Negation and alternatives in counterfactual antecedents

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Alternatives in counterfactual antecedents

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Contemporary semantics of conditionals distinguish

1. the alternatives raised by a conditional antecedent
2. the mechanism used to hypothetically assume each alternative

(3) Ciardelli (2016): $A > C$ is true at a state s just in case for every $p \in \text{alt}(A)$ there is a $q \in \text{alt}(C)$ such that $s \subseteq p \Rrightarrow q$

Recent work on conditional antecedents

Recent work on the semantics of conditionals

- Ciardelli et al. (2018) — inquisitive semantics
- Fine (2012) — truthmaker semantics
- Santorio (2018) — truthmaker/alternative semantics
- Willer (2018) — dynamic semantics
- Schulz (2018) — novel semantics of negation

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Each paper has a different semantic entry for negation

Negation flattens alternatives	Alternatives survive negation
Kratzer and Shimoyama (2002)	Fine (2012)
Alonso-Ovalle (2006)	Willer (2018)
Ciardelli et al. (2018)	Santorio (2018)
	Schulz (2018)

Experiment on what negation does to alternatives

Outline

Recent work on conditional antecedents

Experiment on what negation does to alternatives

- Experimental design
- Predictions
- Results

Discussion

Experimental design

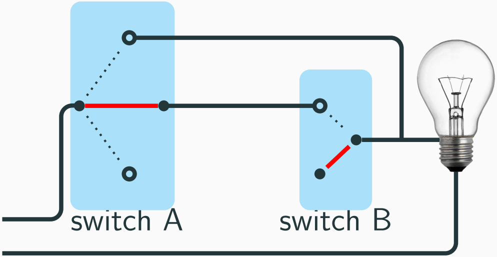
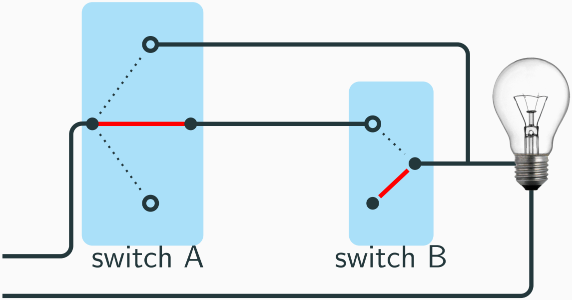


Figure 1: Scenario used in the experiment

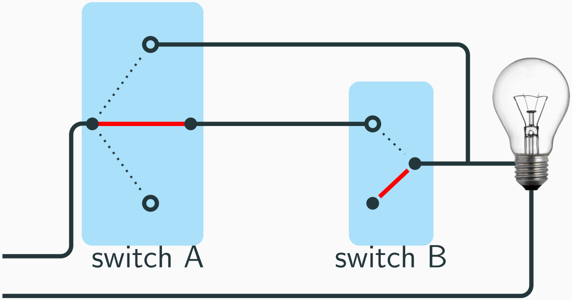
Fillers



False: Currently, switch A is in the middle and switch B is down. If that wasn't the case, the light would be on.

True: Currently, switch A is not up. If that was the case, the light would be on.

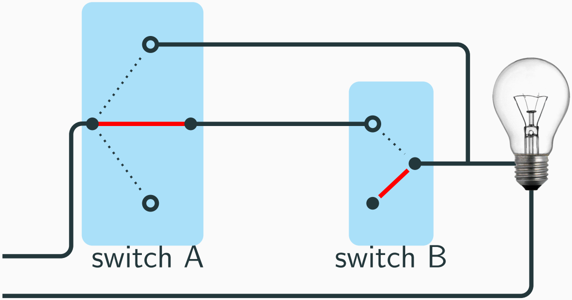
Control



Control: Currently, switch B is down. If that wasn't the case, the light would be on.

- Tests how much the participant keeps fixed

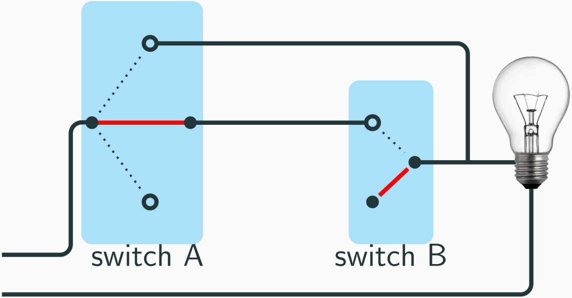
Main test



T1: Currently, neither switch is up. If that wasn't the case, the light would be on.

