Free Choice Questions

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Free Choice Inferences

Free Choice inferences

(1) *You may ride a motorcycle up to 125 cc with power output up to 11 kW, or a motor tricycle with power not exceeding 15 kW* [with this driving license][1]

[1] *The highway code of the UK* p.51 https://www.highwaycodeuk.co.uk/download-pdf.html, access: 30.05.2023

Free Choice inferences

(1) *You may ride a motorcycle up to 125 cc with power output up to 11 kW, or a motor tricycle with power not exceeding 15 kW* [with this driving license][1]

$\rightsquigarrow$ You may ride a motorcycle and (you may ride) a tricycle.

$$FC\colon\ \Diamond(\alpha \vee \beta) \rightsquigarrow \Diamond\alpha \wedge \Diamond\beta$$

[1] *The highway code of the UK* p.51 https://www.highwaycodeuk.co.uk/download-pdf.html, access: 30.05.2023

Free Choice in legal language (Aher, 2013)

Simple solution: *Generally, the words 'or' and 'and' in a statute may be construed as interchangeable when necessary to effectuate legislative intent.*[2]

[2] New York Court of Appeals 13425 U.S. at 410 n. 11

Free Choice in legal language (Aher, 2013)

(2) *This right may not be invoked in the case of prosecutions genuinely arising from non-political crimes or from acts contrary to the purposes and principles of the United Nations.*[2]

$$\times\colon\ \neg\Diamond(\alpha \wedge \beta) \rightsquigarrow \neg\Diamond\alpha \vee \neg\Diamond\beta$$
$$DP\colon\ \neg\Diamond(\alpha \vee \beta) \rightsquigarrow \neg\Diamond\alpha \wedge \neg\Diamond\beta$$

[2] Universal Declaration of Human Rights, Article 14; https://www.un.org/en/about-us/universal-declaration-of-human-rights access: 31.05.2023

Free Choice in legal language - FCQ

(3) **The scope of the case will be at once made manifest by the two questions** *which were certified for solution. First: May a patentee or his assignee license another to manufacture and sell a patented machine and by a mere notice attached to it limit its [patent's] use by the purchaser or by the purchaser's lessee, to films which are no part of the patented machine, and which are not patented?* [...][3]

(4) *May a State prohibit children or foreigners from circulating petitions [...]?*[4]

[3] BOSTON STORE OF CHICAGO v. AMERICAN GRAPHOPHONE CO , 246 U.S. 8 (1918)

[4] BUCKLEY v. AMERICAN CONSTITUTIONAL LAW, 525 U.S. 182 (1999)

Free Choice in legal language - FCQ

(3) *May a State prohibit children or foreigners from circulating petitions [...]?*[3]

$$\textit{FCQ}: \quad ?\Diamond(\alpha \vee \beta)$$
$$\overset{?}{\rightsquigarrow} ?\Diamond\alpha \wedge ?\Diamond\beta$$
$$\overset{?}{\rightsquigarrow} ?(\Diamond\alpha \wedge \Diamond\beta)$$
$$\ldots$$

[3] BUCKLEY v. AMERICAN CONSTITUTIONAL LAW, 525 U.S. 182 (1999)

Free Choice Questions

Examples:

1. *May I have ice cream or cake?*
2. *May I visit the Rijks or Nemo with my Museumkaart?*
3. *May a State prohibit children or foreigners from circulating petitions?*

Free Choice Questions may be used to ask for permission (1), but also to ask to report it (2) or to establish it (3).

Free Choice Questions

Examples:

1. *May I have ice cream or cake?*
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Free Choice Questions may be used to ask for permission (1), but also to ask to report it (2) or to establish it (3).

We will not be considering, similar examples involving ability modals:

(4) Can you send me your paper or the slides of your presentation?

Free Choice Questions: response particles

(5) A: *May I visit the Rijks or Nemo with my Museumkaart?*

B: Yes.

B: No.

Research Questions

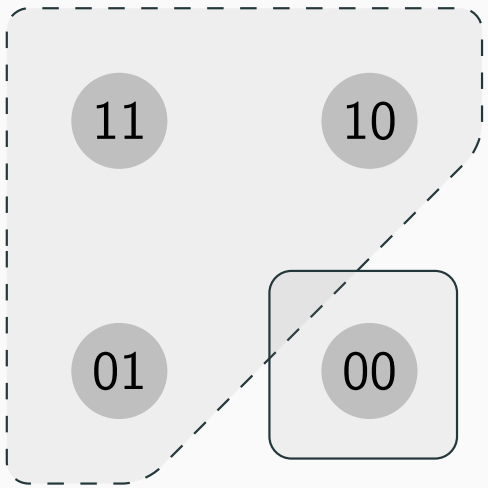
1. What do response particles correspond to as responses to FCQs?
2. What is the source (pragmatic/semantic) of the inferences from the response particles?

Free Choice Questions: response particles

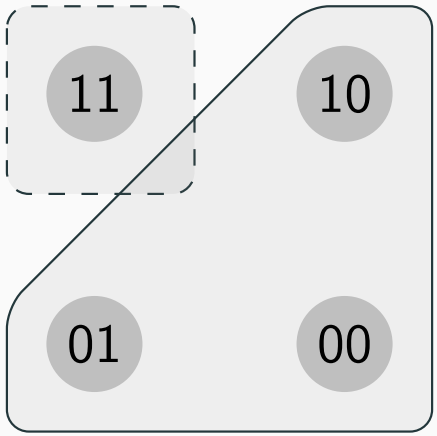
(5) A: *May I visit the Rijks or Nemo with my Museumkaart?*

B: Yes.

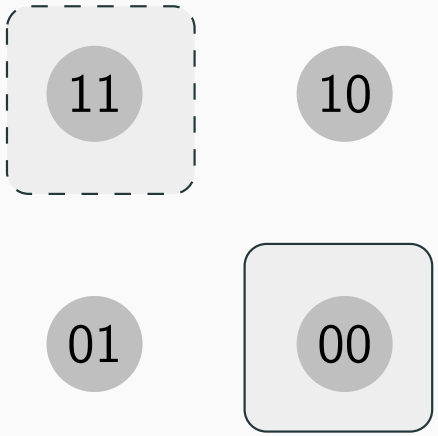
B: No.



(a)



(b)



(c)

Theories of Free Choice

Theories of Free Choice

Theories of free choice (Aloni, 2022)

1. **Semantic:** Non-classical semantics of a logical operator. e.g. Aloni (2007), or Nygren (2022)
2. **Scalar:** Free Choice as an implicature
   - Neo-Gricean: e.g. Kratzer and Shimoyama (2002), Chemla (2009)
   - Exhaustivity: Fox (2007) and Bar-Lev and Fox (2020)
3. **Non-Gricean Pragmatics:** explain Free Choice by a pragmatic effect Goldstein (2019) or Aloni (2022)

What are the predictions of those theories regarding FCQs?

Inquisitive Semantics

To model questions we will use the Inquisitive Semantics framework by Ciardelli et al. (2018) with the analysis of response particles by Roelofsen and Farkas (2015):

$$?\varphi \equiv [\underbrace{\varphi}_{\text{Yes}} \mathbin{\mathbb{V}} \underbrace{\neg\varphi}_{\text{No}}]$$

$M, s \models \neg\varphi$ iff for all $t_{\neq\emptyset} \subseteq s$: $M, t \not\models \varphi$

$M, s \models \varphi \vee \psi$ iff $M, s \models \varphi$ or $M, s \models \psi$ (Inquisitive disjunction)

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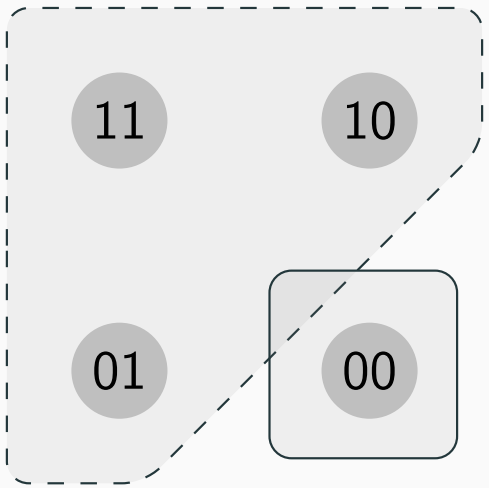
FCQ in standard Inquisitive Semantics

$M, s \models \neg\varphi$ iff for all $t_{\neq\emptyset} \subseteq s$: $M, t \not\models \varphi$

$M, s \models \varphi \mathbin{\mathbb{V}} \psi$ iff $M, s \models \varphi$ or $M, s \models \psi$ (Inquisitive disjunction)

$M, s \models \Diamond\varphi$ iff for all $w \in s : [\varphi] \cap R[w] \neq \emptyset$ (Simple modality)

$$?\Diamond(\alpha \mathbin{\mathbb{V}} \beta) \equiv [\underbrace{\Diamond(\alpha \mathbin{\mathbb{V}} \beta)}_{\text{Yes}} \mathbin{\mathbb{V}} \underbrace{\neg\Diamond(\alpha \mathbin{\mathbb{V}} \beta)}_{\text{No}}]$$



Deontic Inquisitive Logic (Aloni, 2007; Nygren, 2022)

Alt-sensitive Deontic modality:

$M, s \models \Diamond\varphi$ iff for all $w \in s$, for all $Y \in ALT(\varphi) : Y \cap R[w] \neq \emptyset)$

where $ALT(\varphi)$ is a set of all maximal subsets of $[\varphi]$.

