Title
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Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 27(27)

ISSN
1069-7977

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Publication Date
2005

Peer reviewed

Denial inferences: Oaksford, Chater & Larkin (2000) on shaky ground

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A conditional is an 'if, then' sentence. Each conditional can occur in four types of inference:

MP: If p, then q. Given p, what follows? (q)
MT: If p, then q. Given not q, what follows? (not p)
AC: If p, then q. Given q, what follows? (p)
DA: If p, then q. Given not p, what follows? (not q)

When people solve everyday conditional inferences, they rely on background knowledge. The computational theory of Oaksford, Chater, & Larkin (2000) specifies how background knowledge can be used to solve the four inferences: The inference acceptance rates correspond to the probability of the conclusion given the categorical premise. More formally: MP = P(q|p), AC = P(p|q), DA = P(not q|not p) and MT = P(not p|not q). Note that for solving DA and MT, one derives a probability estimate based on a negative proposition. We argue that these kinds of estimations are problematic and that the account of OCL (2000) on denial inferences is debatable.

Experiment

To test the validity of the OCL (2000) account, we used 20 everyday causal conditionals. In order to attain a maximal variation in probability estimations we selected 5 sentences where the cause was necessary and sufficient for the effect, 5 with a necessary but not sufficient cause, 5 with a non-necessary but sufficient cause and 5 with a non-necessary, non-sufficient cause. A group of 25 psychology students rated P(cause|effect) and P(effect|cause). The generic format of this rating task was:

P(q|p): If the cause occurs, does the effect follow?
P(p|q): If the effect occurs, did the cause precede?

The participants answered by circling one of the following alternatives: *'(1)no, never, (2)seldom, (3)sometimes, (4) often, and (5)yes, always'*. Another 23 students rated P(no cause|no effect) and P(no effect|no cause) in a similar way. All participants rated all 20 sentences. Seventy-seven participants solved 20 conditional inferences: Each sentence was randomly combined with one of the four inferences, reasoners received four problems of each inference type. For MP and DA, they selected their answer from: The effect *(1)never, (2)seldom, (3) sometimes, (4)mostly or (5)always* follows. For AC and MT, the answer alternatives were: 'The cause *(1)never, (2) seldom, (3)sometimes, (4)mostly or (5)always* preceded'. Probability estimations were transformed to be directly proportional to the percentage of inference acceptance. For each of the 20 sentences, we calculated the mean of the four probability estimations and the mean proportion of MP, MT, AC and DA acceptance. It is assumed that P(q|p) and P(not p|not q) relate to MP and MT acceptance (sufficiency), while P(p|q) and P(not q|not p) predict AC and DA acceptance (necessity). The resulting Pearson correlations can be found in Table 1 (*: p<.01).

Table 1: Correlations

Sufficiency	P(q|p)	P(not p|not q)
MP	.821*	.353
MT	.893*	.438
Necessity	**P(p|q)**	**P(not q|not p)**
AC	.893*	.507
DA	.996*	.494

Overall, we obseved the expected correlational patterns. However, the two predictors are highly correlated ($R_{P(q|p),\ P(not\ p|not\ q)}$=.52*;* $R_{P(p|q),\ P(not\ q|not\ p)}$=.59, both N =20, p<.01. To get an indication of the correlation between each predictor and the respective acceptance rates with the intercorrelation stripped off, we calculated Pearson partial correlations. The results can be found in Table 2 (*: p<.01).

Table 2: Partial correlations.

Sufficiency	P(q|p)	P(not p|not q)
Controlling for	*P(not p|not q)*	*P(p|q)*
MP	.800*	.153
MT	.866*	.070
Necessity	P(p|q)	P(not q|not p)
Controlling for	*P(not q|not p)*	*P(p|q)*
AC	.961*	.213
DA	.805*	.349

Contrary to the computational model of OCL(2000) it is found that P(q|p)is a better predictor for MT performance than P(not p|not q). Likewise it is found that P(p|q) is a better predictor of DA performance than P(not q|not p).

The equations set forward by OCL(2000) for MT and DA are thus problematic for causal conditional reasoning. A possible alternative to solve denial inferences by use of likelihood information is through a suppositional strategy. For MT: Suppose p is the case, deduce MP by use of P(q|p), the uncertainty of the MP conclusion is then carried forward in the inference process and reasoners solve the partial contradiction by a proportional rejection of their supposition.

References

Oaksford, M., Chater, N., & Larkin, J. (2000). Probabilities and polarity biases in conditional inference. *Journal of Experimental Psychology: Learning, Memory & Cognition, 26*, 883-899.