T2: Currently, switch A is in the middle and switch B is down. If switch A was up or switch B was up, the light would be on.

Final test



T3: If switch B was up but not switch A, the light would be on.

Outline

Alternatives survive negation just in case $[\![\neg A]\!]$ can contain multiple elements.

Do alternatives survive negation?

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Do alternatives survive negation?

(4) Kratzer and Shimoyama (2002):
[Neg](A) $=$ {the proposition that is true in all worlds in which no proposition in A is true}

If alternatives do not survive negation...

$$\neg\neg(A\!\uparrow \vee B\!\uparrow) > \textsc{On} \tag{T1}$$

$$\neq$$

$$A\!\uparrow \vee B\!\uparrow > \textsc{On} \tag{T2}$$

If alternatives survive negation...

Disjunction introduces alternatives

Validate De Morgan's law $\qquad \neg(A \wedge B) \equiv \neg A \vee \neg B$

$\Rightarrow$ Negation introduces alternatives

(5) $\neg\neg(A \vee B) \equiv \neg(\neg A \wedge \neg B) \equiv \neg\neg A \vee \neg\neg B \equiv A \vee B$

T1: Currently, neither switch is up. If that wasn't the case, the light would be on. $\qquad \neg\neg(A\!\uparrow \vee\ B\!\uparrow) > \textsc{On}$

T2: Currently, switch A is in the middle and switch B is down. If switch A was up or switch B was up, the light would be on. $\qquad A\!\uparrow \vee\ B\!\uparrow > \textsc{On}$

If alternatives do not survive negation...

Schulz (2018): according to both the similarity approach and Ciardelli et al. (2018)'s background semantics, if A has one alternative and B is true at w, then

$$w \models (A \wedge B) > C \qquad \text{iff} \qquad w \models B > C.$$

T3 If switch B was up but not switch A, the light would be on.
$B\!\uparrow \wedge \neg A\!\uparrow > \textsc{On}$

$$B\!\uparrow \wedge \neg A\!\uparrow > \textsc{On} \qquad \equiv \qquad B\!\uparrow > \textsc{On}$$

If alternatives survive negation...

(6) Switch A is not up $\equiv$ Switch A is in the middle or down.

$$
\begin{aligned}
& (B\uparrow \wedge \neg A\uparrow) > \textsc{On} \\
\equiv\ & B\uparrow \wedge (A\bullet \vee A\downarrow) > \textsc{On} \\
\equiv\ & (B\uparrow \wedge A\bullet) \vee (B\uparrow \wedge A\downarrow) > \textsc{On} && \text{(Dist } \wedge \text{ over } \vee\text{)} \\
\Rightarrow\ & (B\uparrow \wedge A\downarrow) > \textsc{On} && \text{(SDA)}
\end{aligned}
$$

$$B\uparrow \wedge \neg A\uparrow > \textsc{On} \quad \not\equiv \quad B\uparrow > \textsc{On}$$

Schulz (2018)

(7) *Schulz negation*

a. $\mathcal{L}(\varphi) = \{a : a \text{ is an atomic sentence appearing in } \varphi\}$

b. $w \sim_\varphi v$ iff $w(a) = v(a)$ for every $a \in \mathcal{L}(\varphi)$

(i) Binary version: $w(a) \in \{0, 1\}$ for every world w and atomic sentence a.

(ii) n-ary version: $w(a)$ can be outside $\{0, 1\}$.

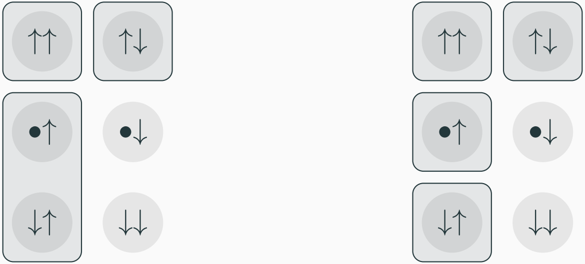
c. For any information state $p \subseteq W$,

(i) $p \models Q(\varphi)$ iff $w \sim_\varphi v$ for every $w, v \in p$ (p 'answers the question raised by φ')