FC: Suppose $M, s \models \Diamond(\alpha \mathbin{\mathbb{V}} \beta)$. Since $[\alpha] \in ALT(\alpha \mathbin{\mathbb{V}} \beta)$ then for all $w \in s$: $[\alpha] \cap R[w] \neq \emptyset)$, and thus $M, s \models \Diamond\alpha$. ✓

DP: Suppose $M, s \models \neg\Diamond(\alpha \mathbin{\mathbb{V}} \beta)$. Then $\exists\eta \in \{\alpha, \beta\}$ such that for some $w \in s$: $\eta \cap R[w] = \emptyset)$. ×

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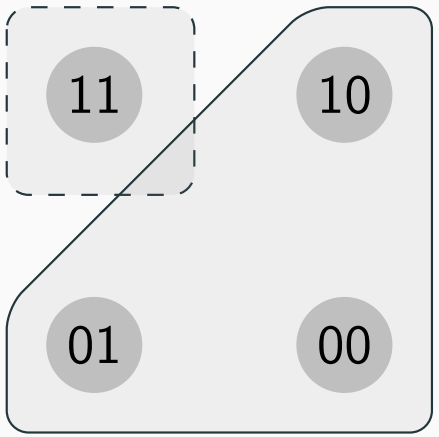

(b)

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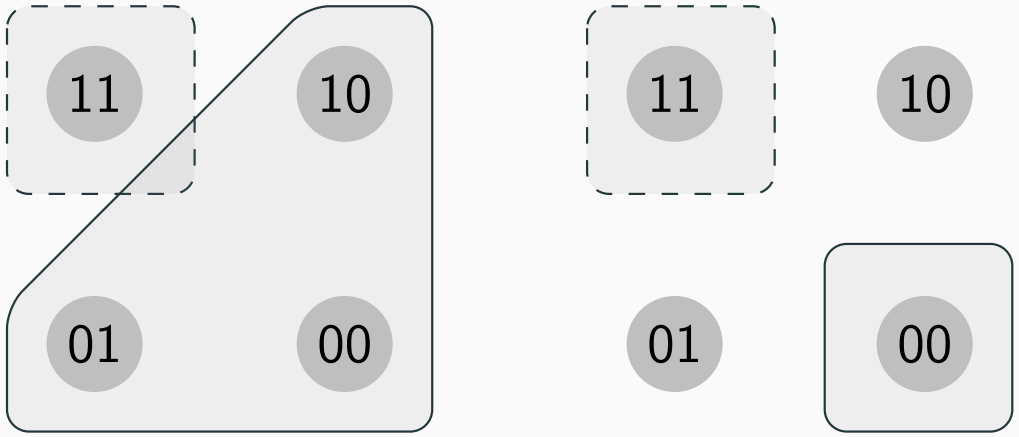
Note that if we use bilateral negation or homogeneity, the prediction changes.



Exhaustivity (Fox, 2007; Bar-Lev and Fox, 2020)

Exhaustivity operator: FC: *Exh*$(\Diamond(\alpha \vee \beta))$ DP: *Exh*$(\neg\Diamond(\alpha \vee \beta))$

Hamblin sets (vs. Horn's scales):

Alt$(\Diamond(\alpha \vee \beta)) = \{\Diamond(\alpha \vee \beta), \Diamond\alpha, \Diamond\beta, \Diamond(\alpha \wedge \beta)\}$

Alt$(\neg\Diamond(\alpha \vee \beta)) = \{\underline{\neg\Diamond(\alpha \vee \beta)}, \neg\Diamond\alpha, \neg\Diamond\beta, \neg\Diamond(\alpha \wedge \beta)\}$

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Exhaustification of FC:

1. Take all maximal sets of alternatives, that can be assigned **false** with the prejacent: $\{\Diamond\alpha, \Diamond(\alpha \wedge \beta)\}$, $\{\Diamond\beta, \Diamond(\alpha \wedge \beta)\}$;
2. *Innocent Exclusion:* Exclude the intersection of those sets: $\{\Diamond(\alpha \wedge \beta)\}$

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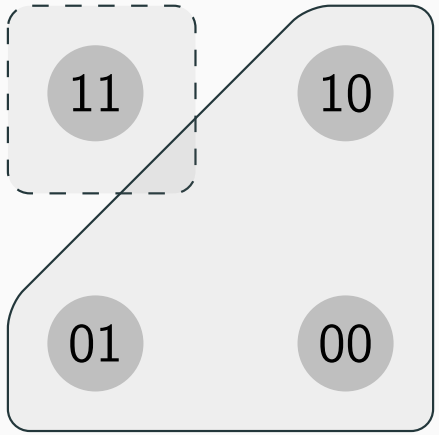
2. *Innocent Exclusion:* Exclude the intersection of those sets: $\{\Diamond(\alpha \wedge \beta)\}$
3. Take all maximal sets of alternatives, that can be assigned **true** with the prejacent and negations of excluded alternatives: $\{\Diamond(\alpha \vee \beta), \Diamond\alpha, \Diamond\beta\}$;
4. *Innocent Inclusion:* Include the intersection of those sets. ✓

Exhaustivity and questions

How should we exhaust FCQs?[4]

- $?Exh(\Diamond(\alpha \vee \beta)) \equiv \underbrace{Exh(\Diamond(\alpha \vee \beta))}_{\text{Yes}} \;\mathbb{V}\; \underbrace{\neg Exh(\Diamond(\alpha \vee \beta))}_{\text{No}}$



(b)

[4]Fox (2018, 2020) proposes his own theory of questions based on partition semantics. The approach has analogical issues like the one mentioned above. For the sake of time, we do not discuss this approach here.

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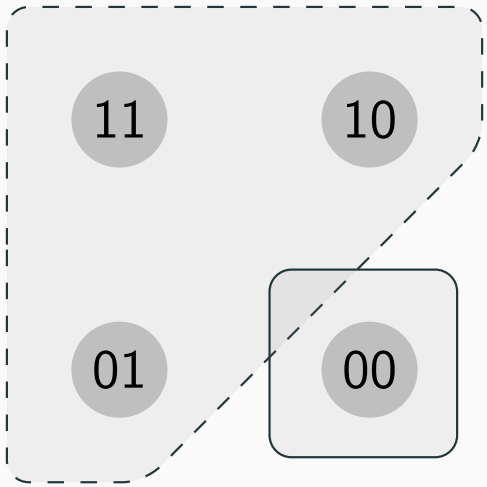

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- $Exh(?\Diamond(\alpha \vee \beta))$
- $Exh(Exh(?\Diamond(\alpha \vee \beta)))$

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Homogeneity (Goldstein, 2019)

"*Disjunctions are homogeneous with respect to modal status...*"
(Goldstein, 2019, p.35)

HAS: $\Diamond\varphi$ is defined only if all the alternatives in $[\![\varphi]\!]$ have the same truth value, where $[\![\alpha \vee \beta]\!] = [\![\alpha]\!] \cup [\![\beta]\!]$

HDS: $\alpha \vee \beta$ is defined only if either both $\Diamond\alpha$ and $\Diamond\beta$ or both $\neg\Diamond\alpha$ and $\neg\Diamond\beta$ are (**non-emptily**) supported. ($\approx$ split $[\vee]^+$)

- Negation is from weak Kleene table ($\approx$ bilateral)

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- Negation is from weak Kleene table ($\approx$ bilateral)

FC: At least one is permitted $\xrightarrow{\mathcal{H}}$ both are permitted.

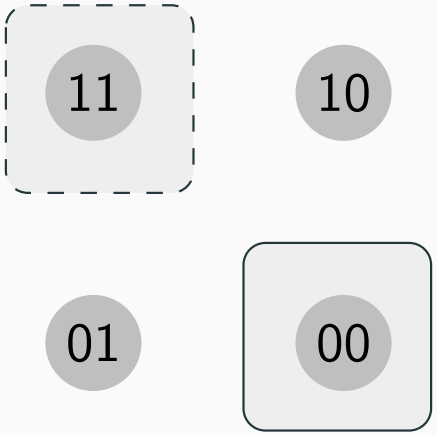
DP: Both are not permitted.

Homogeneity (Goldstein, 2019)

FC: At least one is permitted $\xrightarrow{\mathcal{H}}$ both are permitted.

DP: Both are not permitted.

FCQ: Either both are permitted or both are forbidden. [5]



Is homogeneity semantic or pragmatic?

"*This paper offers a new* **semantic** *analysis of Free Choice...*" (Goldstein, 2019, p.1)

[5] Trivalent homogeneous polar questions by Enguehard (2021) with homogeneity deontic modality yields the same results.

BSML (Aloni, 2022)

- Neglect-zero as a pragmatic enrichment.
- Enriched disjunction is satisfied if both disjuncts are non-emptily supported.
- Bilateral negation
- Adding inquisitive disjunction is theoretically motivated by Anttila (2021)[6]

FC: $[\Diamond(\alpha \vee \beta)]^{+} \models \Diamond\alpha \wedge \Diamond\beta$

DP: $[\neg\Diamond(\alpha \vee \beta)]^{+} \models \neg\Diamond\alpha \wedge \neg\Diamond\beta$

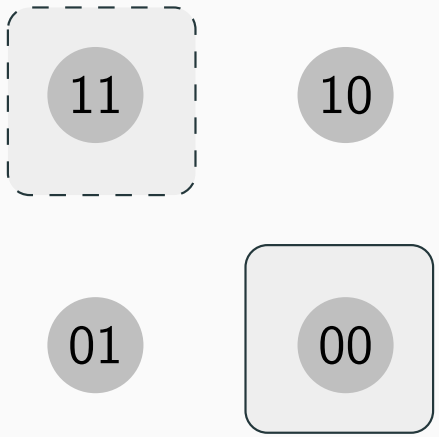
[6] It is also possible to adopt the ? operator by Enguehard (2021) instead, which will yield the same predictions.

