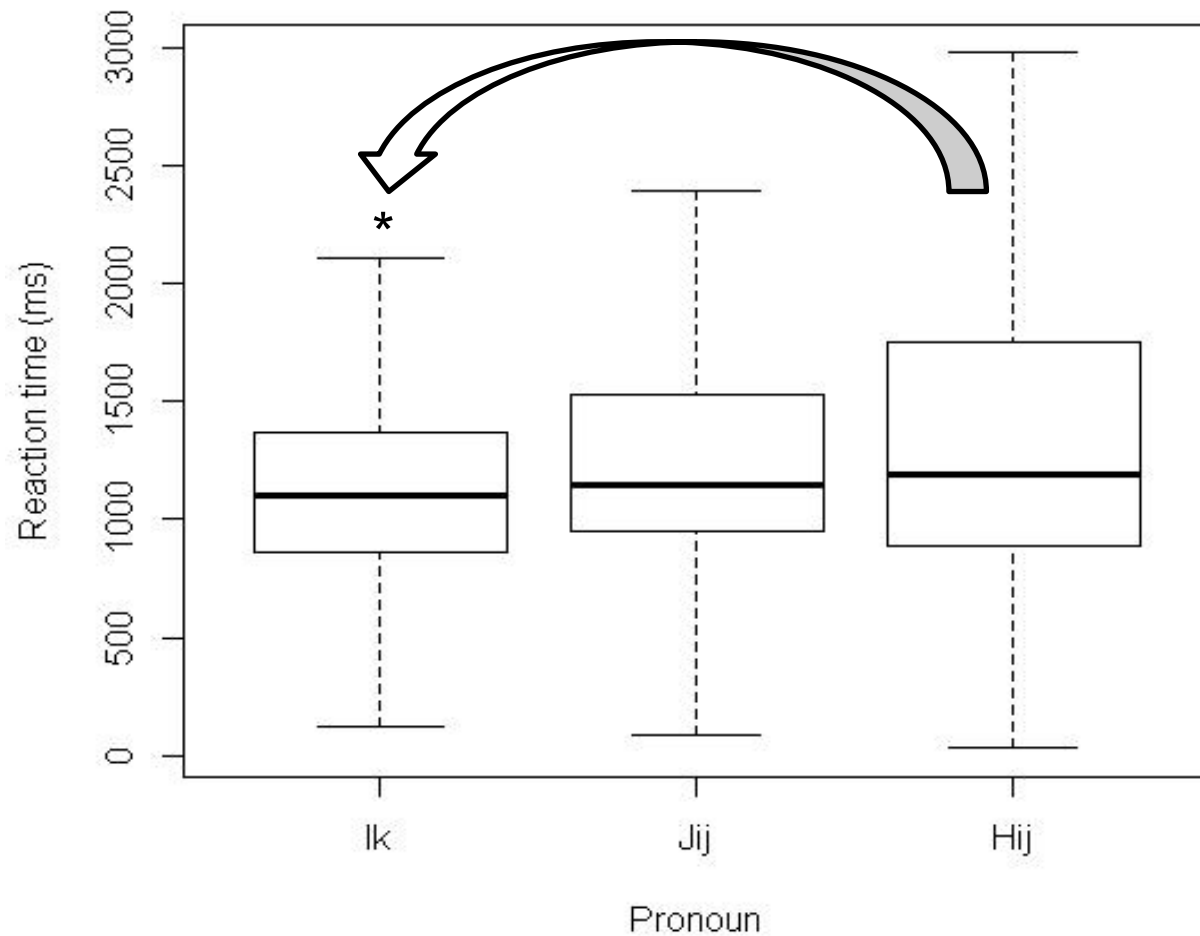
Pronoun

	diff	lwr	upr	p adj
Ik-Hij	-0.12304240	-0.23442517	-0.01165963	0.0260950
Jij-Hij	-0.05138888	-0.16277164	0.05999389	0.5250674
Jij-Ik	0.07165352	-0.03972925	0.18303629	0.2867598

