Sentential Reasoning and Sentential Connectives:

Conditional, Disjunction, Negation, and Modality

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The causal conception of reasoning

(Wedgwood, 2006)

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- Reasoning is a causal process,
- in which one mental event
  (say, one's accepting the conclusion of a certain argument)
- is caused by an antecedent mental event
  (say, one's considering the premises of the argument).

(Wedgwood, 2006)

Core sentential inferences

(Khemlani, 2018)

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- Major Premise:
  If the housing market crashes, then the stock market will crash.

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- Implies that:

  The speaker is not in a position to know the two propositions are true.

(Ramsey, 1929; Russell, 1906)

Possible world and closed box

The Google doodle for Erwin Schrödinger's 126th Birthday
On August 12, 2013

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- 故事中，有个叫小明的男孩得到了其中一个箱子。小明有时侯已经打开了自己的箱子，有时候还没打开自己的箱子。测试句描述的就是小明拿到的那个特定的箱子。

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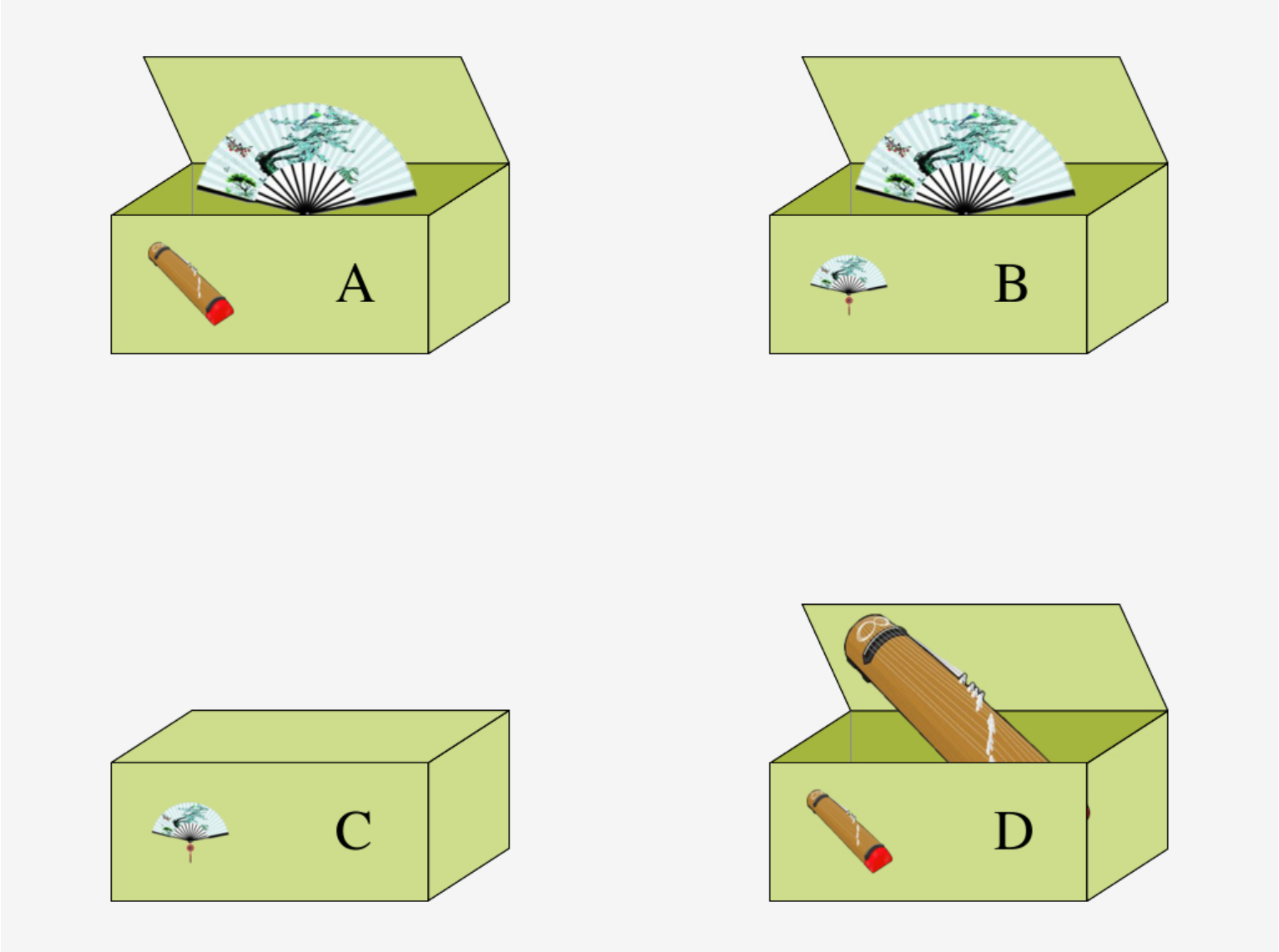
- 你要根据听到的测试句按键选择小明拿到的这个箱子是 A、B、C、D 中的哪个。

The case of conditionals



The case of conditionals

a). **Because**

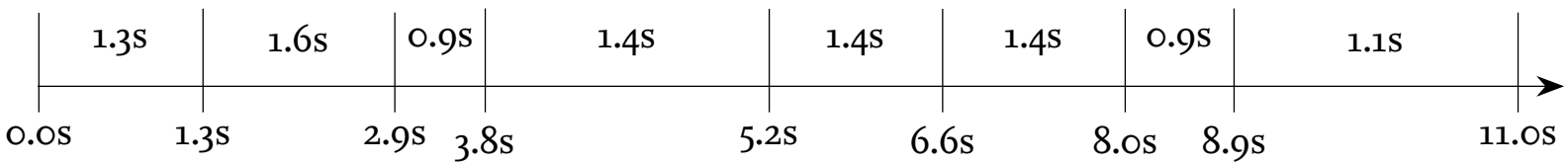
因为	箱子里	是	扇子/古筝	所以	小明	很	高兴/* 伤心
yinwei	xiangzi li	shi	shanzi/guzheng	suoyi	Xiaoming	hen	gaoxing/*shangxin
because	box in	is	fan/zither	therefore	Xiaoming	very	happy/*sad