BSML (Aloni, 2022)

FC: $[\Diamond(\alpha \vee \beta)]^+ \models \Diamond\alpha \wedge \Diamond\beta$

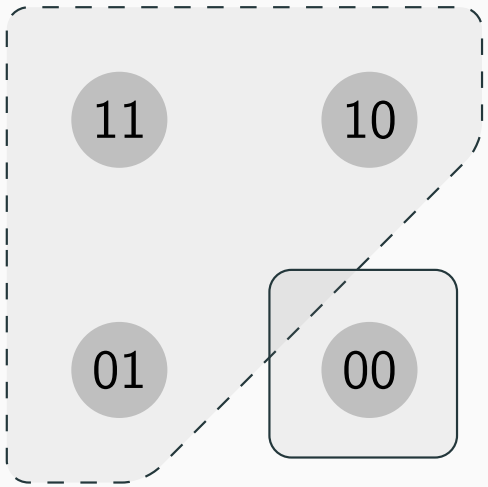
DP: $[\neg\Diamond(\alpha \vee \beta)]^+ \models \neg\Diamond\alpha \wedge \neg\Diamond\beta$

FCQ: $[?\Diamond(\alpha \vee \beta)]^+ \equiv [\Diamond(\alpha \vee \beta)]^+ \mathbin{\mathbb{V}} [\neg\Diamond(\alpha \vee \beta)]^+$



Interim Summary

Theory	FC	Source	DP	Source	FCQ	Source
InqSem	×	sem	✓	sem	a	sem
Deontic InqL	✓	sem	×	sem	b	sem
Exhaustivity	✓	gram	✓	gram+pragm	a/b	gram/prag
Homogeneity	✓	sem/prag	✓	sem	c	sem/prag
BSML	✓	prag	✓	sem+prag	c	sem+prag



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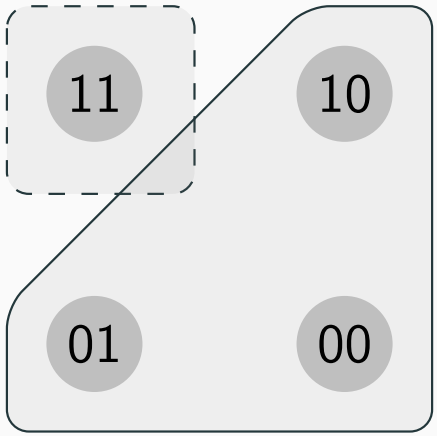

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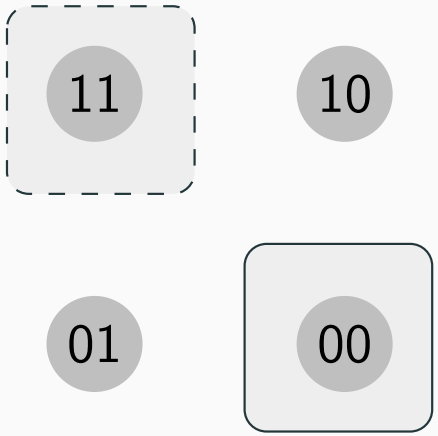


(c)

The Experiment

Methods

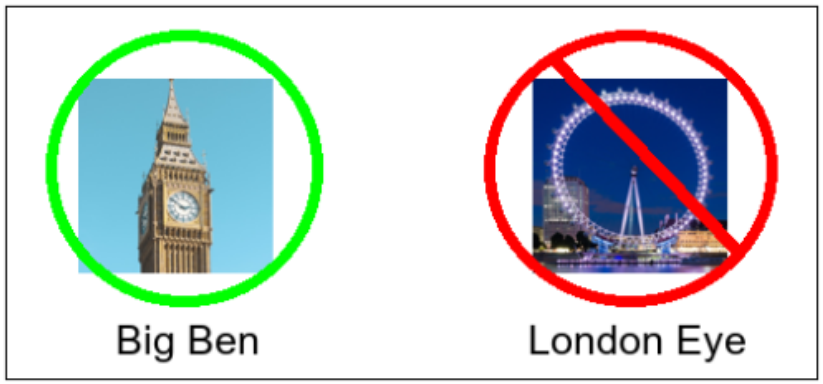
Participants: 60 native speakers of English located in the UK or in the US (*prolific.co*). Participants were informed about their rights and that the study was approved by the Ethics Committee of the Faculty of Humanities of the University of Amsterdam (FGW-341). The participants were paid £2.25 for their participation.

Software: jsPsych (de Leeuw et al., 2023) and *cognition.run*.

Example of an experimental trial

Bill is in London at a tourist office. He wants to know more about the tourist pass they offer. He asks the employee of the office:

BILL: Am I allowed to go to **Big Ben or the London Eye** with this pass?
EMPLOYEE: **Yes**



Was the employee's answer accurate given the picture?

Accurate | Inaccurate

Materials

Two scenarios:

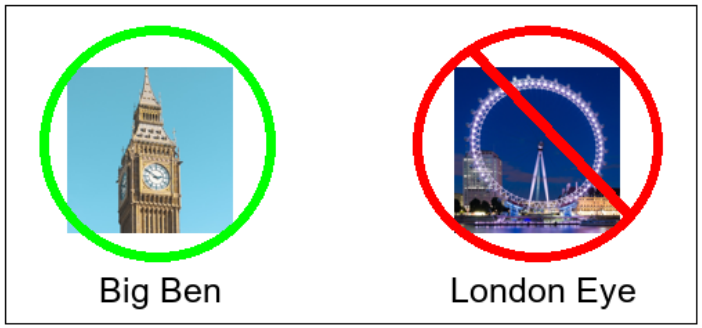
(6) *Ann is about to rent a new apartment. She wants to discuss the terms with her new landlady before drafting a contract. She asks the landlady:* (Establishing permission)

(7) *Bill is in London at a tourist office. He wants to know more about the tourist pass they offer. He asks the employee of the office:* (Reporting permission)

Materials

Three contexts:

Control contexts: The left context is a TRUE control for the "Yes" particle and the FALSE control for the "No" particle.



Target context for both "Yes" and "No" particles.

Materials

$$2 \times 4 \times 3 \times 2 + 24 = 72$$

- Two scenarios
- Four pairs of items for each scenario
- Three contexts (both allowed, one allowed, neither allowed).
- Two response particles ("Yes" and "No")
- 24 filler items

Materials

$$\mathbf{2} \times 4 \times \mathbf{3} \times \mathbf{2} + 24 = 72$$

- Two scenarios
- Four pairs of items for each scenario
- Three contexts (both allowed, one allowed, neither allowed).
- Two response particles ("Yes" and "No")
- 24 filler items

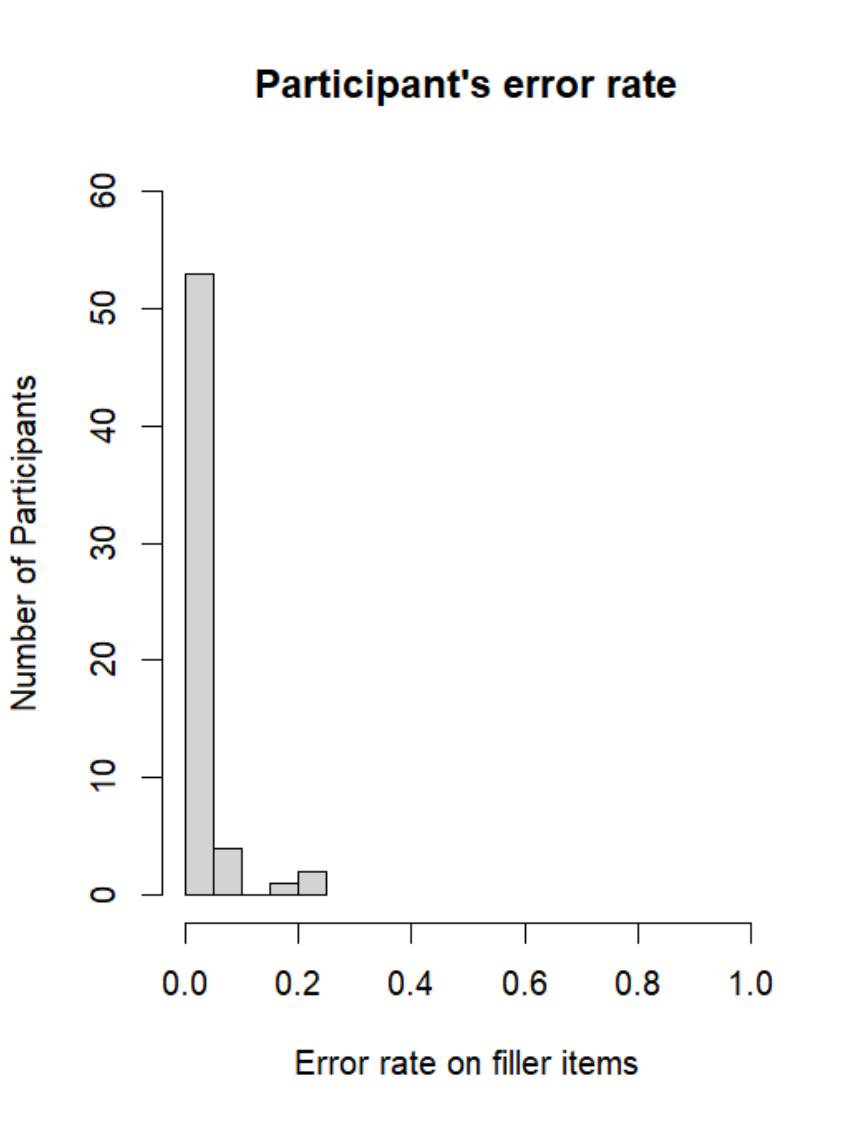
Procedure

Consent $\rightarrow$ **Training** $\rightarrow$ Randomised trials

- 7 filler items
- Feedback after every training item (4 seconds penalty if incorrect)
- Familiarising participants with the design
- Discouraging *politeness* and *precision* readings.

Results

Results: error rate on fillers



No participants were excluded.

Results: acceptance rate

Context	Yes	No
both allowed	99%	3,5%
one allowed	25%	9%
neither allowed	2%	98%

```
model <- glmer(answer ~ response_type:context +
           + (1|participant_id), data,  family = 'binomial')
```

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"Yes" particle: All differences significant ($p < 0.001$)

"No" particle: All differences significant ($p < 0.001$).

