Sufficiency: A surprisingly stretchy concept.

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Introduction

The concepts of necessity and sufficiency play a central role in explaining the reasoning performance. It is often argued that how people interpret the necessity and sufficiency expressed by a conditional relation has a causal impact on the number and types of inferences that are drawn (see e.g. Thompson, 2000). It is however not yet clear whether the formal definitions of necessity and sufficiency reflect the way reasoners use and interpret these concepts.

In logic, one proposition is a necessary condition of another when the second cannot be true while the first is false, and one proposition is a sufficient condition for another when the first cannot be true while the second is false. Research on conditional reasoning revealed that logical conceptions and definitions are not necessarily psychologically relevant or valid. The current experiment will verify whether participants adhere to the logical definitions of the concepts of necessity and sufficiency.

Experiment

A total of 28 first-year psychology students were asked to indicate whether each of four cause-effect combinations are possible or impossible. Figure 1 gives an example of the task for sufficiency. According to the logic definition, we should observe the pattern listed in Table 1 (the definition of sufficiency does not relate to the third combination). For necessity, participants should accept the first and the last combination and reject the third. When a reasoner considers a cause-effect combination possible, the answer is scored as 1; when it is considered impossible it is scored as 0

Figure 1: Example of the possibility-task.

The cause is sufficient for the effect		
Combinations	Possible	Impossible
1. Cause occurs – Effect occurs	x	
2. Cause occurs – No effect		x
3. No Cause – Effect occurs		
4. No Cause – No effect	x	

Table 1 displays the results. According to the formal conceptualisation of necessity the 'no cause-effect' combination is illegal, whereas the combination 'cause–no effect' is irrelevant. As expected, the irrelevant combination was more often considered possible than the illegal combination, *Wilcoxon T* = 15, *Z* = 2.35, *N non-ties* = 14, $p < .05$. For sufficiency, the difference between the irrelevant 'no cause – effect' and illegal 'cause–no effect' combination was not significant. Surprisingly, the illegal combination was considered possible by 60.7% of the participants.

Table 1: Percentage of trials in which each combination was considered possible.

	Cause Effect	Cause No Effect	No Cause Effect	No Cause No Effect
Sufficient	100	**60.7**	46.4	85.7
Necessary	96.4	57.1	14.3	92.9

When we look at the patterns of relevant combinations for a sufficient cause, there were 8 participants (29%) who considered the 'cause–effect', 'cause– no effect' and the 'no cause–no effect' combinations respectively possible, impossible and possible, whereas there were 16 participants (57%) who found all three combinations possible. For necessity, there were 22 participants (79%) that considered the 'cause-effect', 'no cause-effect' and 'no cause- no effect' respectively possible, impossible and possible, whereas only 3 participants (11%) considered all three combinations possible. The 'no cause–effect' combination is thus understood as a combination that contradicts necessity, the combination 'cause–no effect' does not contract sufficiency.

Conclusion

Whereas the subjective conceptualisation of necessity parallels the formal definition, the subjective concept of sufficiency is less stringent than the formal concept. A cause can be considered sufficient to grant the effect, even when the effect does not always follow. However, when causal rules are used to make predictions, it can be adaptive to label a cause that increases the probability of the effect as subjectively sufficient. The observed divergence between the subjective and formal definition raises doubt on the claim that reasoners assess the formal level of sufficiency to derive conditional conclusions.

References

Thompson, V. A. (2000). The task-specific nature of domain-general reasoning. *Cognition, 76, 209-268.*