*Because the box contains a fan/zither, therefore Xiaoming is very happy/*sad.*

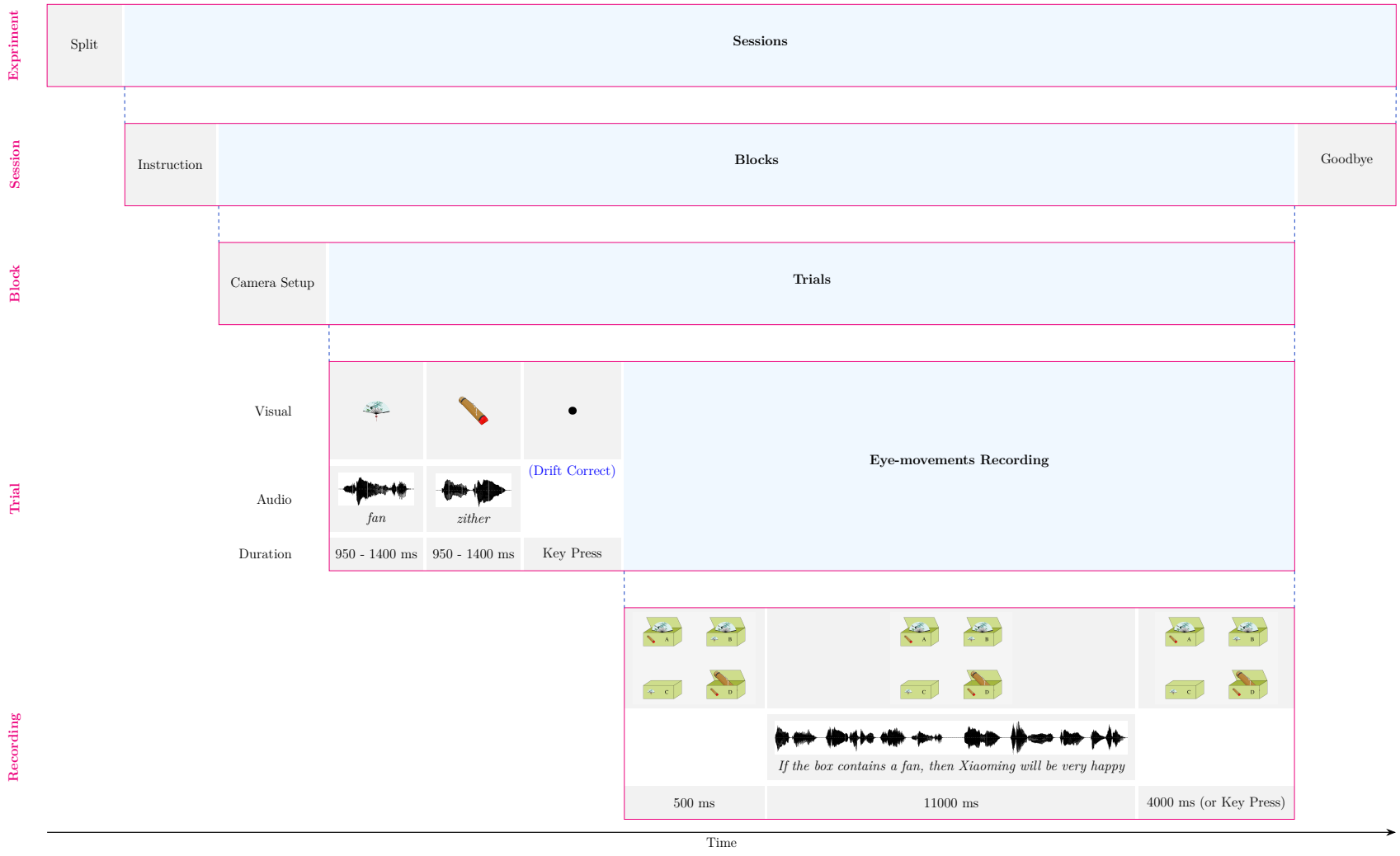
b). **If**

如果	箱子里	是	扇子/古筝	那么	小明	就	高兴/伤心
Ruguo	xiangzi li	shi	shanzi/guzheng	name	Xiaoming	jiu	gaoxing/shangxin
If	box in	is	fan/zither	then	Xiaoming	will	happy/sad

If the box contains a fan/zither, then Xiaoming will be very happy/sad.

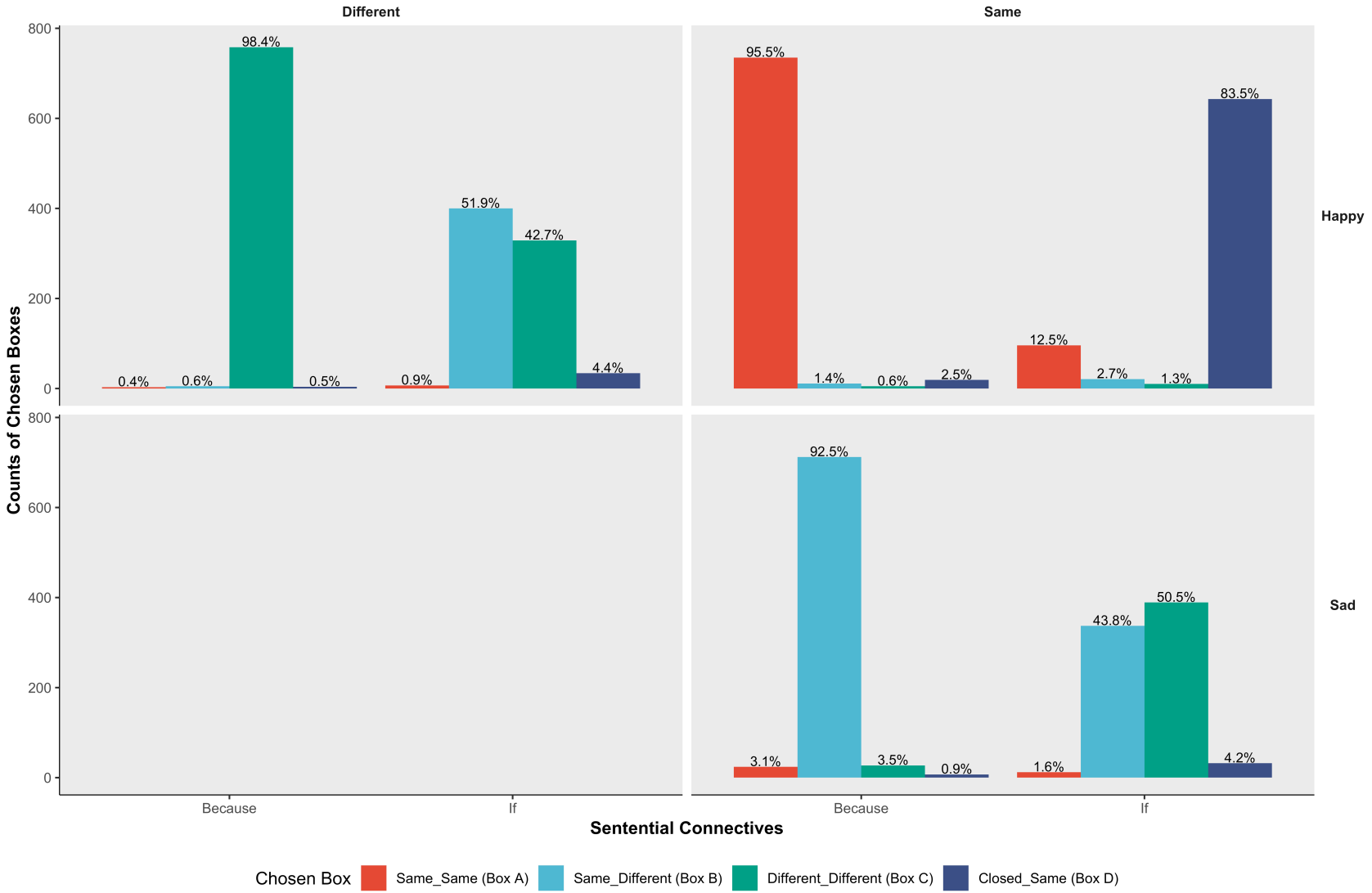


Visual World Paradigm: An eye-tracking technique



(Zhan, 2018b)