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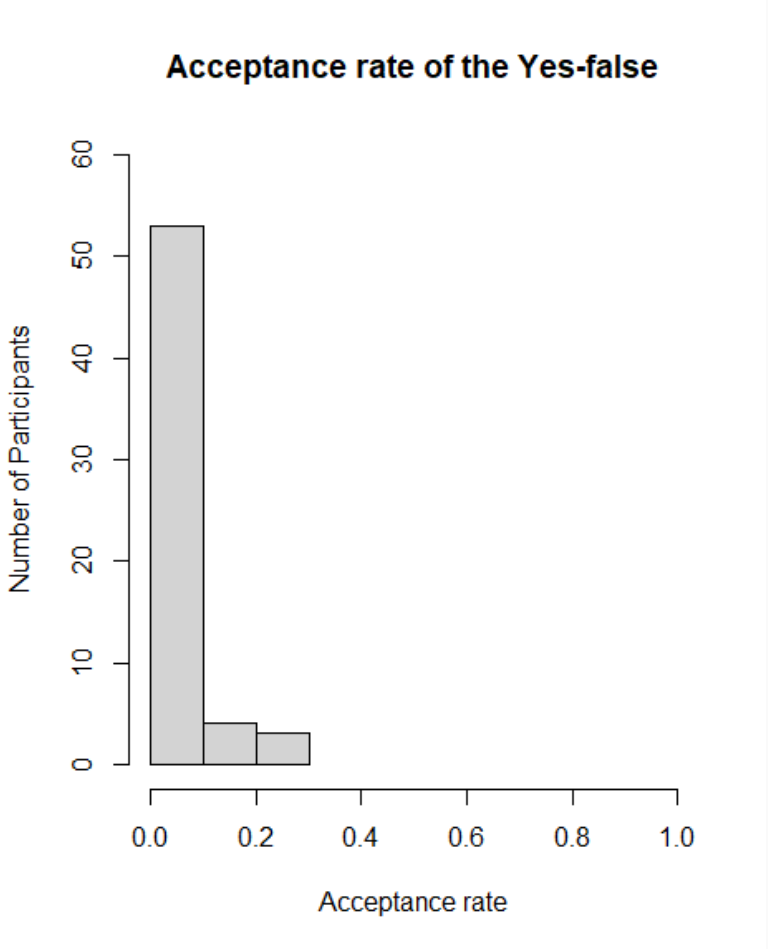
"Yes" particle: All differences significant ($p < 0.001$)

"No" particle: All differences significant ($p < 0.001$).

In both cases, the TARGET condition is still significantly closer (more similar) to the FALSE condition than to the TRUE condition ($p < 0.001$).

There is a significant difference ($p < 0.001$) between the TARGET conditions (between the acceptance rate for Free Choice and Dual Prohibition.)

Results: acceptance rate



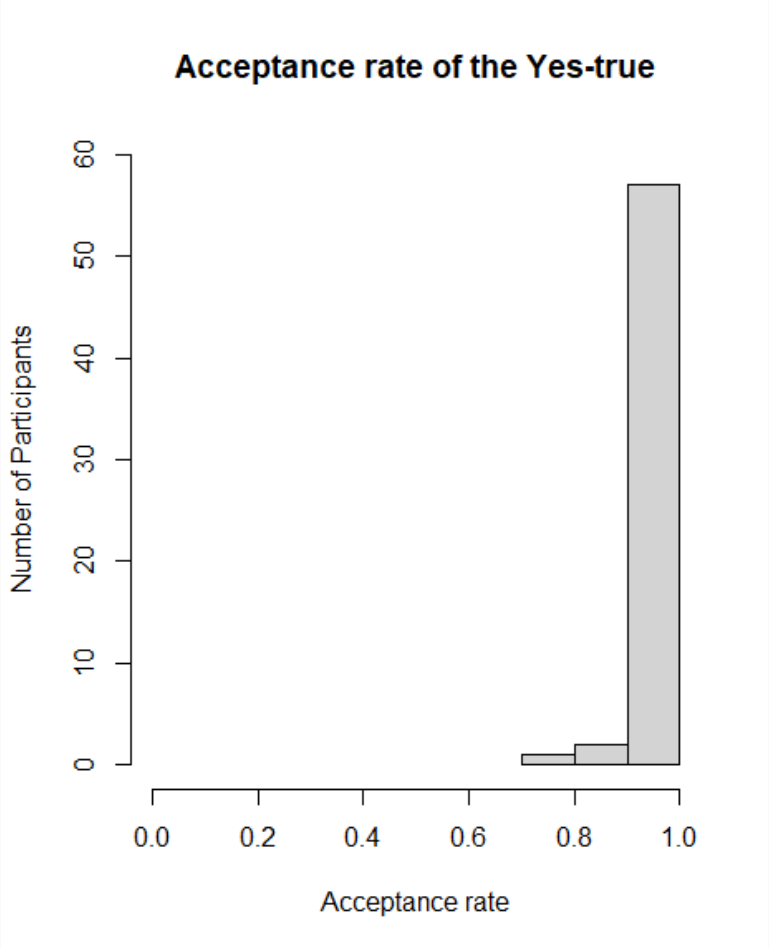


Figure 1: Distribution of participants by mean accepted rate for TRUE and FALSE conditions for the "Yes" particle.

Results: acceptance rate

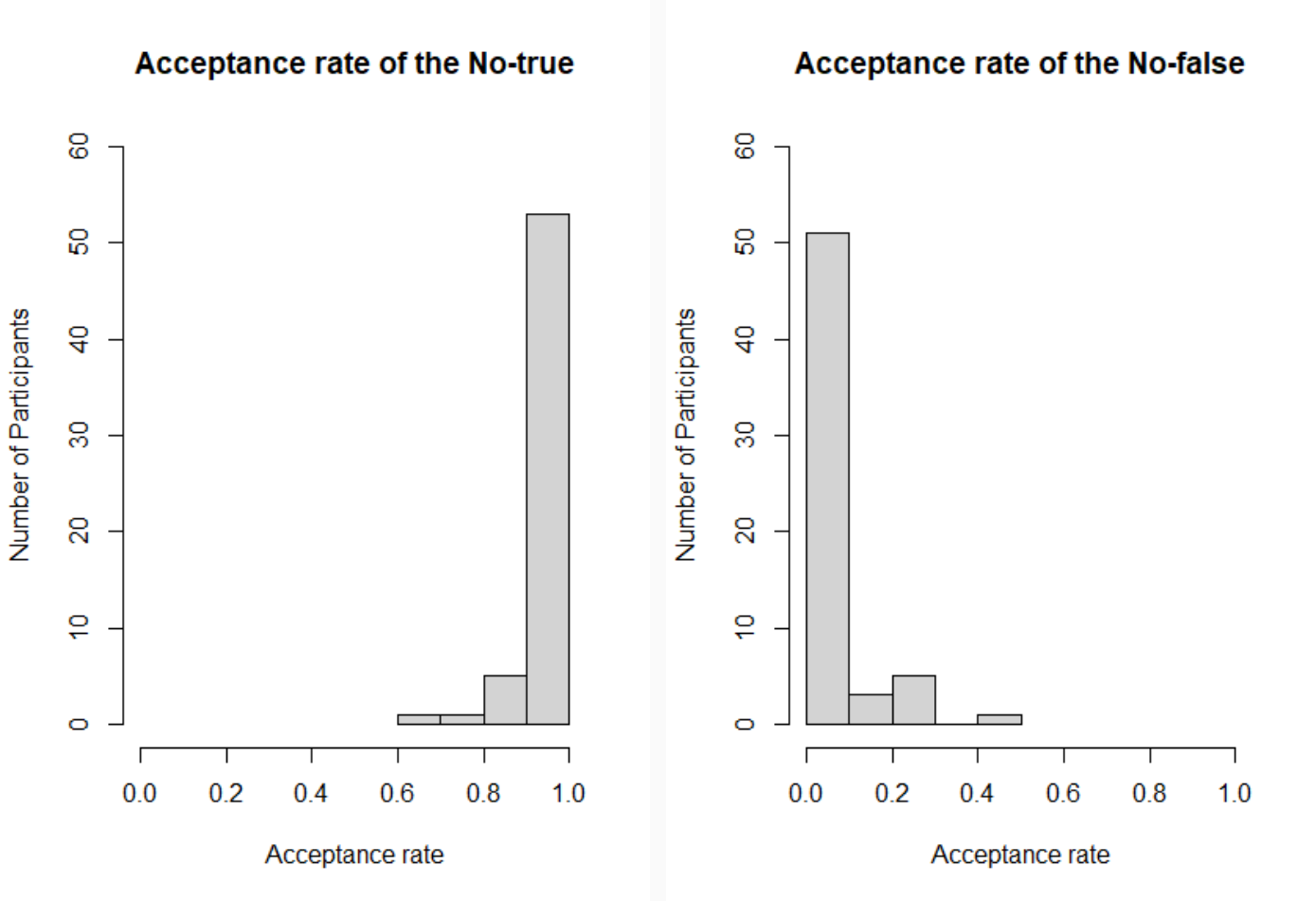
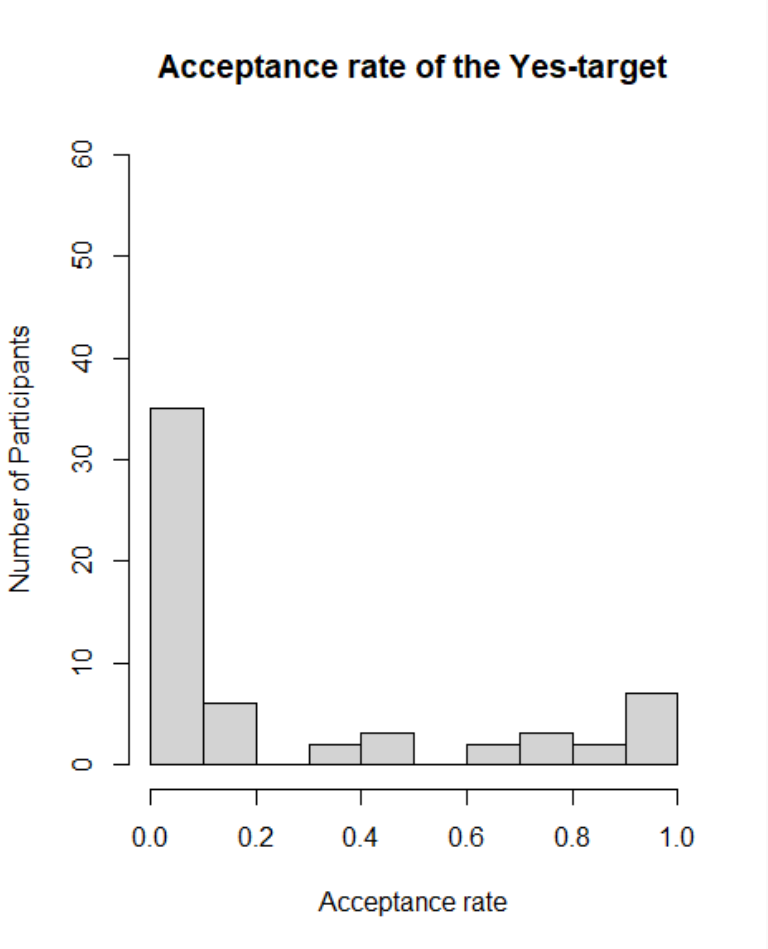


Figure 2: Distribution of participants by mean accepted rate for TRUE and FALSE conditions for the "No" particle.