(ii) $p \perp \varphi$ iff $p \cap |\varphi|$ is empty (p and φ are mutually exclusive)

d. For any proposition $P \subseteq \wp(W)$, $P \models \neg\varphi$ iff $p \models Q(\varphi)$ and $p \perp \varphi$ for every $p \in P$

e. $[\![\text{not } \varphi]\!] = \{p \subseteq W : Q(\varphi) \text{ and } p \perp \varphi\}$



(a) Binary atomics

(b) *n*-ary atomics

Figure 2: T1, $\neg\neg(A\!\uparrow \vee B\!\uparrow)$, in Schulz's framework

Overview of predictions

Theory / Antecedent	T1 $\neg\neg(A\uparrow \vee B\uparrow)$	T2 $A\uparrow \vee B\uparrow$	T3 $B\uparrow \wedge \neg A\uparrow$
Alonso-Ovalle (2006)	✗	✓	✓
Ciardelli et al. (2018)	✗	✓	✓
Fine (2012)	✓	✓	✗
Santorio (2018)	✓	✓	✗
Willer (2018)	✓	✓	✗
Schulz (2018) binary	✓	✓	✗
Schulz (2018) *n*-ary	✗	✓	✗

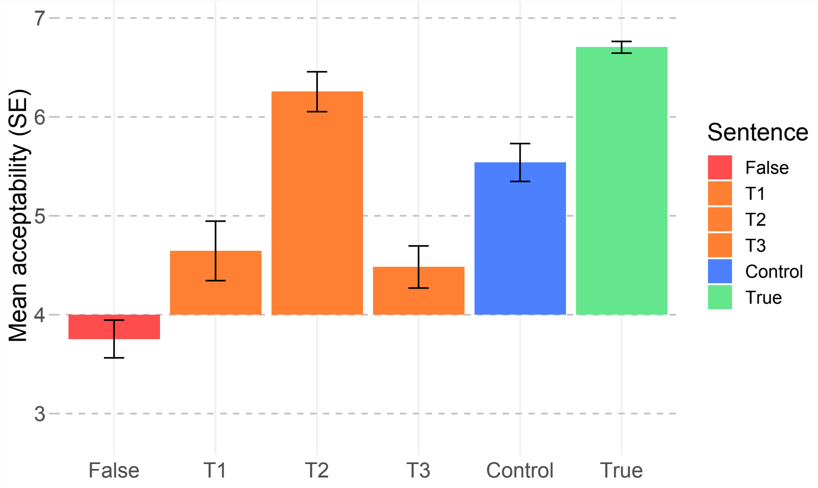
Table 1: Overview of predictions

Experimental setup

- 192 Mechanical Turk participants, excluding:
  - 74 participants who responded ≤ 4 on the True filler;
  - 3 participants who didn't report English as native language
- Each participant only saw one of T1 and T2, in random order with the True and False filler and the Control item, T3 presented last

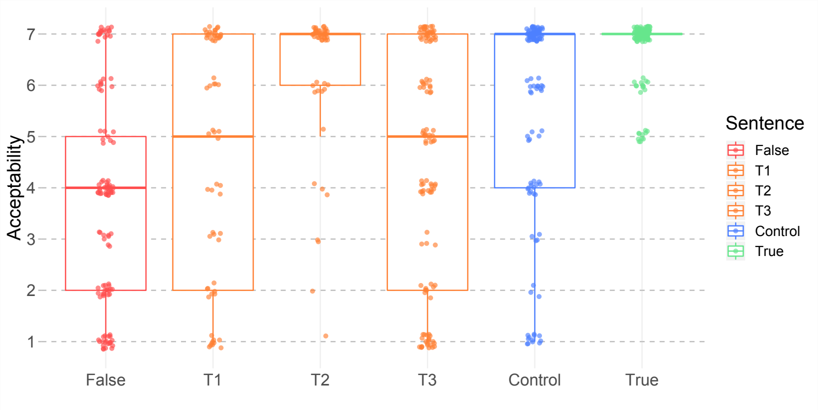
Outline

Results



F	T1	T2	T3	C	T
$\neg(A \cdot \wedge B\downarrow)$	$\neg\neg(A\uparrow \vee B\uparrow)$	$A\uparrow \vee B\uparrow$	$B\uparrow \wedge \neg A\uparrow$	$\neg B\downarrow$	$A\uparrow$

