A Semantics for Causing, Enabling, and Preventing with Structural Causal Models

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Introduction

What are the differences between the following?

• Jo caused the children to dance.



- Jo enabled the children to dance.
- Jo prevented the children from dancing.

Previous Work

- 1. Wolff (2007) argues that periphrastic causal verbs can be organized into CAUSE, ENABLE, and PREVENT-families [7]
- 2. Researchers have used structural causal models (SCMs) in the style of Pearl (2009) to define semantics for these verbs [5, 3, 4]

Semantics using SCMs

A structural causal model (SCM) represents events as settings of variables. For example:

 $\mathcal{F}(\text{Location} = 3, \text{Timestep} = 4) = \checkmark$ represents the event of a banana being at location 3 at



Figure 1. A mockup of one of the short videos shown to participants.

Results & Discussion











timestep 4.

Hypotheses

Our semantics based on SCMs makes the following predictions for constructions of the form:

$$X \begin{cases} caused enabled \\ got \quad allowed \end{cases} to Z X \begin{cases} made \\ let \end{cases} Z \\ x \begin{cases} prevented \\ stopped \\ blocked \end{cases} from Zing$$

H1. X may be an event of omission for all verbs, contra [2, 6]

H2. Enabling verbs do not entail that Z happened, contra [1, 8]

H3 Preventing verbs do not entail that Z would have hap-

(e) \blacksquare , $\P \to \square$, \Re does nothing, \P reaches \square



rock is not initially placed	🐔 removes 🐗: wizard removes the rock
rock is initially placed	🐔 places 👞: wizard places the rock
\rightarrow •: farmer goes for the apple	or does nothing: wizard does nothing
$\rightarrow \rightarrow$: farmer goes for the banana	🐐 reaches 🎃: farmer reaches the apple
blaces . wizard places the rock	reaches -: farmer reaches the banana

Figure 2. Proportion of participants who judged the different expressions to be accurate (blue bars with 95% bootstrapped confidence intervals) together with the theoretical predictions (striped pink bars).

H1 is supported in Figures 2c, 2d, and 2e H2 is supported in Figures 2b and 2d H3 is supported in Figures 2a and 2e

Takeaway: When both the entities in X and Z are agentive, X may be an event of omission, enabling verbs do not entail that Z occurred, and preventing verbs do not entail that Z would have happened if not for X.



pened if not for X, contra [1, 8]

Methods

With a structural causal model defining a gridworld with two fruits (an \clubsuit and \checkmark) and two agents (a \checkmark and \checkmark), we presented 80 participants with 7 videos described by sentences, such as:

"The NP of the rock verbed the farmer (to/from) reach(ing) the apple."

Check out our paper!

References

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