Results: Target acceptance rate



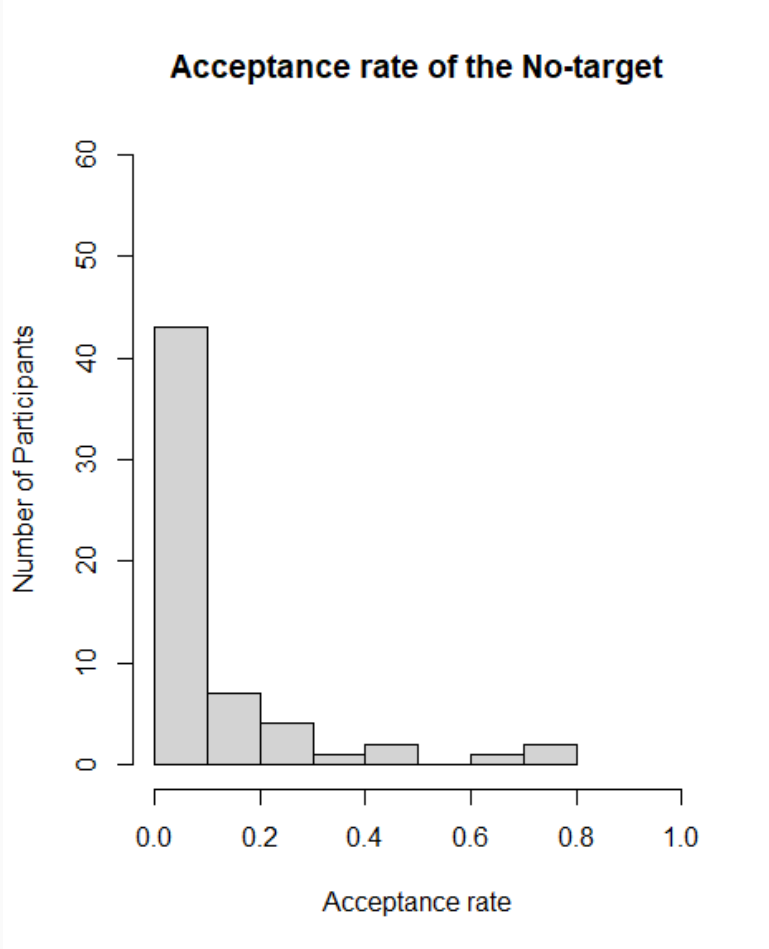


Figure 3: Distribution of participants by mean accepted rate for TARGET conditions "Yes" and "No" particles. There are Non-Free Choice participants, but no Non-Dual Prohibition participants.

Results: acceptance rate

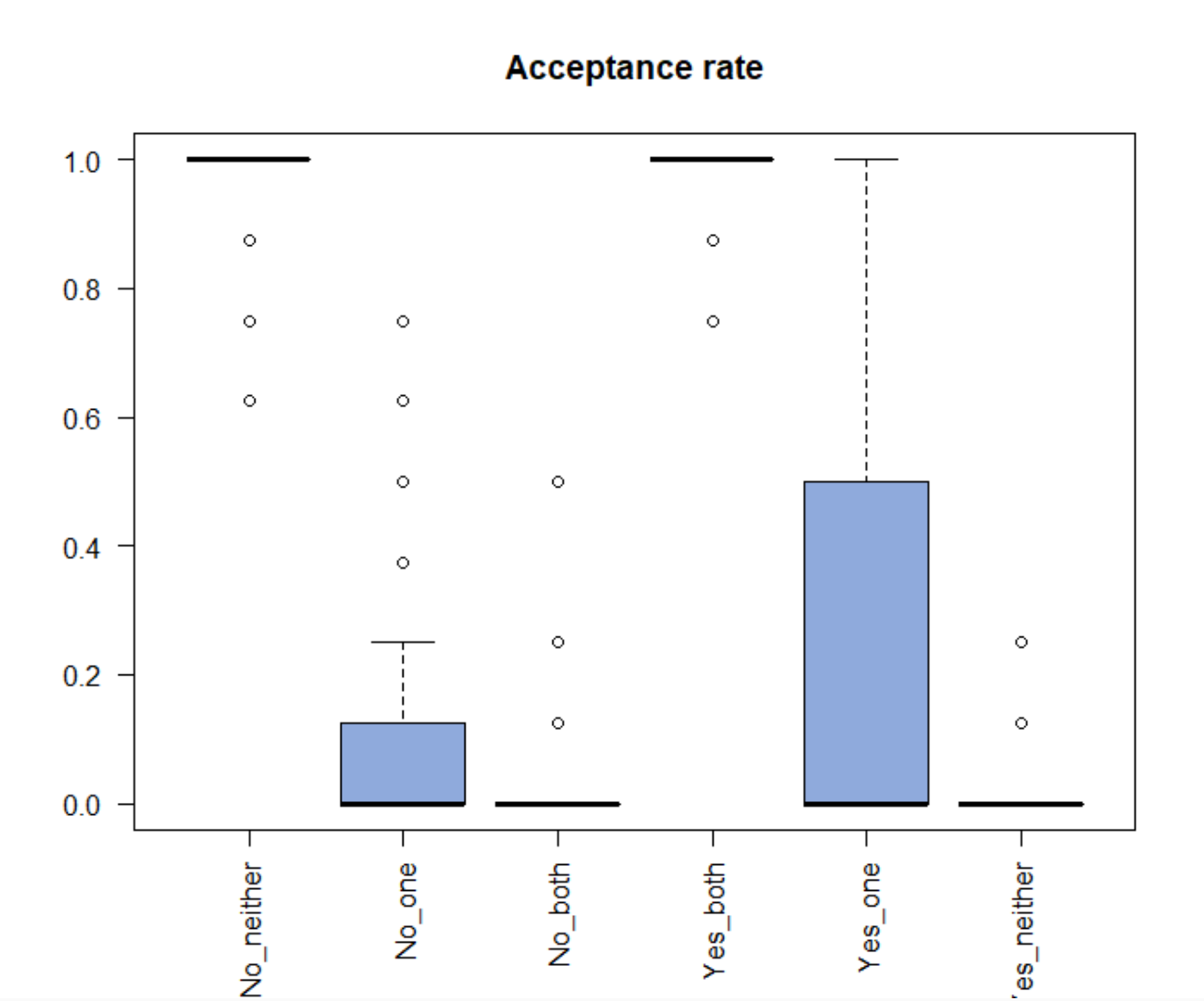


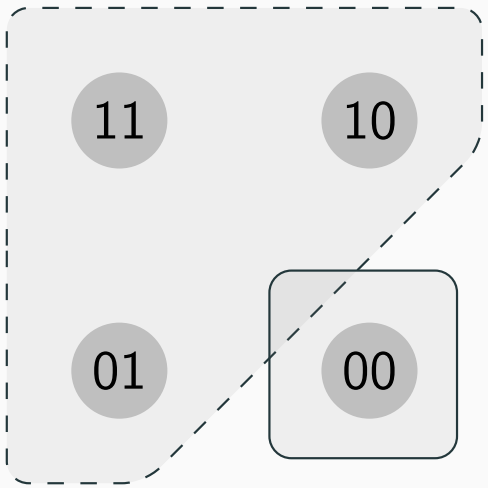
Figure 4: Mean accepted rate of participants for "Yes" and "No" particles.

Results: acceptance rate

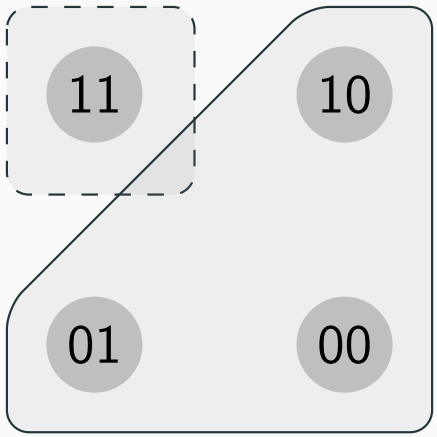
- The "Yes" answer to an *FCQ* corresponds to Free Choice .
- The "No" answer to an *FCQ* corresponds to Dual Prohibition .
- Acceptance rates of FC and DP are lower than for the controls.
- We did not find any differences between scenarios/speech acts.
- There are Non-Free Choice participants , but no Non-Dual Prohibition participants.

