Counterfactuals, indicative conditionals, and negation under uncertainty: Are there cross-cultural differences?

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Introduction

Research aim:

- We aim to extend the domain of the new paradigm psychology of reasoning to investigate potential cross-cultural differences between Westerners and Easterners (Yama, in press). Specifically, we investigate...
- ...reasoning about conditionals and negation under uncertainty.

Example of an indicative conditional:

If the drawn card shows an ace, then it shows spades. (1)

Example of a counterfactual:

If the drawn card were to show an ace, then it would show spades. (2)

Negating conditionals:
In general, a conditional $A \to C$ can be negated in two ways:

$$A \to \overbrace{\neg C}^{\text{narrow scope neg.}} \quad \text{versus} \quad \overbrace{\neg(A \to C)}^{\text{wide scope neg.}}$$

Experimental evidence:
Westerners' degrees of beliefs in (1) and in (2) correspond to conditional probabilities $p(C|A)$. Negations of (1) and (2) are formed by the narrow scope interpretation (e.g., Pfeifer, 2012; Pfeifer & Tulkki, 2017).

Research questions:

- How do people interpret and negate (1) and (2)?
- Are there cross-cultural differences?

Method

- Participants: 63 Japanese university students
- 2 (formulation) $\times$ 2 (task order) between-participant design: indicative conditional formulation versus counterfactual formulation

Task Name (abbreviation)	Argument Form
Aristotle's thesis #1 (AT1)	it is not the case that: $(\neg A \to A)$
Aristotle's thesis #2 (AT2)	it is not the case that: $(A \to \neg A)$
Negated Reflexivity (NR)	it is not the case that: $(A \to A)$
From "Every" to "If–not" (EIn)	Every S is P $\therefore S \to \neg P$
From "Every" to "If" (EI)	Every S is P $\therefore S \to P$
Modus Ponens (MP)	$A, A \to C \therefore C$
Negated MP (NMP)	$A, A \to C \therefore \neg C$
Paradox (Prdx)	$\neg A \therefore A \to C$

Sample task AT1 (indicative conditional):

Hanako works in a factory that produces toy blocks. She is responsible for controlling the production. Every toy block has a shape (cylinder, cube *or* pyramid) *and a colour* (red, blue *or* green). *For example:*

- *Red cylinder, red cube, red pyramid*
- *Blue cylinder, blue cube, ...*
- *Green cylinder, ...*

How sure can Hanako be that the following sentence holds?

***It is not the case**, that: **If** the toy block is **not** a* cube, ***then** the toy block is a* cube.
(もしおもちゃのブロックが立方体ではないならば、そのおもちゃのブロックは立方体である、というわけではない。)

Can Hanako infer at all how sure she can be that the sentence in the box holds? (please tick the appropriate box)

- □ *NO, Hanako can* **not** *infer how sure she can be that the sentence in the box holds.*
- □ *YES, Hanako can infer how sure she can be that the sentence in the box holds.*

*If you chose "*YES*", please tick one of the following answers:*

- □ *Hanako can be sure that the sentence in the box holds.*
- □ *Hanako can be sure that the sentence in the box does* **not** *hold.*

Results

For (1) and (2) in all four groups: the majority of responses is consistent with the conditional probability interpretation of conditionals and with the narrow scope interpretation of negating conditionals (**bold**).

Responses in % ($n = 63$)	Tasks			
	AT1	AT2	NR	EIn
holds:	**65.08**$(\overset{\supset}{\wedge}\neg)$	**76.19**$(\overset{\supset}{\wedge}\neg)$	6.35	6.45
doesn't hold:	15.87	11.11	**63.49**$(\neg\supset)$	**69.35**
non-informative:	19.05$(\neg\supset)$	12.70$(\neg\supset)$	30.16$(\overset{\supset}{\wedge}\neg)$	24.20
	EI	MP	NMP	Prdx
holds:	**88.89**	**53.97**	9.52	0.00$(\supset)$
doesn't hold:	6.35	3.17	**52.38**	17.46$(\wedge)$
non-informative:	4.76	42.86	38.10	**82.54**

- No significant differences were observed among the four groups.
- No cross-cultural differences were found.
- The experiment supports the conditional probability interpretation of conditionals.

Discussion

- The data support the universality hypothesis of the conditional probability interpretation.
- Why is the belief in a counterfactual evaluated by the corresponding conditional probability? Formally (see, e.g. Gilio & Sanfilippo, 2013),

$$\overbrace{\textit{Prevision}\ \underbrace{[(C|A)\,|\,\overbrace{\neg A}^{\text{fact}}]}_{\text{cond. random quantity}}}^{\text{belief in counterfactual}} = \overbrace{\textit{Probability}\ (C|\overbrace{A}^{\text{assumed}})}^{\text{belief in indicative conditional}}\underbrace{}_{\textit{cond.event}}.$$

Concluding Remarks

- Conditional probability is basic for modeling indicative and counterfactual conditionals.
- Like Westerners, most Japanese participants interpret indicative and counterfactual conditionals by conditional probabilities...
- ...and negate conditionals ($A \to C$) by the narrow scope negation ($A \to \neg C$).

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References

Gilio, A., & Sanfilippo, G. (2013). Conditional random quantities and iterated conditioning in the setting of coherence. In L. C. van der Gaag (Ed.), *ECSQARU 2013* (Vol. 7958, pp. 218–229). Berlin, Heidelberg: Springer.

Pfeifer, N. (2012). Experiments on Aristotle's Thesis: Towards an experimental philosophy of conditionals. *The Monist*, *95*(2), 223–240.

Pfeifer, N., & Tulkki, L. (2017). Conditionals, counterfactuals, and rational reasoning. An experimental study on basic principles. *Minds and Machines*, *27*(1), 119–165.

Yama, H. (in press). Thinking and reasoning across cultures. In L. J. Ball & V. A. Thompson (Eds.), *International handbook of thinking and reasoning*. Hove, UK: Psychology Press.