



Review: [untitled]

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Reviewed work(s):

A Logic of Questions and Answers. by David Harrah

Communication: A Logical Model. by David Harrah

A Model for Applying Information and Utility Functions. by David Harrah

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formation Theory. X. Cybernetics. XI. Linguistics. XII. Sign-Behavior. XIII. Game Theory. XIV. Decision-Making Theory. XV. Value Inquiry. XVI. General Systems.

The authors speak of behavioral scientists as wanting "to develop an objective and experimental science of human behavior," and say that "what is essential is the rule that all *hypotheses be experimentally confirmed by reference to publicly observable changes in behavior.*" In view of this characterization it is surprising to find, among the topics treated, some which have traditionally belonged to philosophy. The inclusion of, e.g., value theory can no doubt be justified on the ground that the experimental study of human behavior in value-related situations is not easily separated from philosophical questions concerning the notion of value. But it does seem to the reviewer that there is a tendency by the authors, not only to stretch the applicability of scientific method beyond its own domain, but within scientific method to overestimate the experimental aspect as against the aspect of abstraction and theory construction.

As an example of the latter, the discussion of "ideal laws" in the second section of the *Introduction* misses altogether the point that all scientific laws necessarily involve an element of abstraction.

It is perhaps this underestimate of abstraction that leads the authors to underestimate the relevance of mathematical logic to some of the topics they treat. Deontic logic is not mentioned. The construction of "formal idealized languages" by "philosophers sympathetic to the logical positivistic movement" does receive mention, but in the reviewer's opinion the special association with logical positivism is unfortunate, and the relevance of such abstract languages to problems of human communication is unduly minimized. The important semiotic of Morris and the still more substantial developments by Carnap in this same area are discussed at length, but the semantics of Tarski, on which they partly depend, is dismissed with a brief and rather unilluminating quotation from IX 68. Applications of mathematical logic to automata theory might have been thought relevant in the chapter on cybernetics, but are not mentioned. Applications to linguistics are at best suggested in a brief reference to the work of Chomsky.

In the chapter on information theory, misuses of the Shannon theory by behavioral scientists are severely and (it would seem) justly condemned, with the support of Cronbach, Bar Hillel, and others, who are quoted at length. The difficulty lies, it is pointed out, in partial misunderstandings of the technical term *information* in a sense that is too much influenced by that of the same word in its everyday use. The Carnap-Bar Hillel notion of semantic information (XIX 230(2-6)) is mentioned briefly and somewhat critically. Indeed if the Carnap-Bar Hillel measure of information can serve the purposes of the behavioral sciences better than Shannon's, it is clear that this has still to be established. But the present authors go on to describe as "first attempts toward an extension of semantic information theory in the direction of analyzing actual communication behavior" the papers of Harrah, *A logic of questions and answers* (reviewed below), and Rulon Wells, *A measure of subjective information*.

ALONZO CHURCH

DAVID HARRAH. *A logic of questions and answers. Philosophy of science*, vol. 28 (1961), pp. 40-46.

DAVID HARRAH. *Communication: A logical model*. The M.I.T. Press, Cambridge, Massachusetts, 1963, xi + 118 pp.

DAVID HARRAH. *A model for applying information and utility functions. Philosophy of science*, vol. 30 (1963), pp. 267-273.

Harrah develops, in the three items under review, an abstract model of certain aspects of the process of sender-receiver communication, with emphasis on the way in which this process can be articulated in terms of (a) questions asked and answered

and (b) methods of evaluating messages received. It is supposed that the language L in use has a formal standard part (an applied first-order functional calculus with identity), which is described in the early sections of the book.

In the papers and in sections 6–10 of *Communication*, Harrah develops a “logic of questions and answers” in the double sense of (1) providing an illuminating method of formalizing questions and answers, and (2) providing a set of precisely defined meta-linguistic concepts useful in talking about questions and answers. As (formal) questions, Harrah employs certain sentences of an applied first-order functional calculus with identity. He distinguishes two types of questions, *disjunctive* questions and *which* questions; in the book (which makes some improvements on the earlier paper), one uses a certain disjunction of conjunctions, having the effect of asserting that exactly one of A_1, \dots, A_n is true, in order to ask the disjunctive question, “Which of the following is true: A_1, \dots, A_n ?” A *direct answer* to this question is then one of the disjuncts of the question, namely, a conjunction having as conjuncts one of the A_i together with the negations of each the others. Such a sentence evidently has the effect of saying that A_i is the true answer among the alternatives A_1, \dots, A_n . In order to ask the which question, “Which n -tuples of individuals satisfy the condition $Fx_1 \dots x_n$?” Harrah bids us use $\exists x_1 \dots \exists x_n Fx_1 \dots x_n$, with *direct answers* having the form $(x_1) \dots (x_n)[Fx_1 \dots x_n \leftrightarrow [(x_1 = a_1 \& \dots \& x_n = a_n) \vee \dots \vee (x_1 = b_1 \& \dots \& x_n = b_n)]]$, where the a 's and b 's are individual constants. Such an answer gives us a *complete list* of all the individuals satisfying the condition $Fx_1 \dots x_n$. A question, then, is defined formally as a statement of one of these two types. In the earlier paper there was a further requirement that the statement which is the question be true, but this condition on questionhood is dropped in *Communication*.