Results: acceptance rate

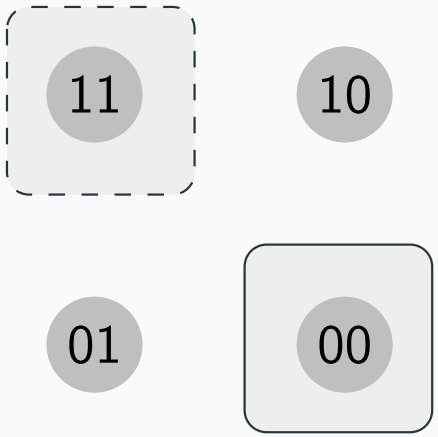
- The "Yes" answer to an *FCQ* corresponds to Free Choice **(c)**.
- The "No" answer to an *FCQ* corresponds to Dual Prohibition **(c)**.
- There are Non-Free Choice participants **consistently choosing (a)**, but no Non-Dual Prohibition participants.



(a)



(b)



(c)

Interpretation of reaction times data

Various studies observed the delay effect: computing a scalar implicature takes longer than computing the literal meaning (e.g. Bott and Noveck, 2004; Bott et al., 2012).

Performing a pragmatic weakening e.g. suspending presupposition (Schwarz, 2013) or neglect-zero (Ramotowska et al., 2022) takes longer than computing the meaning using the pragmatic effect. (reversed delay effect).

Bott et al. (2019) as well as Ramotowska et al. (2022) showed that it takes longer to process zero-models than non-zero-models at least in the domain of quantifiers.

Predictions:

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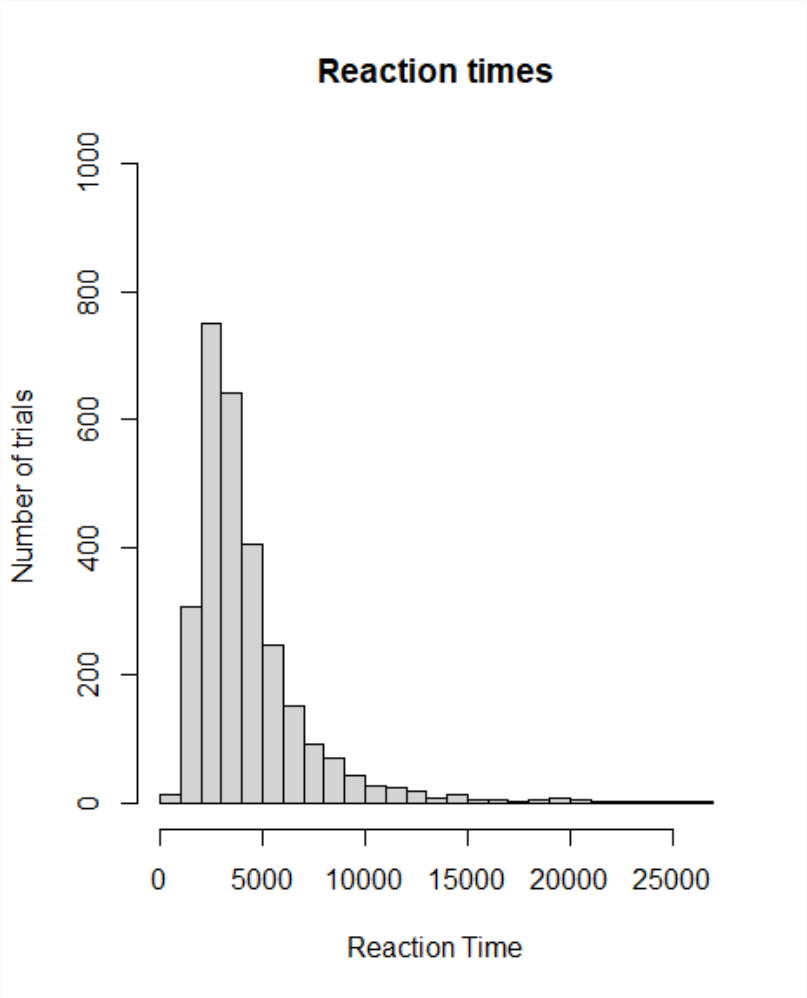
- **Neglect-zero** effect used in BSML predicts that considering zero models (TARGETS) should take **longer** the non-zero controls. Suspending neglect-zero should take longer, than using it: **reversed delay effect**.

Predictions regarding reaction times data

	Yes		No	
Data	RT	Delay	RT	Delay
InqSem	const	no	const	no
Deontic InqL	const	no	const	no
Exhaustivity	longer	yes	shorter	no
Homogeneity	longer	reversed	longer	?no
BSML	longer	reversed	longer	?no

Results: reaction times

We removed 24 outliers which lay further than 3σ from the mean (longer than 27 seconds) leaving us with 2856 trials with a mean reaction time of 4.3 seconds and a standard deviation of 3 seconds.



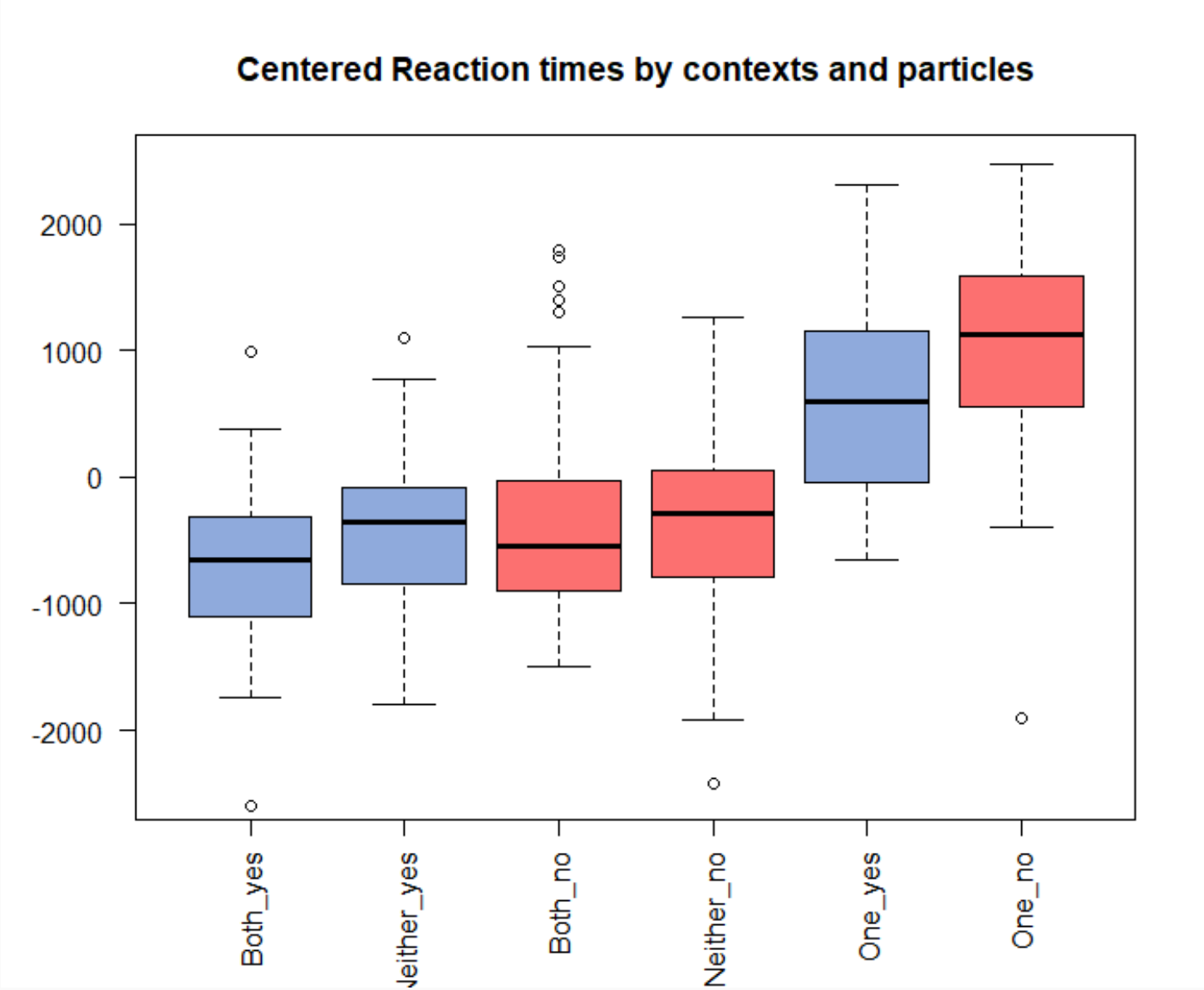
Results: reaction times

We observed two effects on the test trials:

Negation effect: The items with the "No" particle as the answer, took significantly longer ($\beta \approx 0.3$sec, $p < 0.001$).

Target effect: The items with the context where only one alternative is allowed took significantly longer ($\beta \approx 1.4$sec, $p < 0.001$).