The case of conditionals



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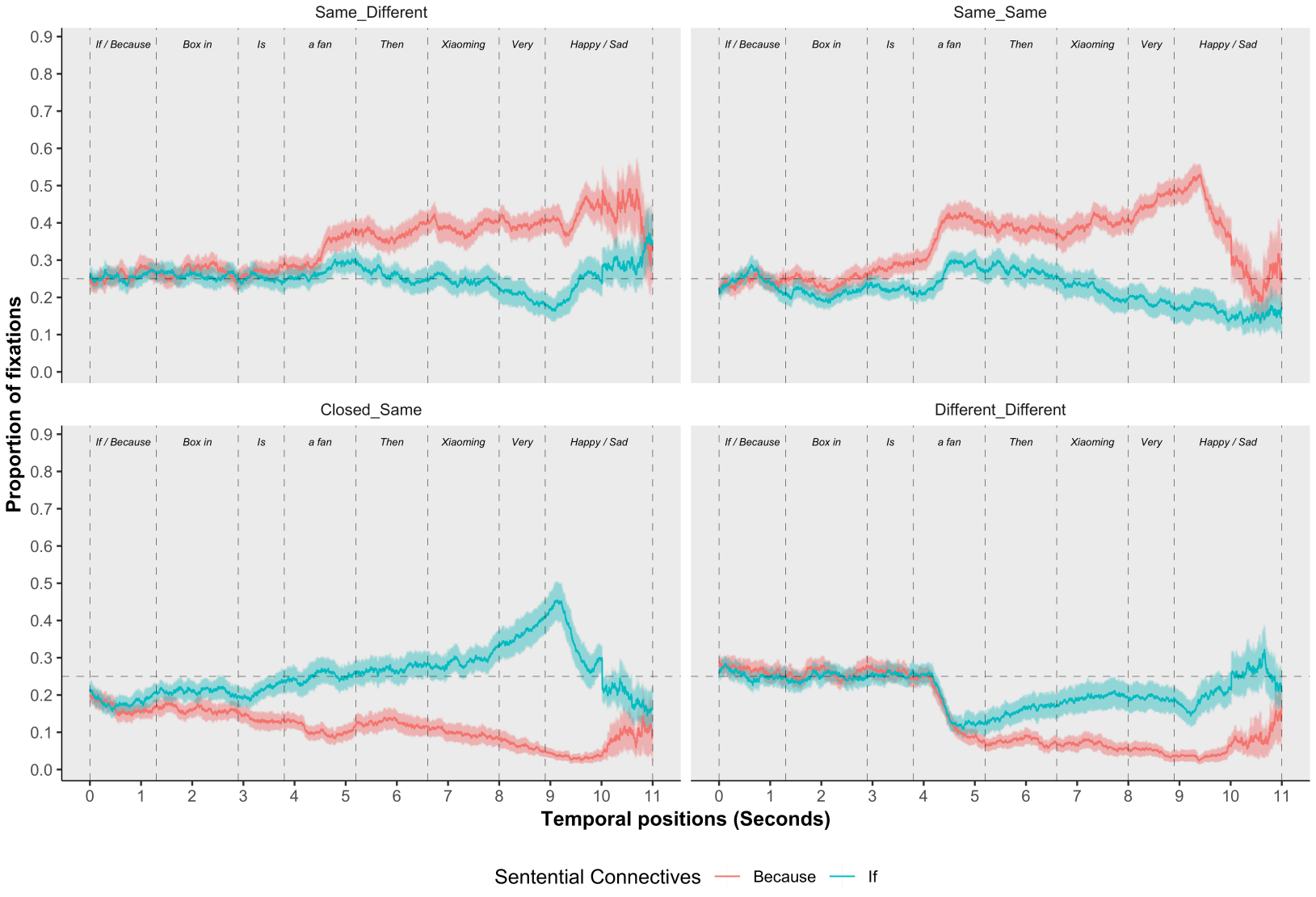

The case of disjunctions

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- Return to the two atomic propositions:

$$A, B$$

The case of disjunctions

- Return to the two atomic propositions:

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- The conditional statement:

  If not-A, then B

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  A, B

- The conditional statement:

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- Is logically equivalent to:

  A or B

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- 首先你会顺序看到两个动物，如母鸡、狐狸。然后你会看到一个黑点，你要用眼睛盯着这个黑点的同时按一下空格键。

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- 再然后你会看到四个箱子，有大有小，有开有关。每个大箱子中都装着前面看到的两个动物，并且这两个动物不相同，如母鸡、狐狸；每个小箱子中都装着前面看到的两个动物中的一个，有时是母鸡，有时是狐狸。每个箱子里装着什么动物与其他箱子里装的动物无关。每个箱子里装的动物也与这个箱子是开着还是关着无关。

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- 最后你会听到一个测试句。你的任务是根据听到的测试句尽快判断哪个箱子是小明的，并按相应键选择 (键盘上用标签标出来的 ABCD 键)。如果有两个或以上选项都合适，请选最合适的一个。如果没选项合适，请随机选一个。

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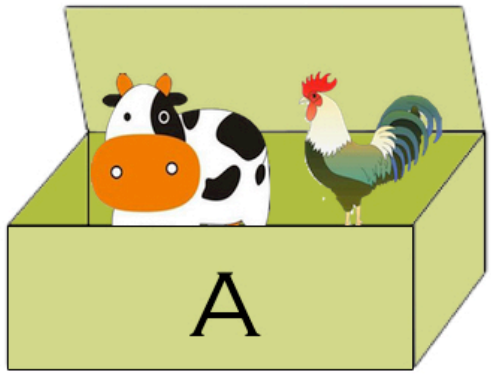

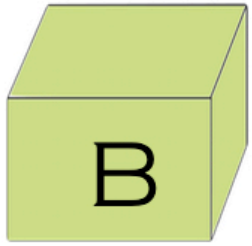

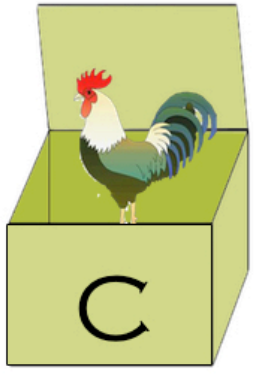

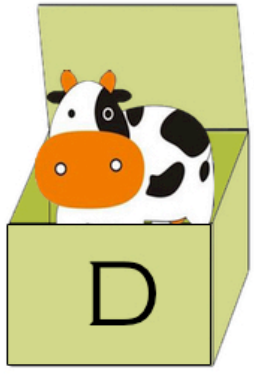

(Zhan, 2018a, 2018b)