Effect of condition on reaction time



Effect of pronoun type on reaction time



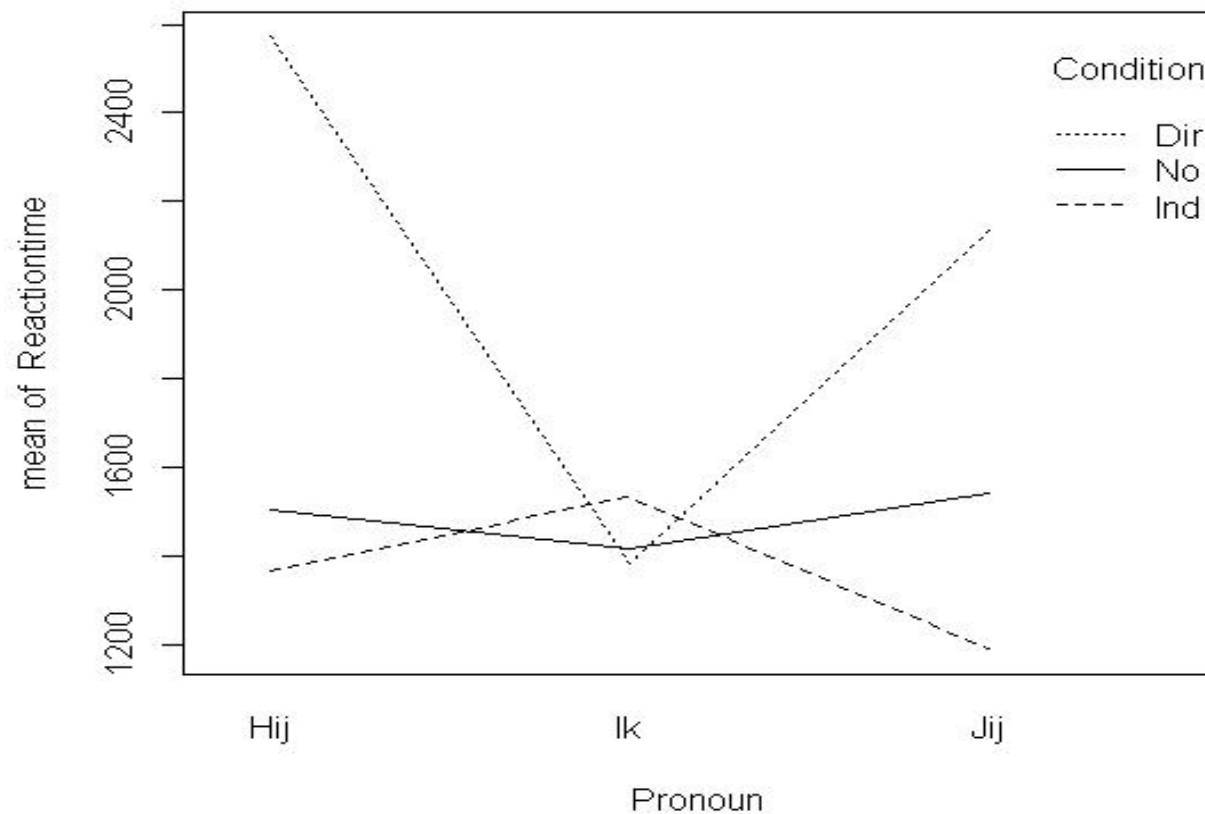
Significance codes

‘***’ $p < 0.001$

‘**’ $p < 0.01$

‘*’ $p < 0.05$

Interaction between reporting type and Pronoun (RT)





Accuracy explained by condition and pronoun

Error: ID

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Residuals	28	32.82	1.172		

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Condition	2	5.80	2.9019	34.327	3.03e-15 ***
Pronoun	2	2.65	1.3249	15.673	1.89e-07 ***
Condition: Pronoun	4	1.60	0.3996	4.727	0.000867 ***
Residuals	1268	107.19	0.0845		



Tukey's HSD test (accuracy)

Condition

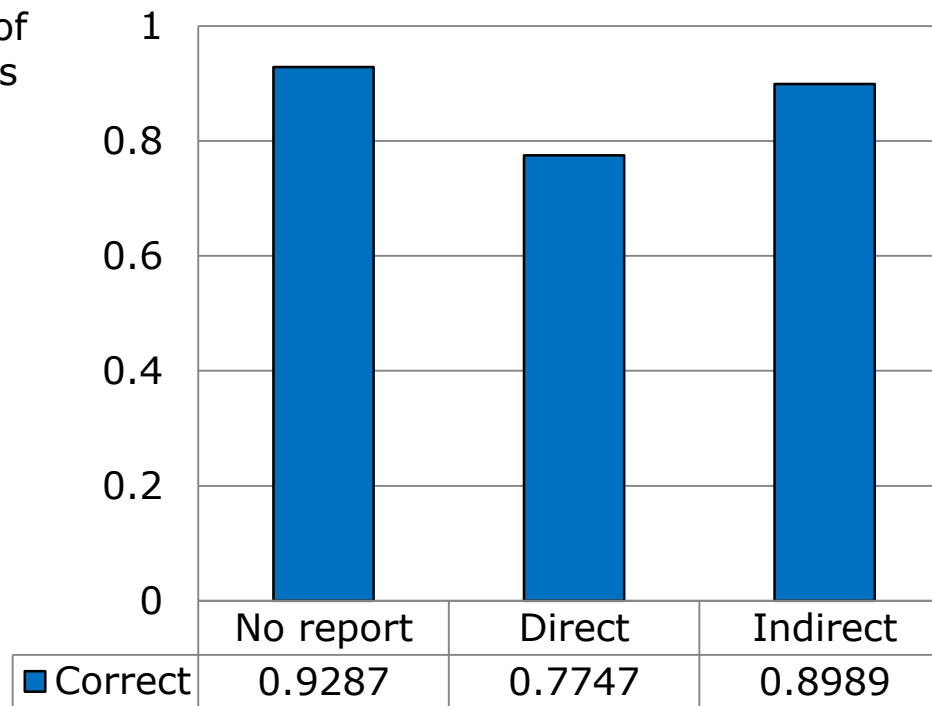
	diff	lwr	upr	p adj
Ind-Dir	0.12413793	0.07184348	0.17643238	0.0000001
No-Dir	0.15402299	0.10172854	0.20631744	0.0000000
No-Ind	0.02988506	-0.02240939	0.08217951	0.3727367