Results: reaction times



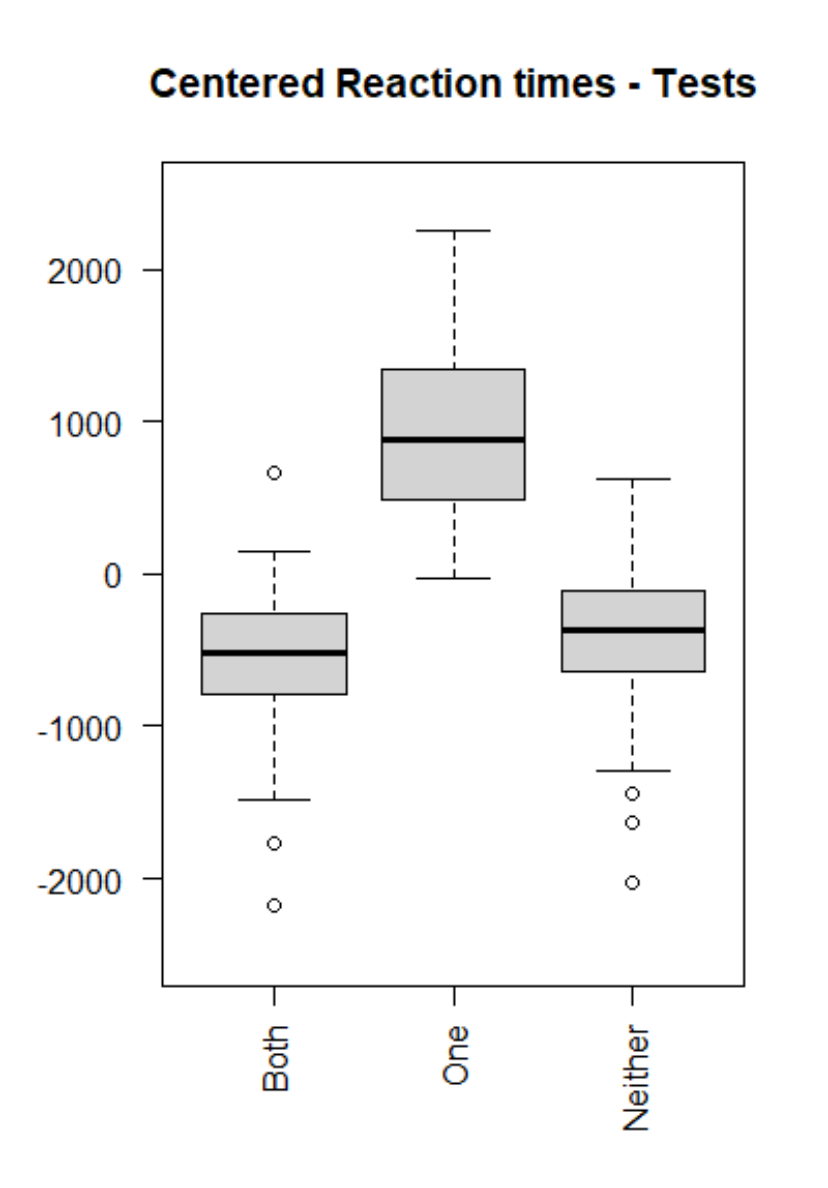
Results: reaction times

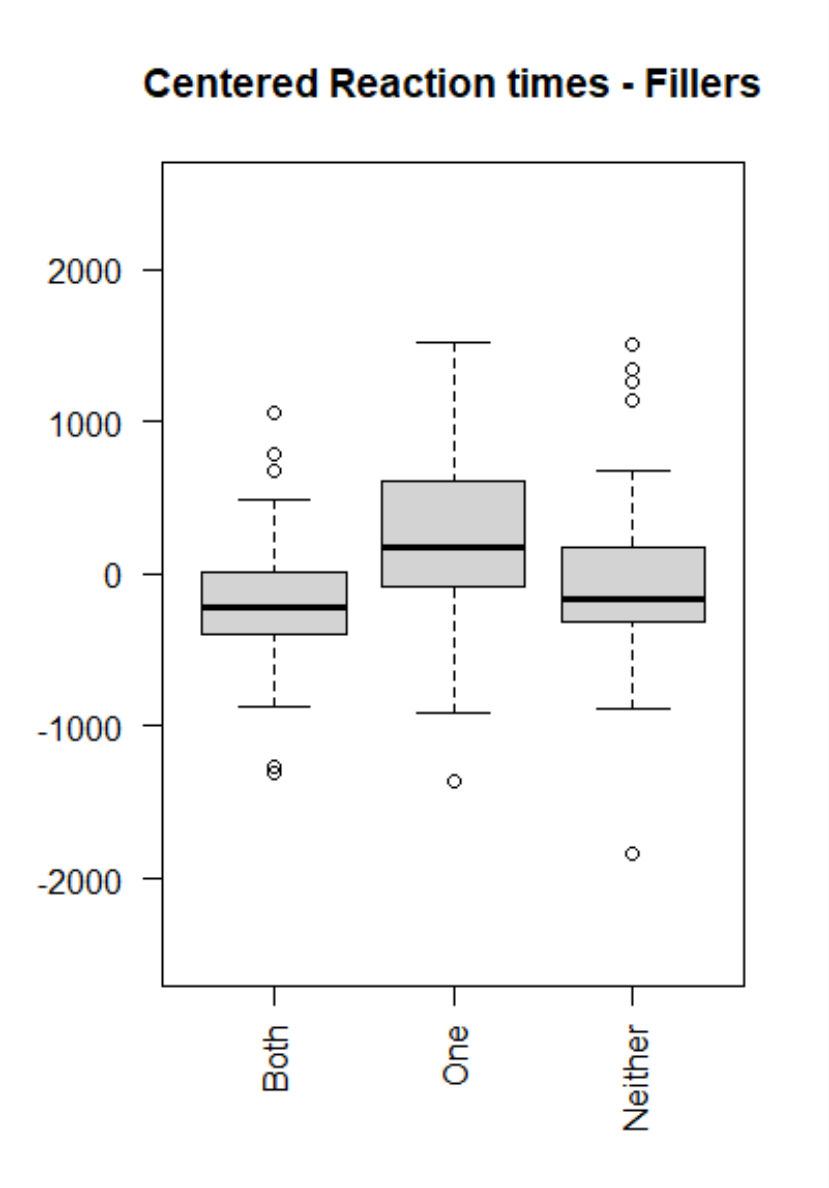
Since longer reaction times for TARGET may have multiple sources, we can compare the test items to filler items, and see if we can find the same effect there:

Negation effect, is significant and similar in size to the one found on test items ($\beta \approx 0.3sec$, $p < 0.001$).

Target effect, but it is much smaller in size ($\beta \approx 0.2sec$) and barely significant ($p \approx 0.03$).

Results: reaction times





Results: delay effect

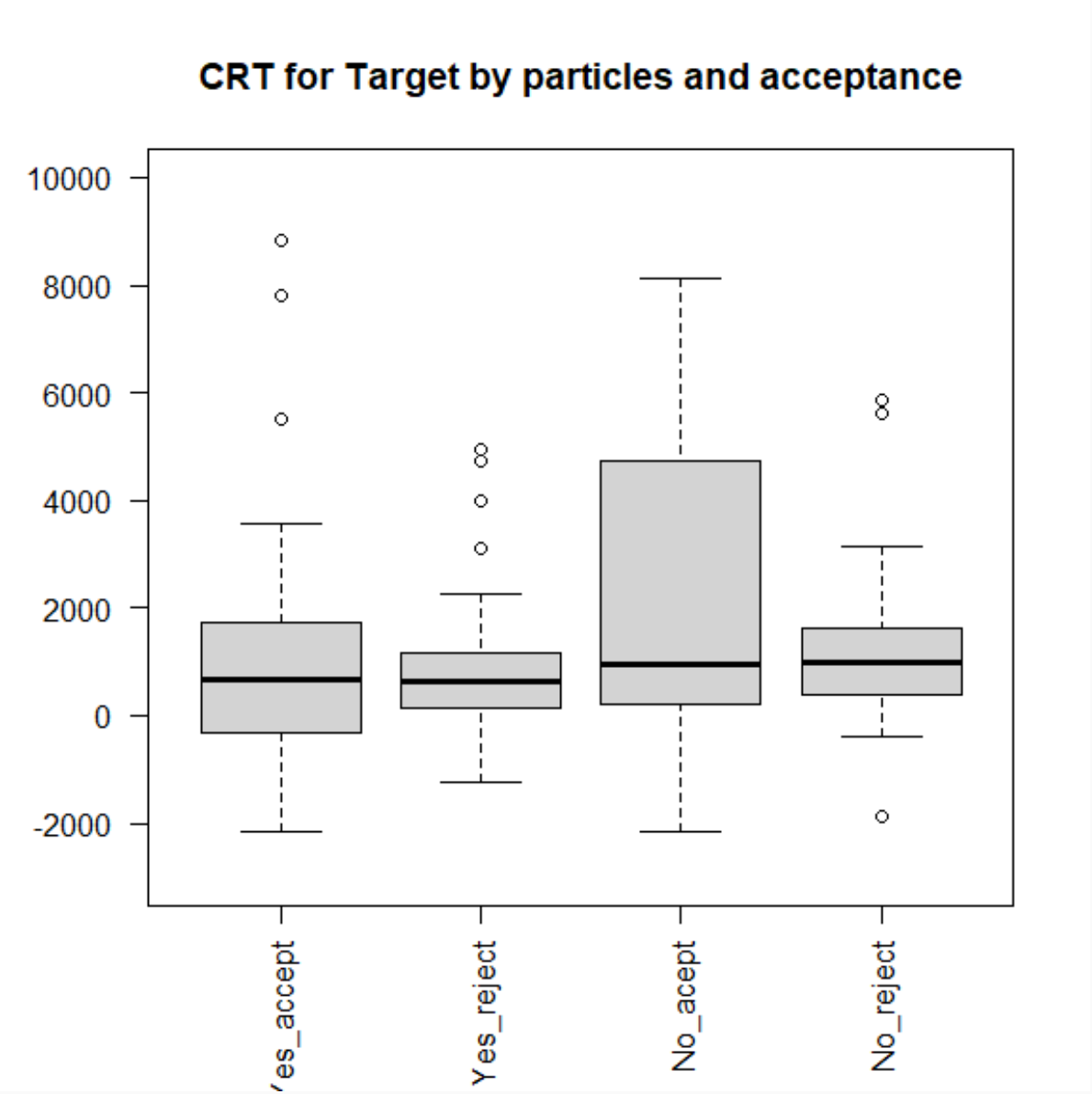
Delay effect (centred reaction times):

×*FC* No delay: rejecting TARGET conditions for "Yes" particle took as long as accepting them ($\beta \approx -0.1$sec, $p > 0.1$).

?DP Reversed delay: Rejecting TARGET conditions for "No" particle takes significantly shorter than accepting, however, this difference is barely significant. ($\beta \approx 1.2$ sec $p = 0.0183$) Moreover, removing outliers from the set of TARGET conditions makes this result smaller ($\beta \approx 0.7$ sec $p > 0.05$). [6]

[6] Since we only consider 9% of the "No" responses to TARGET(42 trials and 17 participants), the significance is expected to be low. Moreover, the impact of outliers increases.