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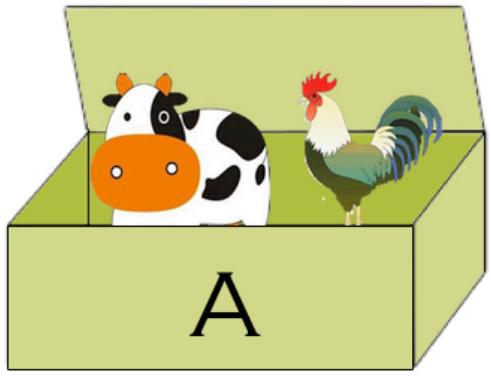
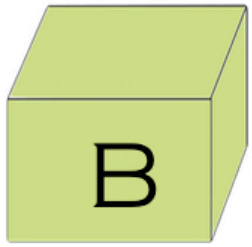
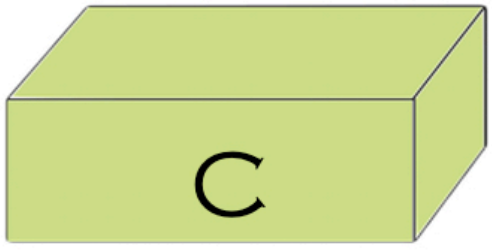
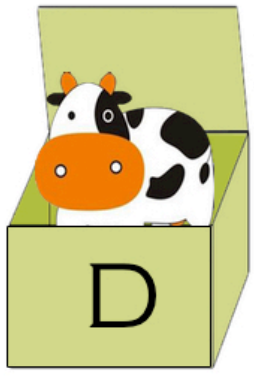








(Zhan, 2018a, 2018b)

The case of disjunctions

a. **And**

小明的	箱子里	有	一只	奶牛	和	一只	公鸡
Xiaoming de	xiang zi li	you	yi zhi	nai niu	he	yi zhi	gong ji
Xiaoming's	box in	have	one-CL	cow	and	one-CL	rooster

Xiaoming's box contains a cow and a rooster.

b. **But**

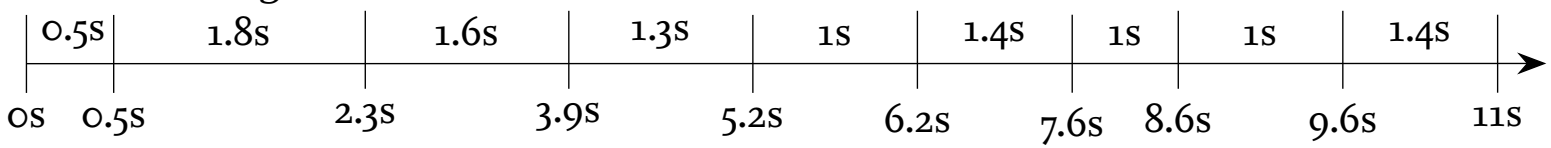
小明的	箱子里	有	一只	奶牛	但	没有	公鸡
Xiaoming de	xiangzi li	you	yi zhi	nai niu	dan	meiyou	gong ji
Xiaoming's	box in	have	one-CL	cow	but	not	rooster

Xiaoming's box contains a cow but not a rooster.

c. **Or**

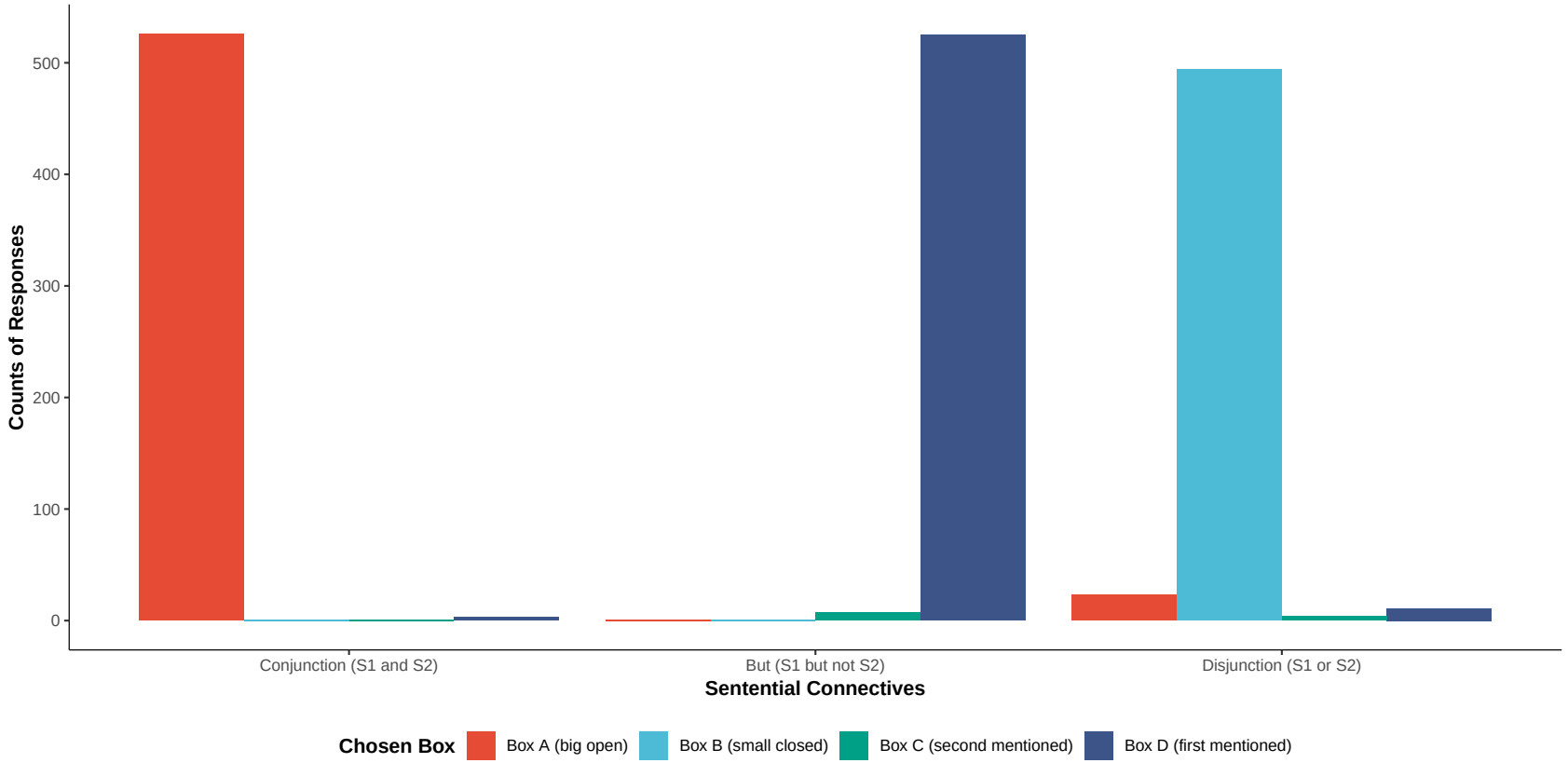
小明的	箱子里	有	一只	奶牛	或	一只	公鸡
Xiaoming de	xiang zi li	you	yi zhi	nainiu	huo	youzhi	gongji
Xiaoming's	box in	have	one-CL	cow	or	one-CL	rooster

Xiaoming's box contains a cow or a rooster.