Box plot



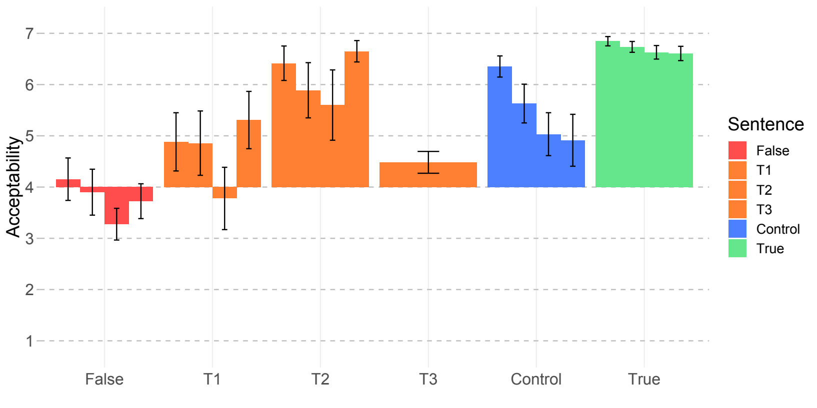
;

F	T1	T2	T3	C	T
$\neg(A\cdot \wedge B\downarrow)$	$\neg\neg(A\uparrow \vee B\uparrow)$	$A\uparrow \vee B\uparrow$	$B\uparrow \wedge \neg A\uparrow$	$\neg B\downarrow$	$A\uparrow$

Analysis of results

- Cumulative link mixed model on data from the control and test sentences
- T1 and T3 rated significantly lower than the control (both $z < -2.5$, $p < .01$)
- T2 rated significantly higher than control ($z = 2.1, p = .039$)
- Posthoc comparison of targets T1 and T3 revealed no difference between the two ($z = -0.5, p = .62$)

Order effects



F	T1	T2	T3	C	T
$\neg(A \cdot \wedge B\downarrow)$	$\neg\neg(A\uparrow \vee B\uparrow)$	$A\uparrow \vee B\uparrow$	$B\uparrow \wedge \neg A\uparrow$	$\neg B\downarrow$	$A\uparrow$

Discussion

Overview of predictions (interpreted)

Theory / Antecedent	T1 $\neg\neg(A\uparrow \vee B\uparrow)$	T2 $A\uparrow \vee B\uparrow$	T3 $B\uparrow \wedge \neg A\uparrow$
Our data (interpreted)	✗	✓	✗
Alonso-Ovalle (2006)	✗	✓	✓
Ciardelli et al. (2018)	✗	✓	✓
Fine (2012)	✓	✓	✗
Santorio (2018)	✓	✓	✗
Willer (2018)	✓	✓	✗
Schulz (2018) binary	✓	✓	✗
Schulz (2018) *n*-ary	✗	✓	✗

Table 2: Overview of predictions, with new data

Summary

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- Experimental evidence against
  - Alonso-Ovalle (2006) — alternative semantics
  - Ciardelli et al. (2018) — inquisitive semantics
  - Fine (2012) — truthmaker semantics
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  - Willer (2018) — dynamic semantics
- Our results can be accounted for by adapting the semantic entry for negation
  - Schulz (2018) accounts for our data by taking into account the ‘question’ raised the the conditional antecedent
- But our results challenge a purely semantic explanation of the data

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Schulz (2018)'s experiment

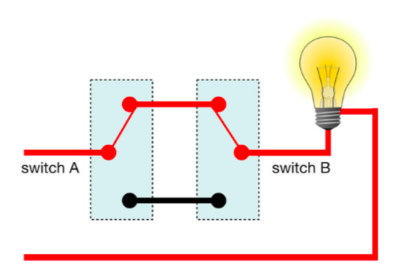

Figure 3: Scenario used in Ciardelli et al. (2018)'s experiment

(8) a. If the electricity was working, then the light would be on.
b. If the electricity was working and switch A was up, then the light would be on.
c. If the electricity was working and switch A and switch B were not both up, then the light would (still) be off.

Results from Schulz (2018)'s experiment

sentences	true	%	false	%	indet.	%
$E \rightsquigarrow On$	8	16%	42	82%	1	2%
$(E \wedge A) \rightsquigarrow On$	43	84%	5	10%	2	4%
$[E \wedge \neg(A \wedge B)] \rightsquigarrow On$	14	27%	27	53%	8	16%
$[E \wedge \neg(A \wedge B)] \rightsquigarrow On^{*}$	9	26%	20	59%	5	15%

Figure 4: Results from Schulz (2018)'s experiment

Conclusion

- The mechanism for making hypothetical assumptions in Ciardelli et al. (2018) keeps too much fixed