Pronoun

	diff	lwr	upr	p adj
Ik-Hij	0.10344828	0.05115382	0.15574273	0.0000114
Jij-Hij	0.08505747	0.03276302	0.13735192	0.0004164
Jij-Ik	-0.01839080	-0.07068526	0.03390365	0.6874506

Effect of condition on accuracy

Mean number of
correct answers



Significance codes

***' $p < 0.001$

**' $p < 0.01$

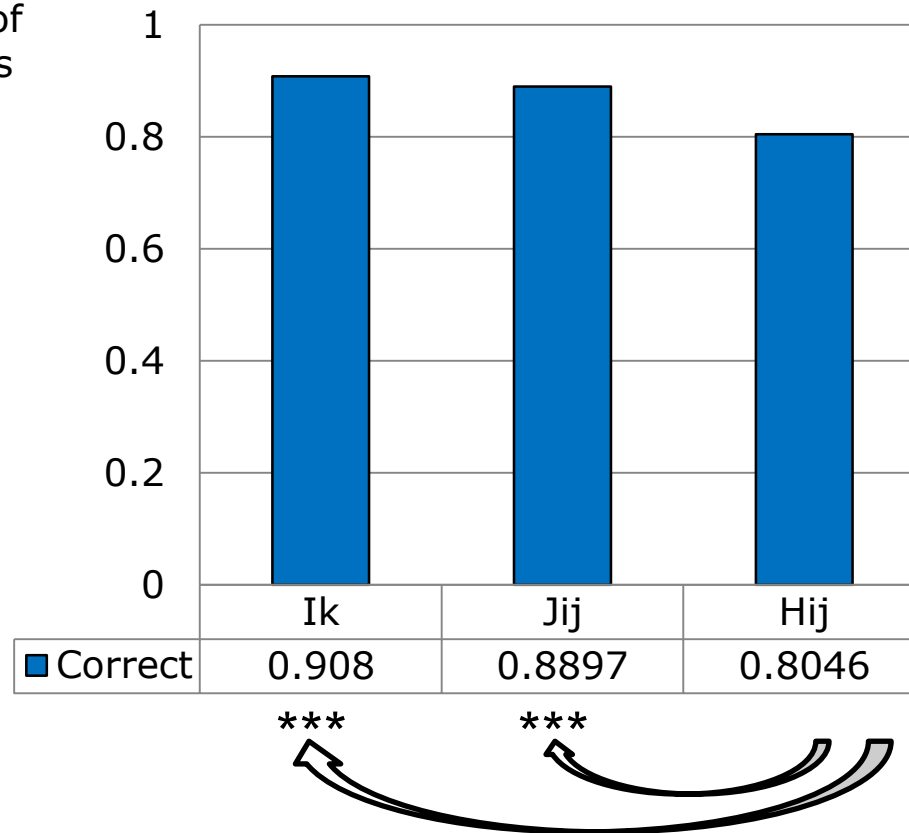
*' $p < 0.05$





Effect of pronoun type on accuracy

Mean number of
correct answers



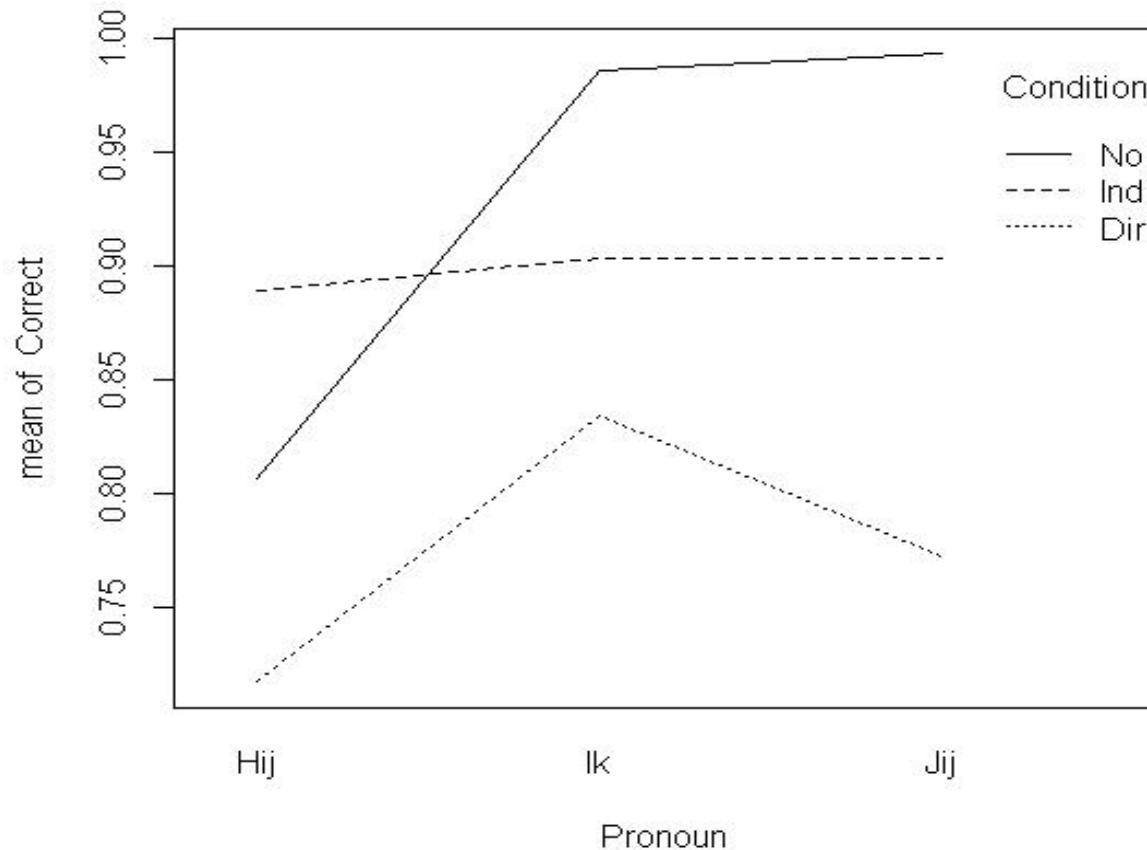
Significance codes

‘***’ $p < 0.001$

‘**’ $p < 0.01$

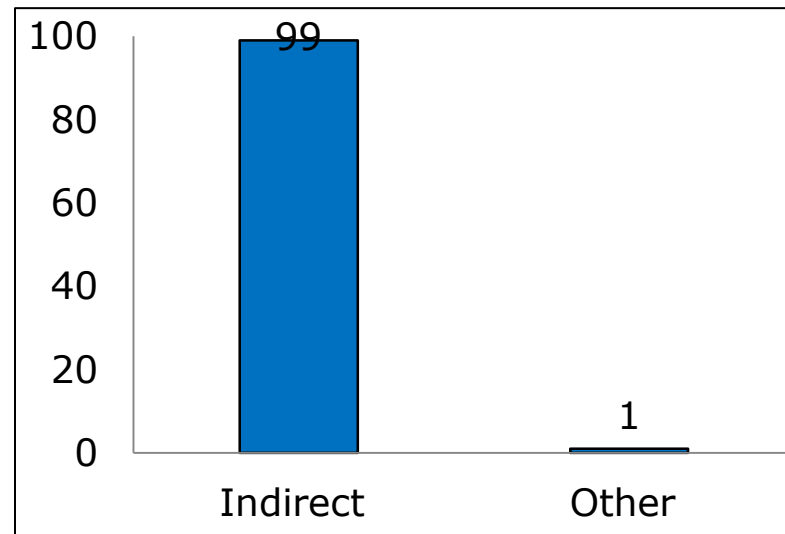
‘*’ $p < 0.05$

Interaction between reporting type and Pronoun (Accuracy)



Analysis of mistakes in direct speech

Percentage of mistake types ($N=98$)



- When participants make mistakes in direct speech, they predominantly interpret the pronouns like in indirect speech.

Evaluation of Hypotheses

1. Increasing difficulty: no report, indirect speech < direct speech
 - a. more mistakes ✓
 - b. longer reaction times ✓
2. Systematic mistakes: Choice of indirect speech interpretation of pronouns in direct speech. ✓
3. Increasing difficulty: 1p, 2p < 3p
 - a. more mistakes ✓
 - b. longer reaction times ✓



Ecological validity

Is direct speech always more difficult to interpret than indirect speech?

- Not necessarily, only if both the actual and the original speech context are highly salient and a shift between two representations is required. Otherwise a representation of the original speech context is sufficient.



Franziska says

Thanks for
your
attention!

