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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

Issues in Reasoning about iffy Propositions: The Development of Deductive Rationality in Conditional Reasoning.

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Deductively rational reasoning performance is characterised as performance that is in accordance with the strictures of logic. Judging performance as such implies neither that people should reason deductively nor that they would always have the goal of establishing logically valid inferences. Indeed, a rational analysis (Anderson, 1990) distinguishes normative from adaptive rationality. That is, there is no absolute norm against which to measure human reasoning performance. Sometimes deductively rational behaviour is appropriate, and sometimes probabilistically rational behaviour is appropriate. Neither logic nor probability theory provides an absolute standard of human rationality. Rational behaviour is adapted to the environment; it is flexible behaviour marked by responsiveness to the environmental demands, whether it is the environment of evolutionary adaptation or our technologically evolved modern day cultural environment.

Table 1 presents *logic indices* computed over four arguments about conditionals of the form <if A then C>. The Modus Ponens (MP) <A therefore C> and Modus Tollens argument <not-C therefore not-A> are logically valid. The Affirmation of the Consequent (AC) argument <C therefore A> and Denial of the Antecedent argument <not-A therefore not-C> are logically invalid. The logic index is computed as the difference between the mean acceptance rates of logically valid vs. invalid arguments. In Experiment 1, participants first solved the four arguments about an abstract rule (e.g. "if the letter is an A then the number is a 7"). Participants selected the conclusion among three alternatives: e.g. a) The number is a 7, b) The number is not a 7 and c) The number is possibly a 7 but also possibly not a 7. After solving a set of spatial problems, they then evaluated arguments about knowledge-rich causal conditionals. These conditionals were pre-tested and have few vs. many alternative causes and few vs. many disabling conditions. Alternatives reflect <not-A and C> cases and form a counterexample to the logically invalid argument. (e.g. background knowledge about the possibility of dead batteries falsifies AC about "if you turn the ignition key then the car starts). Disablers reflect <A and not-C> cases and counter the logically valid arguments. In Experiment 2 and 3 participants received two sets of causal inference problems. In Experiment 2 participants first evaluated the conclusions on a five point rating scale ("very uncertain" to "very certain" that the conclusion follows). In the second set of "logical problems" they evaluated the conclusions as either "yes, it follows" or "no, it does not follow necessarily". This condition also stressed the truth-assumption that is inherent to the notion of logically validity. They read as follows: If it were always true that: "if water is heated to 100°, then it will boil", and you know that "Water is heated to 100°" then it would follow that "the water would boil". In Experiment 3 the conclusions in both the open and logic conditions were evaluated on a 7 point rating scale marking respectively the certainty that the conclusion "follows" or "would follow if one assumes that the rule is true".

Table 1: Logic indices across high school grade.

	Grade							
Problem set	7	8	9	10	11	12	F[a]	Mse
Exp. 1: n	60	45	51	31	52	50		
Abstract	.042	.011	.108	.097	.154	.230	13.1	.104
Causal	.010	.033	.026	.032	.073	.104	13.6	.019
Exp. 2 : n	140	114	101	122	116	123		
Un-Logical	.033	.032	.053	.056	.078	.073	17.6	.012
Logical	.115	.198	.207	.284	.309	.317	40.6	.089
Exp. 3: n	121	102	112	101	89	118		
Un-logical	.020	.009	.041	.033	.041	.047	5.9	.013
Logical	.041	.054	.065	.098	.104	.124	31.8	.018

Note.[a.] F value of linear contrasts defined over grade.

The results of three experiments presented in Table 1 support three main anticipated conclusions. First, deductively rationality increases with age and experience. All linear contrasts over grade were significant beyond $\alpha = .01$. Second, the propensity to exhibit deductively rational behaviour is positively related to measures of general aptitude. In Experiment 1 participants completed the Standard Raven Progressive Matrices (RPM), and the sum scores correlated significantly with the logic index on the two problem sets ($r = .152$, $p < .01$ and $r = .226$, $p < .01$). In Experiment 2 participants completed analogies, word meaning lists, and RPM like figure series. The sum total scores of these tests were positively related to the logic indices ($r = .244$, $p < .01$ and $r = .431$, $p < .01$), as were scores on the rationality subscale of the Rational-Experiential Inventory ($r = .116$, $p < .01$ and $r = .199$, $p < .01$). Third, the propensity to behave deductively rational is effectively dependent on the environmental demands (Experiment 2 and 3). When we explicate the rules of the "game" of logic (and the relation with general aptitude shows it is not just a game in the common sense meaning of the word) as in Experiment 3, logic indices are generally higher, $F(1,637) = 71.8$, $Mse = .011$, $p < .01$ and the developmental effects are more pronounced, $F(1,637) = 10.3$, $Mse = .011$, $p < .01$.

References

Anderson, J. R. (1990). The adaptive character of thought. Hillsdale, NJ: Lawrence Erlbaum.