(Zhan, 2018a, 2018b)

The case of disjunctions



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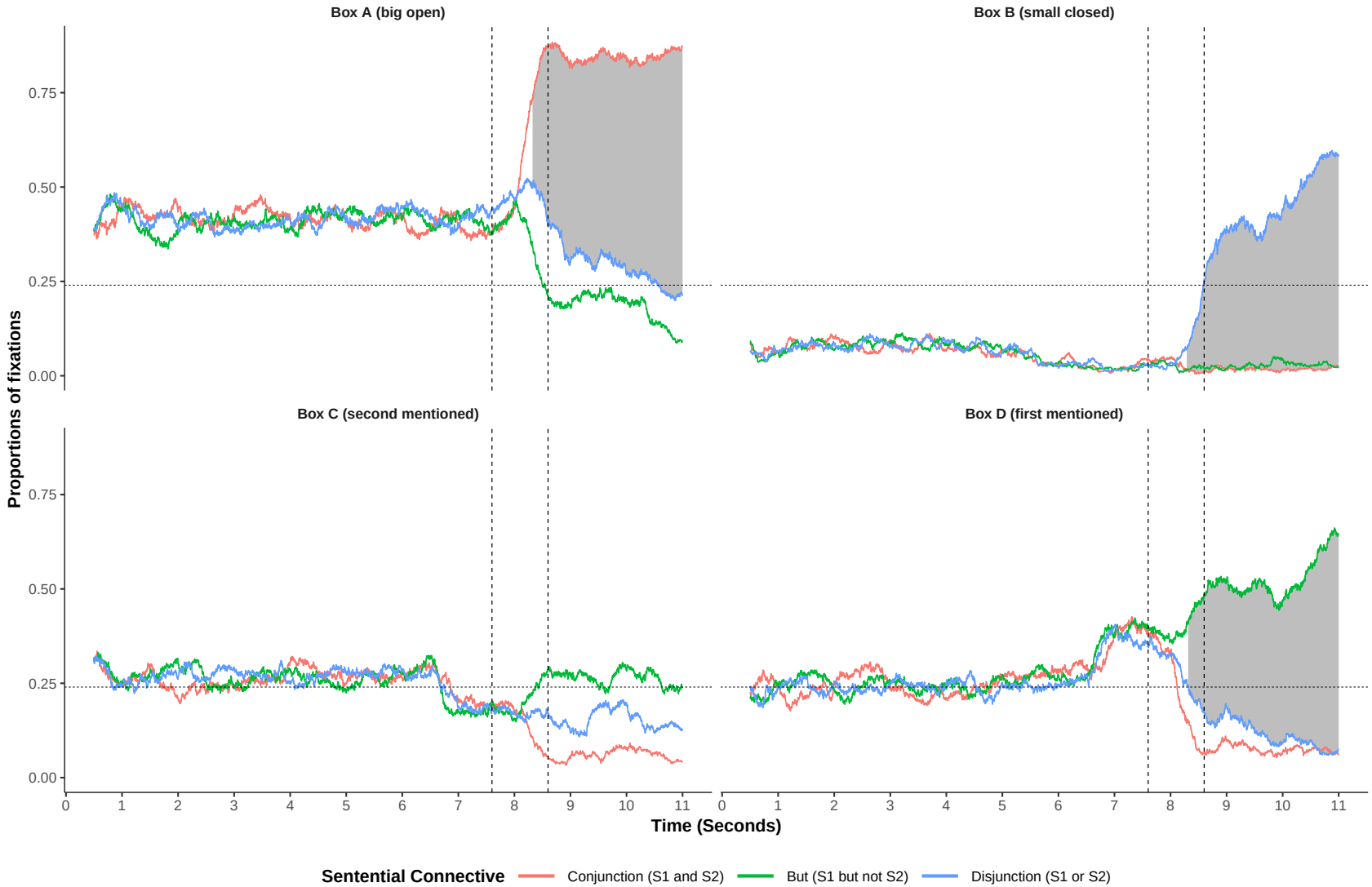

(Zhan, 2018a, 2018b)

The case of negation

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- Given a set of atomic propositions:

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- The negated statement:

$$\mathit{Not}\ A$$

The case of negation

- Given a set of atomic propositions:

$$A, B, C, \cdots$$

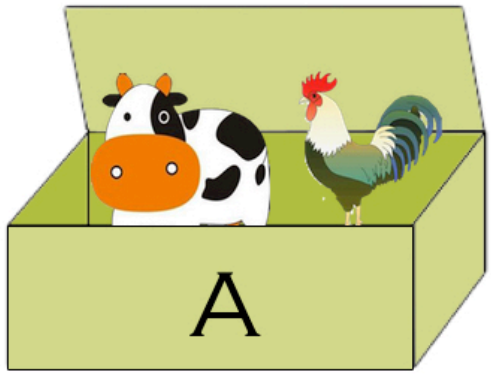
- The negated statement:

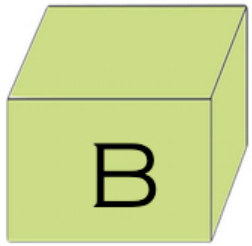
$$\textit{Not } A$$

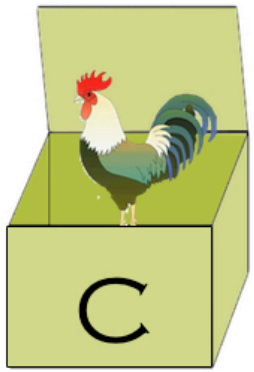
- Is roughly equivalent to:

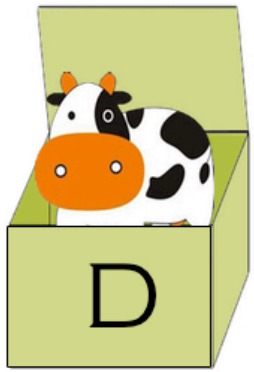
$$\textit{B or C or } \cdots$$

The case of negation









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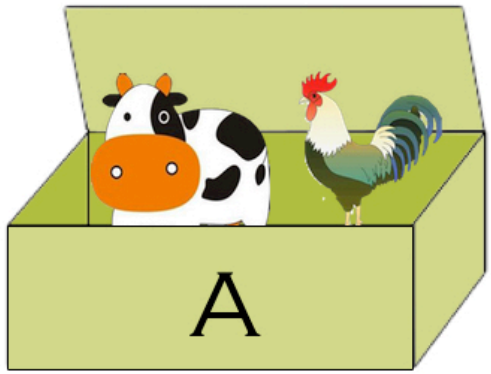
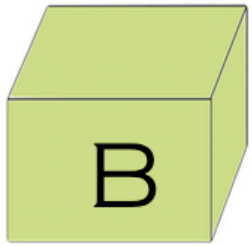
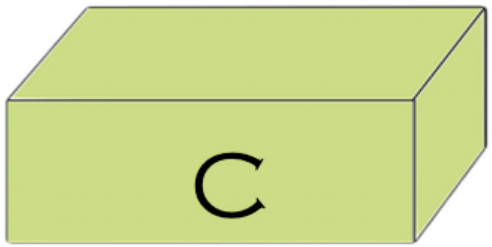
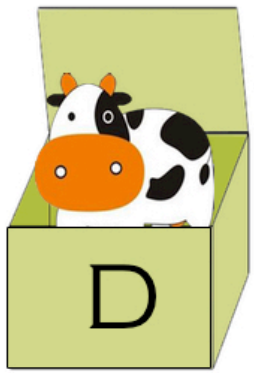