Results: delay effect



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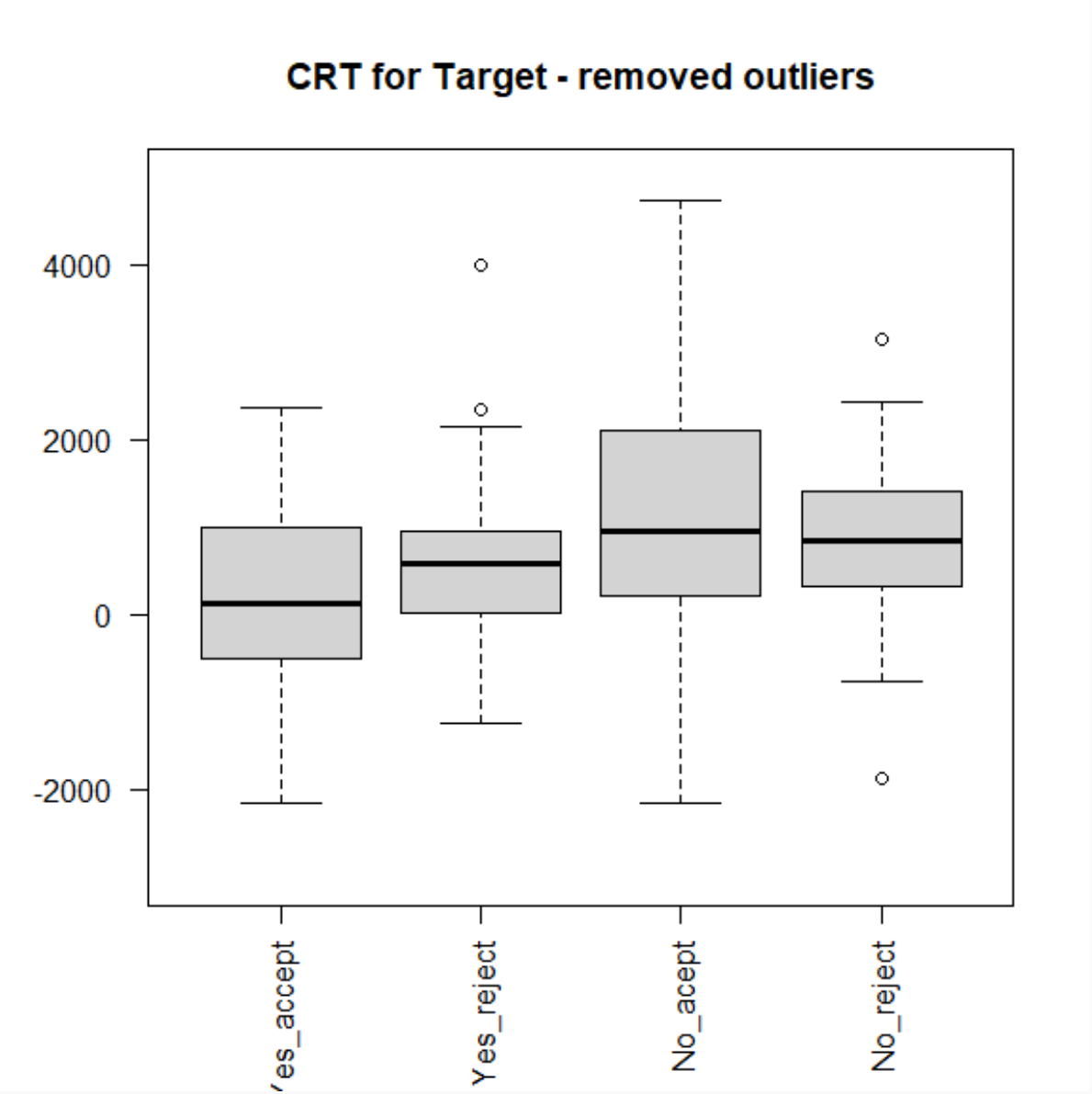

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Conclusions:

1. The "Yes" answer to a *FCQ* corresponds to Free Choice.
2. The "No" answer to a *FCQ* corresponds to Dual Prohibition.
3. Both these inferences most likely have a pragmatic source (lower acceptance rate + longer reaction times).
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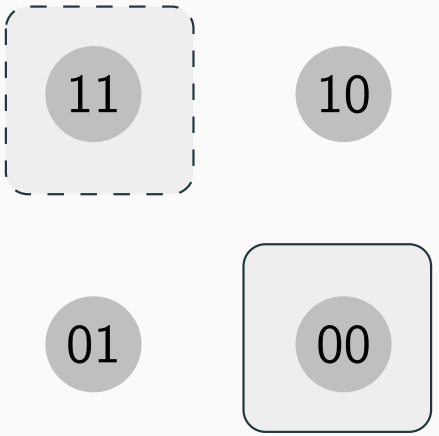
Potential weaknesses:

- Not much data on delay effect for "No"
- More trials with default rejection than acceptance (2:1) + Yes-bias.
- Difference in reaction times may have various explanations.

Theory vs. data

Theory	FC	Source	DP	Source	FCQ	Source
InqSem	×	sem	✓	sem	×	sem
Deontic InqL	✓	sem	×	sem	×	sem
Exhaustivity	✓	gram	✓	gram/prag	×?	sem/prag
Homogeneity	✓	sem/prag	✓	sem	✓	sem/prag
BSML	✓	prag	✓	sem+prag	✓	sem+prag



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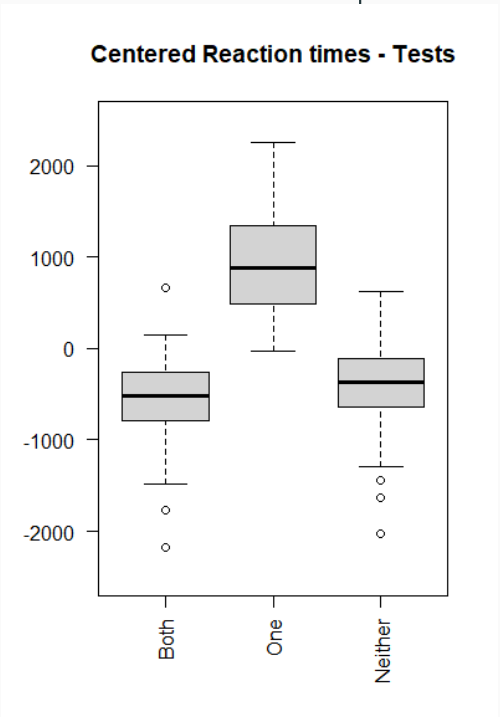

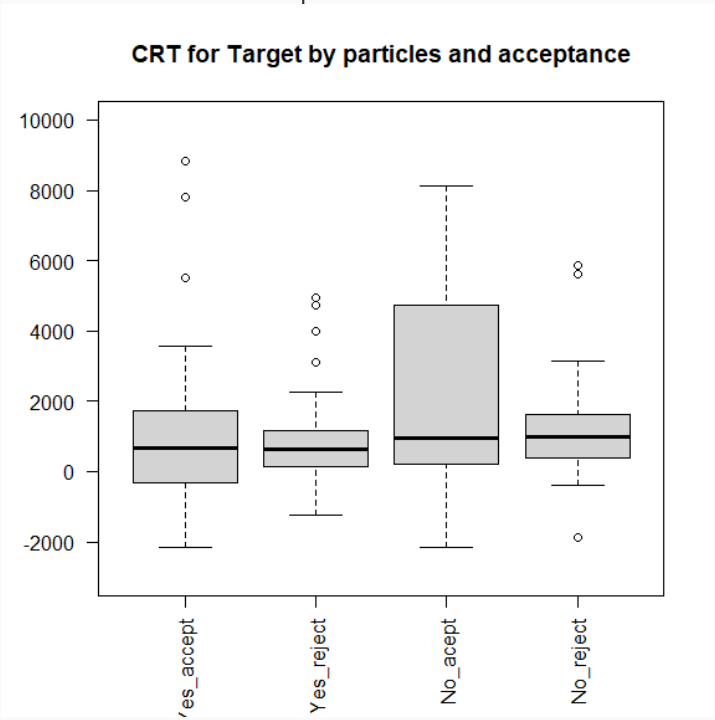

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- ✓ **BSML** with inquisitive disjunction explains the behaviour of FCQs and longer reaction times in terms of neglect-zero. However, the predicted reversed delay effect was not observed.
- ✓ BSML can explain the Non-Free Choice participants through suspension of neglect-zero. We would expect that the Homogeneity presupposition cannot be globallly "suspended".

Further research

1. Other possible answers to Free Choice Questions (e.g. involving cancellation)
2. Embedded Free Choice Questions: *Mary knows whether Bill may go to the park or to the beach.*
3. Scalar Questions and Homogeneity Questions:
   - *Did* **some** *students pass the exam?*
   - *Did* **the boys** *go to the park?*
   - *Did you* **stop** *smoking?*
4. Relation between FCQ, wh-questions and indefinites:
   - *May I have* **a cookie***?*
   - Which cookie may I have?
   - Which boy may have which cookie?

Thank you!

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Exhaustification backup

$Alt(\mathcal{Q}) = \{\Diamond(\alpha \vee \beta), \neg\Diamond(\alpha \vee \beta), \Diamond(\alpha \vee \beta) \wedge \neg\Diamond(\alpha \vee \beta)\}$

Exclusion: $\Diamond(\alpha \vee \beta) \wedge \neg\Diamond(\alpha \vee \beta)\}$

Inclusion: $\{\Diamond(\alpha \vee \beta)\} \cap \{\neg\Diamond(\alpha \vee \beta)\} = \emptyset$

Rejecting TARGET conditions took as long as accepting them ($\beta \approx$ 0.1sec, $p > 0.1$).