Causal Cycles in Categorization

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Introduction

People readily perceive cyclic causal patterns in their environment. However, little is known about exactly how cyclic causal beliefs affect conceptual thinking. Ahn (1998) previously documented a *causal status effect* such that cause features are treated as more important than their effects in categorization (all else held equal), and Thagard (1999) has argued that an explanation is thought to be better to the extent that it explains more components of the concept. Taking these ideas together, we hypothesized that when causal relations do not explain additional features in a concept (as in the return relation in a causal cycle), they may be discounted from the calculation of feature weights based on causal status. That is, if A<->B, then only A->B will count toward feature weighting of A, because the return causal relation does not involve any new features, and only B->A will count toward the weighting of B in categorization. The reported studies tested this hypothesis.

Method

Participants were 60 undergraduates. Eight artificial concepts were used to minimize the influence of participants' prior background knowledge. These included 2 living natural kinds, 1 nonliving natural kind, and 1 artifact developed by Rehder (2003), and 4 artificial mental disorder concepts developed by Kim and Ahn (2002). Four background knowledge scenarios (causal cycle, causal chain, common-cause, and non-causal control) for each of the 8 concepts were assembled. Thirty participants saw the 4 natural kind/artifact concepts, and the other 30 saw the 4 disorder concepts. All participants viewed one of each type of background knowledge scenario. For each concept, they answered 3 category membership likelihood questions of the form, "suppose that an [instance] is in all ways like a [member of category X] except that it does not have [feature of category X]. What is the likelihood that this [instance] is a [member of category X]?" Ratings were made on a scale of 0-100, where 0=very unlikely and 100=very likely.

Results

Mean ratings are listed in Table 1, with standard deviations in parentheses. For illustrative purposes, ratings were subtracted from 100 so that higher numbers correspond to greater importance of that feature in determining category membership.

The primary comparisons of interest were between the cycle features (features A, B), each of which ultimately explained only feature other than itself, and the root causes in the acyclic structures (features D, G), each of which explained two additional features. Thus, ratings for the 2 cycle features were collapsed and compared to the common cause and to the root cause in the chain. Two Bonferroni-corrected paired-sample t-tests were conducted ($\alpha = .025$). The common cause feature was reliably given more weight than the cycle features ($M = 69.11$; $SD = 24.16$; $t[59] = 2.68$; $p = .01$; $\eta^2 = .11$). The root cause in the causal chain was also reliably given more weight in categorization than the cycle features ($t[59] = 2.69$; $p < .01$; $\eta^2 = .11$).

Table 1: Feature importance indices (0-100).

	Feature position		
Causal structure	Left	Middle	Right
Causal cycle	72.23	65.98	42.17
A <-> B C	(25.81)	(26.55)	(29.01)
Causal chain	78.25	63.28	48.07
D -> E -> F	(24.60)	(28.19)	(27.93)
Common cause	79.00	49.98	44.73
G -> H & I	(27.43)	(24.80)	(24.77)
Non-causal control	47.95	50.15	46.48
J K L	(34.47)	(32.64)	(31.38)

Discussion

Thus, as hypothesized, when causal relations did not explain the presence of additional features of a concept, they were discounted from calculations of feature weighting based on causal status. The results of two additional studies demonstrated, in support of this interpretation, that features in a causal cycle, A<->B, were each given the same weight as the cause (C) in a simple cause-effect relation, C->D. This finding held true even when the same causal relations were used across cyclic and acyclic structures, feature ordering was counterbalanced, and the infinitely cycling nature of the causal cycle was made clear. Future studies will further investigate differences in people's reasoning regarding cyclic versus acyclic causal structures.

References

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