The case of negation

a. **But**

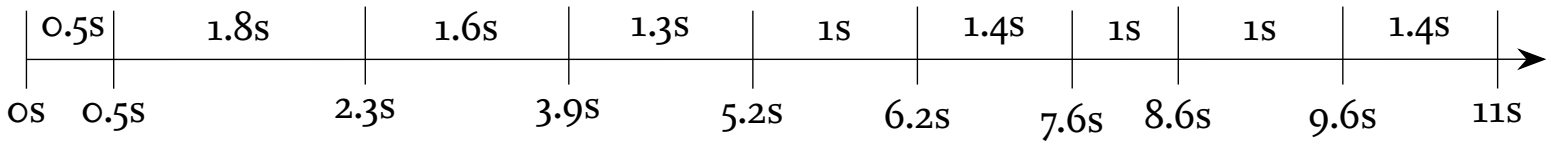
小明的	箱子里	有	一只	奶牛	但	没有	公鸡
Xiaoming de	xiangzi li	you	yi zhi	nai niu	dan	meiyou	gong ji
Xiaoming's	box in	have	one-CL	cow	but	not	rooster

Xiaoming's box contains a cow but not a rooster.

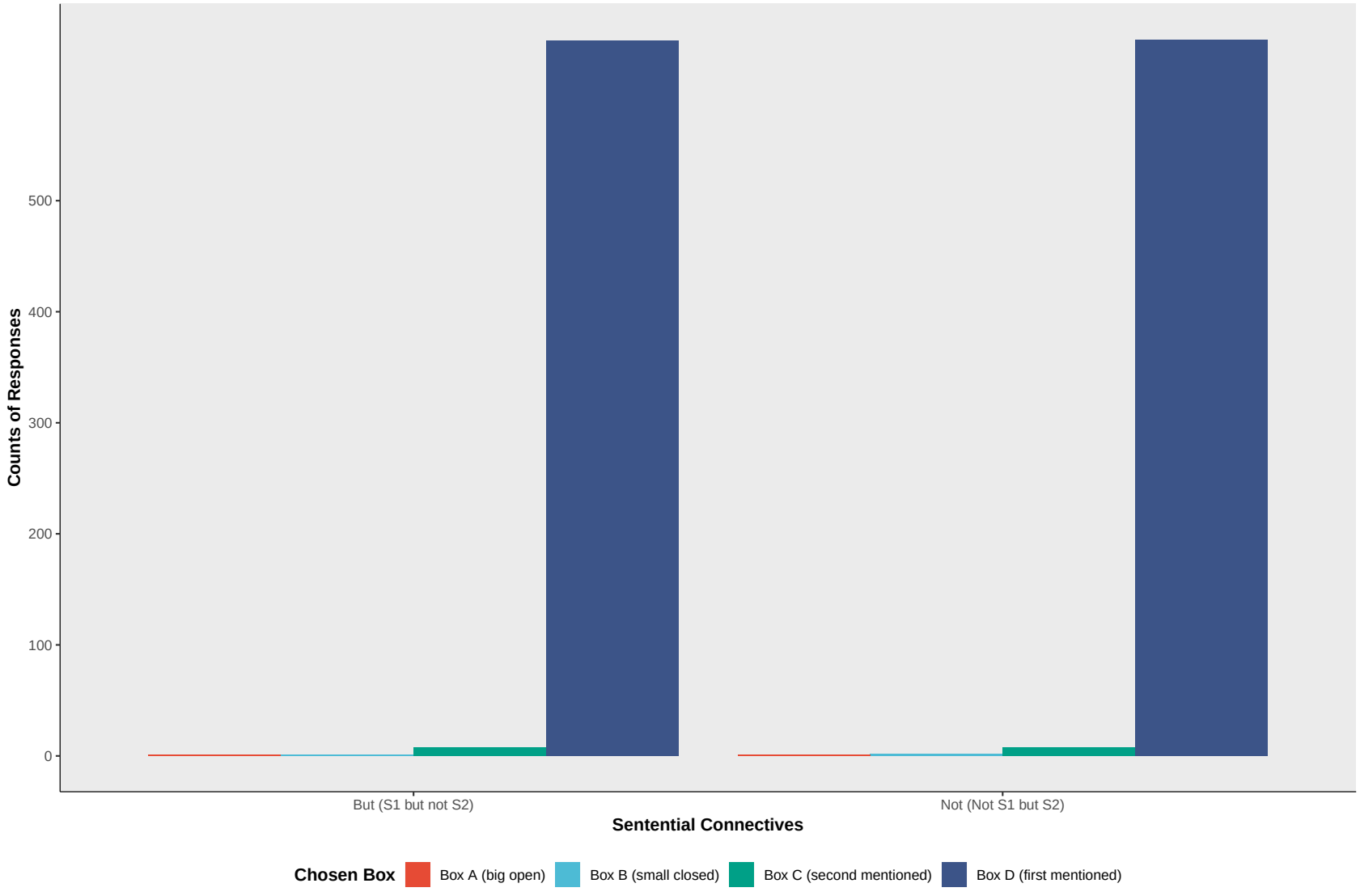
b. **Not**

小明的	箱子里	没有	一只	公鸡	但	有只	奶牛
Xiaoming de	xiang zi li	meiyou	yi zhi	gongji	dan	youzhi	nainiu
Xiaoming's	box in	not have	one-CL	rooster	but	has-CL	cow