Comment: It seems to the reviewer that a reasonable criterion for a formalization of a question as a statement is that the statement which is the question should be true if and only if the question is answerable in the sense that at least one of its direct answers is true. This criterion is satisfied in the case of Harrah's disjunctive questions as defined in *Communication*, but is met neither by his formalization of disjunctive questions in the earlier paper nor by his formalization of which questions in either place.

Beyond providing ways of asking and answering questions in a formal language, Harrah defines a set of meta-linguistic erotetic concepts, of which we give some examples. (When definitions change from earlier paper to book, we use the later formulations.) A question commits *the fallacy of many questions* if it is false. p is a *complete answer* to a question q if either p is a direct answer or else $p \& q$, being L -consistent, L -implies some non- L -true direct answer to q . (This concept is not defined in *Communication*; it would have been in the spirit of that book to have dropped the conditions of L -consistency and non- L -truth.) A *partial answer* to q is any sentence L -implied by some consistent direct answer to q . A question q_1 *answer-contains* a question q_2 if every direct answer to q_1 L -implies some direct answer to q_2 . Harrah also defines *answer-equivalence*, and tells us what it means to say that a question is *rhetorical* or *interesting*.

Though of considerable interest in its own right, Harrah developed his erotetic apparatus chiefly to subserve his theory of message evaluation. The way questions come in is that the receiver (R) wants to pay for a message partly according to how relevant it is to his interests — i.e., according to the extent to which it answers his questions. Thus, R pays only for partial answers to his questions.

In the model of the later paper, which in this respect is essentially like the book, a *receiver* R is defined as an ordered quadruple $\langle L, k, Q, I \rangle$, with L a language, k a consistent sentence representing the receiver's knowledge, Q a set of questions representing the receiver's interests, and I a semantic information function representing the

value which the receiver attaches to each sentence. A *communication event* is defined as a triple $\langle R, m, i \rangle$, with R a receiver, m a statement representing a message received, and i a numerical (e.g., temporal) index. A controversy \mathbf{E} is defined as a sequence of communication events E_1, \dots, E_n satisfying certain minimal conditions.

A chief aim is to devise methods for applying functions like I in order to evaluate messages received in the context of a controversy; the knottiest problems derive from the potential presence of contradictions, including those due to changes in the state of knowledge, k . Harrah solves these problems by postulating that prior to evaluation one has selected some subset of the messages m which engender no conflict when conjoined with each other and with one's knowledge k ; in the book one is directed to obtain a maximal such *usable message total* by working backwards through the sequence of messages, omitting (roughly) those inconsistent with later messages and with one's knowledge at E_i , while in the later paper the concept of such a "usable message total" is simply characterized axiomatically. Harrah then defines fumt_i^* (the cumulative conjunction of finally usable messages received prior to E_i) and $\text{fumt}_{i,n}$ (the conjunctive total of messages which R found usable at E_i and still finds usable at the termination of \mathbf{E}). Then, using $k_{i,n}$ for what R believed at E_i and still believes at the end of \mathbf{E} , and Q for the subset of questions of E_i in which R retains interest at the end of \mathbf{E} , Harrah defines the central concept of *news value* of the controversy in terms of a notion of a *news-value datum for E_i in a controversy \mathbf{E}* . This latter notion is defined in the later paper as a value of $I_i[(p \vee \text{fumt}_{i,n}) \mid ((p \vee \text{fumt}_i^*) \& k_{i,n})]$ where $p \& k_n$ is consistent with the n^{th} usable message total, where p is either L -true or (in the interesting cases) a conjunction of direct answers to the questions in Q , and where $I(A \mid B) = I(A \& B) - I(B)$. Thus, informally, the news value of a message is the degree to which that portion of it which answers one's questions represents an informational advance over the conjunction of previous usable messages with one's knowledge. The usefulness of this concept in evaluating messages for payment is evidenced in both the book and the later paper, which in this respect supplement each other, by some least upper bound theorems.

Comment: Though the later definition of "news value datum" represents an advance over that of the book in point of neatness, it appears to be not very different theoretically; indeed, in the presence of $I(p \& q) = I(p) + I(q) - I(p \vee q)$ (not postulated by Harrah), both definitions give rise to the same concept of "news value."

Communication also outlines various concepts of *meaning* definable in terms of a sequence of communication events, and develops some measures of message adequacy based on the ratio $I_i[p \mid (k_{i,n} \& \text{fumt}_i^*)] / I_i[DA \mid (k_{i,n} \& \text{fumt}_i^*)]$, where DA is a conjunction of direct answers to questions in Q and p a conjunction each of whose conjuncts is either L -true or is both a direct or partial answer to some question in Q and also L -implied by both DA and $(k_{i,n} \& \text{fumt}_{i,n})$.

Author's corrections to Communication: Page 46, lines 10 and 11 from below, for " CQ ", read " DA "; page 56, line 16 from below, insert ")") after " $I(p_1)$ "; page 101, line 18, for "equal to," read "identical with." NUEL D. BELNAP, JR.

NICHOLAS RESCHER. *Belief-contravening suppositions. The philosophical review*, vol. 70 (1961), pp. 176–196.

"Belief-contravening suppositions" are hypotheses which, whether true or false, are *believed* to be false by the supposer; typically, they serve as antecedents of "purely hypothetical" counterfactual conditionals. The article gives a careful and detailed argument, with many examples, for the conclusion that "belief-contravening suppositions outrun the possibility of logical resolution because of their contextual ambiguity, which can only be removed by further information not available from the