Is The Weighting of Contingency Data Contingent on the Hypothesis Assessed?*

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Causal Induction

Causal reasoning exerts a significant influence on how people explain the past and predict outcomes in the future. An important question concerns the ways in which people integrate frequency data about the co-occurrence of events, or contingency information, as they learn causal relations. If contingency information is presented in the form of the presence or absence of a cause (c) and an effect (e), the problem appears as follows:

		Effect (e.g., illness Y)	
		e	~e
Cause (e.g., virus X)	c	A = ∑ (c ∩ e)	B = ∑ (c ∩ ~e)
	~c	C = ∑ (~c ∩ e)	D = ∑ (~c ∩ ~e)

The delta rule, $\Delta P = P(e|c) - P(e|\sim c)$, is a normative model of information integration for causal learning that assigns equal weight to cells A to D. However, several studies (e.g., Kao & Wasserman, 1993; Mandel & Lehman, 1998) have shown that people tend to give the greatest weight to the cells as follows: A > B > C > D. Mandel and Lehman (1998) accounted for this cell weight inequality (CWI) in terms of a combination of two biases: A *positive-event bias*, according to which a greater weight is given to information about event presence than event absence, and a *sufficiency bias*, according to which greater weight is given to assessments of sufficiency than necessity.

A Critical Test of the PSB and PCB Accounts

According to Mandel and Lehman's positive-event-sufficiency-biases (PSB) account, cell A is positive because it provides information about event co-presence, cells B and C are neutral because they provide information about event presence and event absence, and cell D is negative because it provides information about event co-absence. The positive-event bias predicts that A > B = C > D. The PSB account also proposes that B > C due to a sufficiency bias because B is uniquely indicative of sufficiency violations, whereas C is uniquely indicative of necessity violations when testing hypotheses about *generative* causes. A critical test of the PSB account yet to be conducted consists of asking subjects to test hypotheses about generative and inhibitory causes, respectively. If the PSB account is correct, we should observe a stronger weighting of cell A in the inhibitory condition than in the generative condition because cell A is the "sufficiency" cell in the former case, whereas cell B is the sufficiency cell in the latter case.

Conducting this critical test, we pit the PSB account against an alternative positive-test-confirmation-biases (PCB) account. The PCB account posits that the CWI is attributable to a tendency to overweight confirmatory information within a positive-test strategy (i.e., a test that conforms to the hypothesis tested; Klayman & Ha, 1987), which invariably involves cells A and B. This experiment tested these competing hypotheses.

Method

Among 40 undergraduate subjects, 20 judged the strength of a generative cause (whether a particular virus causes an illness), and the other 20 judged the strength of an inhibitory cause (whether a particular antivirus prevents an illness). Judgments were made on a 0 (not at all causal/preventative) to 4 (strongly causal/preventative) scale. Contingency data were presented trial by trial. The 24 stimuli used corresponded to the 10- and 20-set size conditions from Mandel and Lehman (1998, Exp. 1). Cell means and variances were constant across the 24 stimuli.

Results and Conclusion

The table below shows the mean Fisher correlations between subjects' ratings and the cell frequencies by condition.

	Cell			
Hypothesized cause	A	B	C	D
Generative	.83	.27	.14	.00
Inhibitory	.37	.65	.03	.14

A two-way (Cell × Condition) ANOVA revealed a main effect for Cell, such that A and B were weighted more heavily than C and D, $F(3, 228) = 74.8$, $p < .001$. In addition, there was a significant interaction effect, $F(3, 228) = 33.9$, $p < .001$. In support of the PCB account but inconsistent with the PSB account, cell A was weighted more heavily in the generative condition than in the inhibitory condition, $t(78) = 6.64$, $p < .001$, $d = 1.50$. Moreover, as the PCB account predicts, cell B was weighted more heavily than cell A in the inhibitory condition, $t(39) = -3.8$, $p < .001$, $d = 1.22$.

References

Kao, S.-F., & Wasserman, E. A. (1993). Assessment of an information integration account of contingency judgment with examination of subjective cell importance and method of information presentation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19*, 1363-1386.

Klayman, J., & Ha, Y.-W. (1987). Confirmation, disconfirmation, and information in hypothesis testing. *Psychological Review, 94*, 211-228.

Mandel, D. R., & Lehman, D. R. (1998). Integration of contingency information in judgments of cause, covariation, and probability. *Journal of Experimental Psychology: General, 127*, 269-285.

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