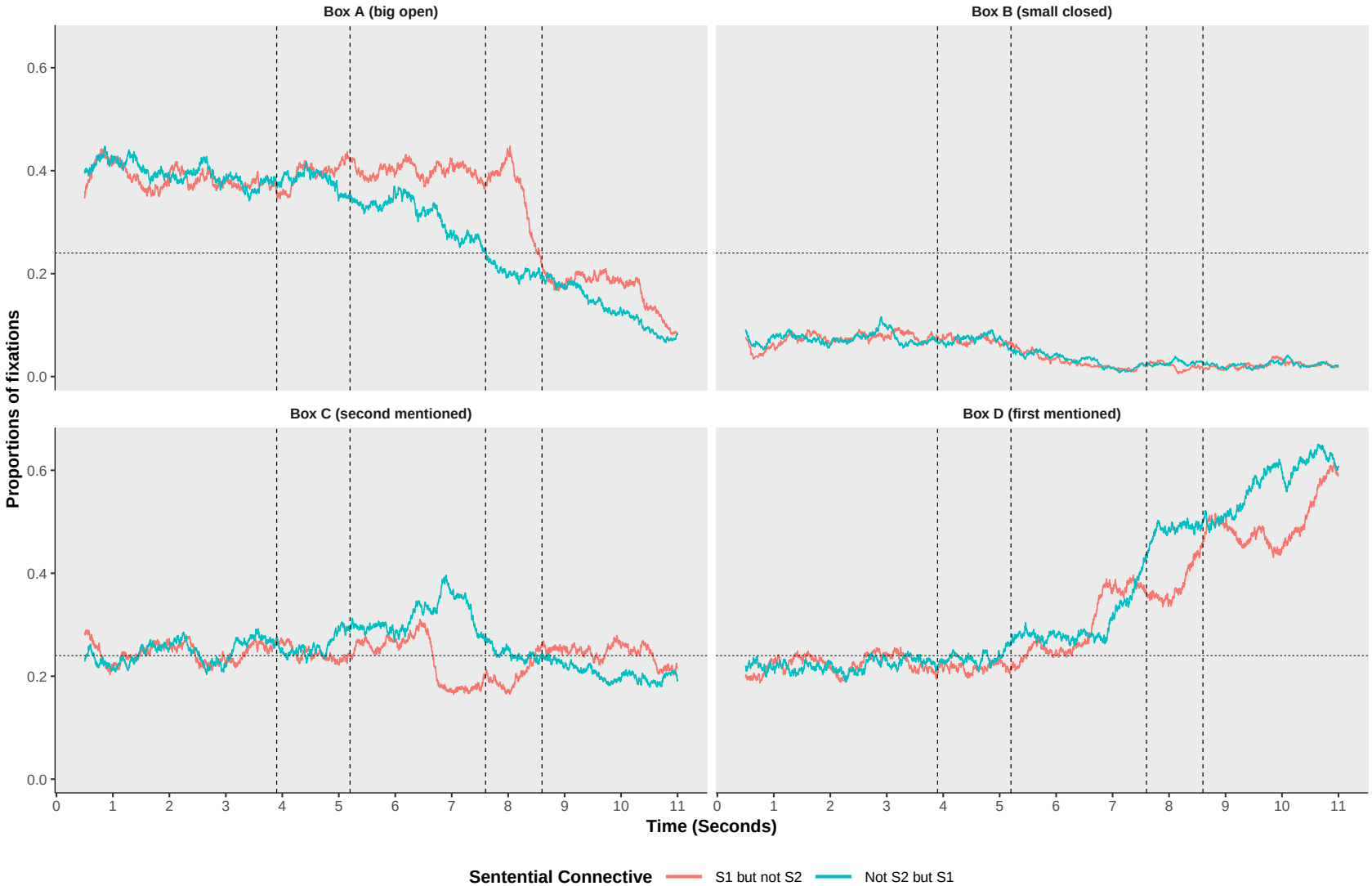
Xiaoming's box doesn't contain a rooster but a cow.



The case of negation



The case of negation



The case of epistemic modality

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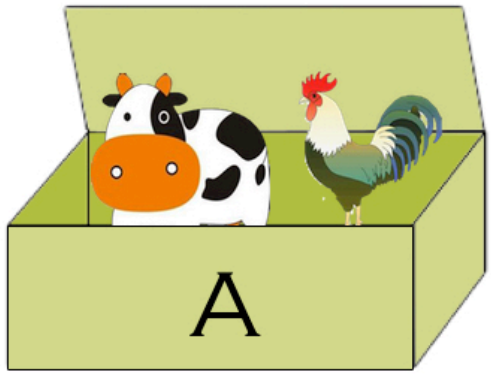
- Conditional, Disjunction, and Negation all involve Modality.

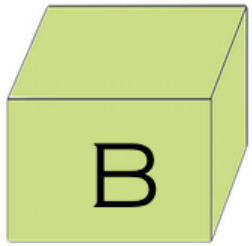
The case of epistemic modality

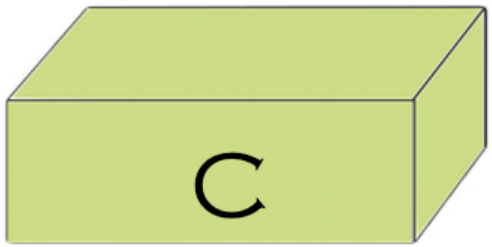
- Conditional, Disjunction, and Negation all involve Modality.
- But, wait, what about the epistemic modals themselves?

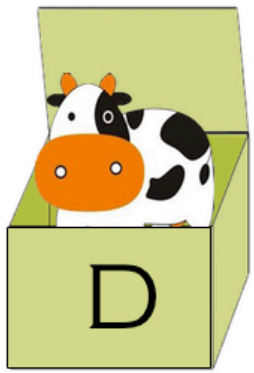
Might, Must

The case of epistemic modality









The case of epistemic modality

a. **Be**

小明的	箱子里		有一只	奶牛
Xiaoming de	xiang zi li		youyizhi	nai niu
Xiaoming's	box in		have one-CL	cow

There might be a cow in Xiaoming's box.

b. **Might**

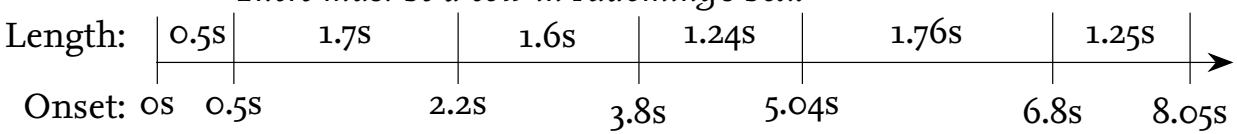
小明的	箱子里	也许	有一只	奶牛
Xiaoming de	xiang zi li	yexu	youyizhi	nai niu
Xiaoming's	box in	might	have one-CL	cow

There might be a cow in Xiaoming's box.

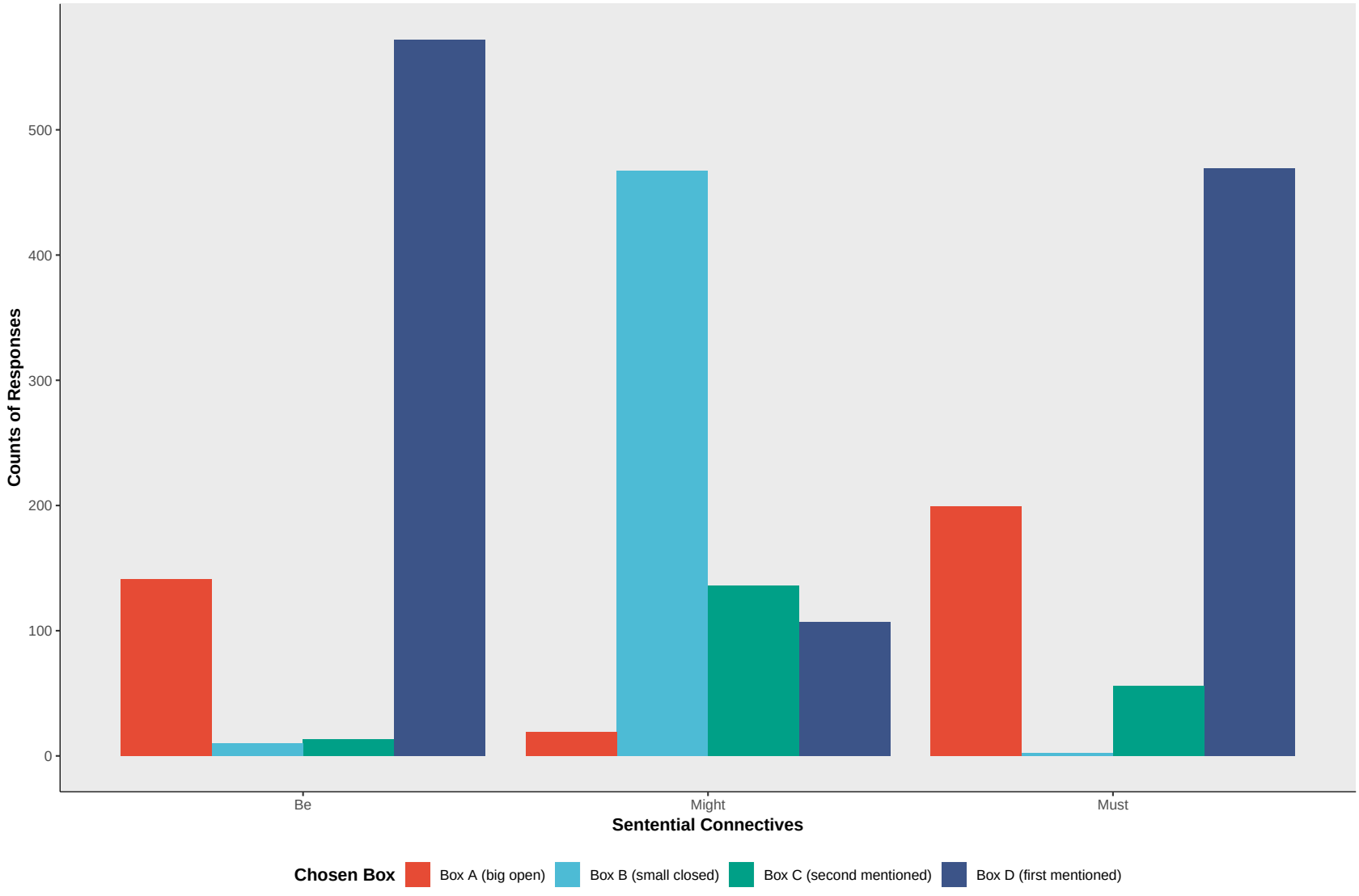
c. **Must**

小明的	箱子里	一定	有一只	奶牛
Xiaoming de	xiang zi li	yiding	youyizhi	nai niu
Xiaoming's	box in	must	have one-CL	cow

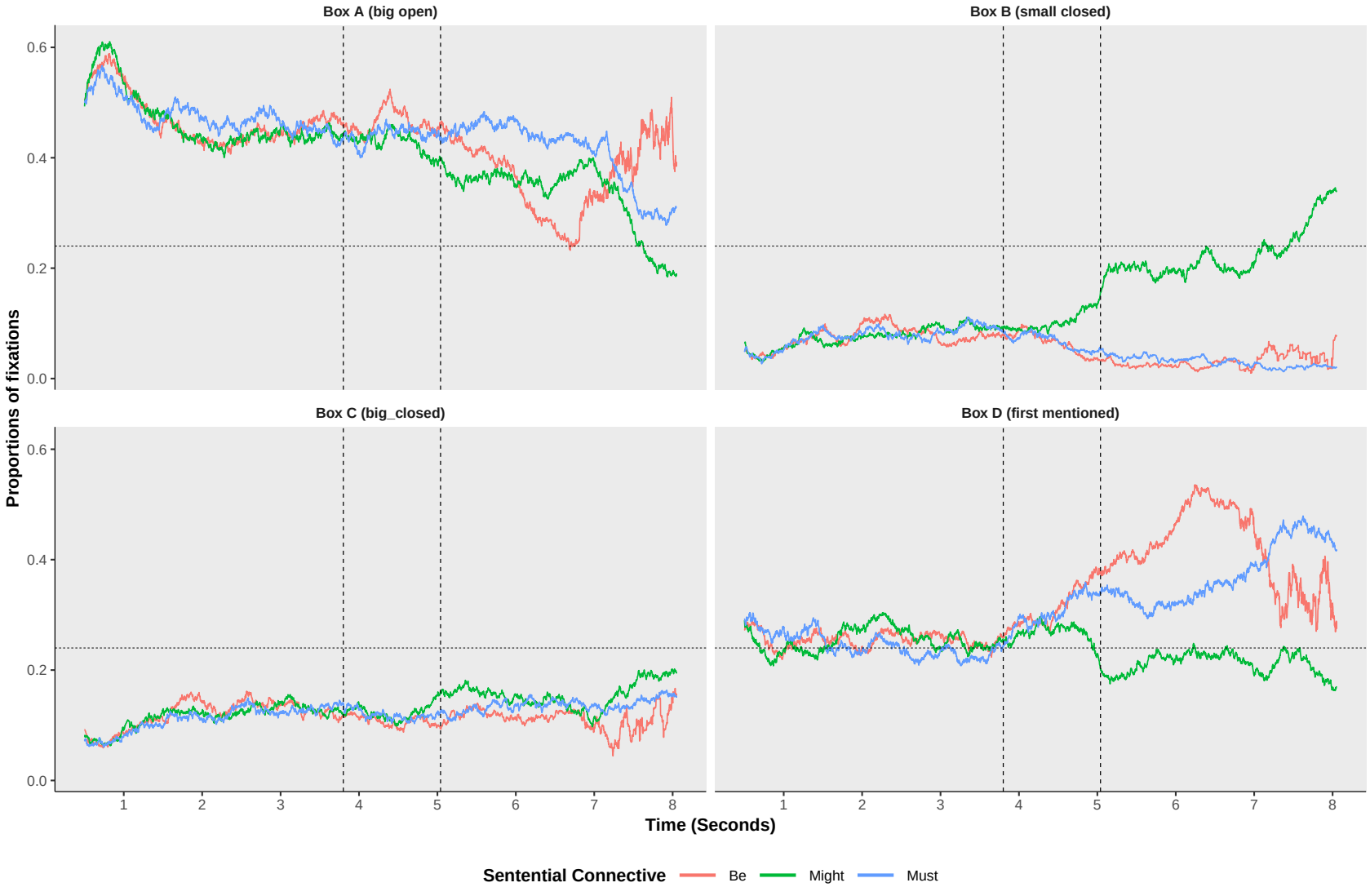
There must be a cow in Xiaoming's box.



The case of epistemic modality



The case of epistemic modality



Outstanding questions

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- Is modality an essential property in reasoning, especially in deductive reasoning?
- Is modality important in language itself?
- What are the neural mechanism underling the modal processes?
- Can these observations be generalized to other reasoning processes?

The End

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