JOURNAL OF EXPERIMENTAL SOCIAL PSYCHOLOGY 11, 439–458 (1975)

Processing the Information Contained in Another's Behavior

YAACOV TROPE AND EUGENE BURNSTEIN

The University of Michigan

This study investigates attributions based on behavior congruent with situational demands (in-role) and those based on behavior incongruent with situational demands (out-of-role). By analyzing these processes in terms of a Bayesian inference model, it was possible to determine (a) the diagnostic values observers initially assign to behaviors, (b) the actual informational impact of these behaviors, and (c) the degree of optimality in processing information contained therein. The main results can be summarized as follows: (1) The diagnostic value and actual informational impact of out-of-role behaviors were much higher than those of in-role behaviors. (2) Information about out-of-role behaviors was less optimally processed than information about in-role behaviors. (3) Observers assigned smaller diagnostic values to behaviors which were described in great detail than to behaviors which were described in summary statements. (4) Observers' attitudes influenced their initial beliefs about the actors but not the processing of new information about the actor. (5) The Bayesian inference model predicted observers' inferences reasonably well.

Attribution theory deals with the process whereby one infers personal attitudes, traits, or dispositions as causal explanations of observed behavior. The basic tenets about the informational aspects of this process were formulated by a number of theorists (Heider, 1958; Jones & Davis, 1965; Kelley, 1971). Recently, it has been proposed that if attributions are viewed in terms of probabilistic information processing, these tenets are consistent with a Bayesian model of trait inference (Ajzen, 1971; Messick, 1971; Trope, 1973, 1974). The usefulness of this model is that it identifies a set of quantitative variables by which the observer's perception of an actor in a situation can be analyzed. Furthermore, the model specifies quantitatively the optimal way in which these perceptions should be combined into inference of traits.

THE BAYESIAN MODEL

An application of the Bayesian inference model to inference of attitudes from observed behavior suggests that the observer considers (1) a

This research was supported by a Grant from the National Institute of Mental Health (MH-16950-05). The authors are grateful to Barbara Nelson for valuable help in carrying out the study. Requests for reprints should be sent to Yaacov Trope, Department of Psychology, Hebrew University, Jerusalem, Israel.

set of attitudes one of which the actor holds, and (2) a set of behavior alternatives one of which the actor will choose. The observer's perception of an actor in a situation can be characterized then by the following sets of variables: (a) prior attitude probabilities, $P(A_i)$, each of which reflects the observer's initial certainty that the actor holds a given attitude; and (b) conditional behavior probabilities, $P(B_j|A_i)$, each of which reflects the observer's certainty that an actor who holds a given attitude will choose a given behavior alternative. The model specifies how these likelihoods should be combined into posterior attitude probabilities $[P(A_i|B_j)]$, i.e., the probabilities of attitudes after observing some behavior. Considering two mutually exclusive attitudes (A_1 and A_2), Bayes' theorem can be writen as:

$$\frac{P(A_i|B_j)}{P(A_2|B_j)} = \frac{P(A_1) \cdot P(B_j|A_1)}{P(A_2) \cdot P(B_j|A_2)}$$

or

$$\Omega_1 = \Omega_0 \cdot BLR(B_j), \tag{1}$$

where $\Omega_0 = \frac{P(A_1)}{P(A_2)}$ are the odds prior to observing B_j; $\Omega_1 = \frac{P(A_1|B_j)}{P(A_2|B_j)}$ are the odds after observing B_j; and $BLR(B_j) = \frac{P(B_j|A_1)}{P(B_j|A_2)}$ is the likelihood ratio of behavior B_j. By taking logarithms in Equation (1), the following additive inference model is obtained:

$$L\Omega_1 = L\Omega_0 + BLLR(B_j). \tag{2}$$

The model suggests, then, that in light of the actor's behavior the observer changes his beliefs about the actor from prior odds to posterior odds. The magnitude of the change is prescribed by a function of the likelihood ratio associated with the actor's behavior, *BLLR*. This quantity represents the extent to which the behavior is thought of as being uniquely produced by actors possessing a given attitude, i.e., it indicates the extent to which the behavior distinguishes between the different types of actors (in attitude). Given that the log likelihood ratio is estimated by the observer, it provides an index of the *diagnostic value* of the behavior in relation to the attitudes considered. Furthermore, from the observer's prior and posterior odds, the actual revision in light of behavior can be inferred as follows: $SLLR(B_j) = L\Omega_1 - L\Omega_0$, where $SLLR(B_j)$ stands for the subjective log likelihood ratio. By comparing diagnostic values and actual revisions, the fit between the optimal and the actual impact of observer behavior can be assessed.

THE ASYMMETRIC CERTAINTY PRINCIPLE

Equipped with these theoretical notions, we can turn to a phenomenon which is of central importance in the attribution literature, to wit: the observers' inferential processes in situations where the actor is under pressure to behave in one way rather than in another (e.g., Thibaut & Riecken, 1955; Jones, Davis, & Gergen, 1961; Bem, 1965; Messick & Reeder, 1972). Bayesian probabilistic information processing would suggest that in order to account for observers' inferences the perceived stochastic relationships between traits and behaviors should be delineated. Such an *ideal* probabilistic model was proposed by Messick (1971) as a prototype of observers' perception of such situations. In Messick's model, it is assumed that there are two behavioral alternatives in the situation, B_1 and B_2, and that observers consider two attitudes, A_1 and A_2, which are, respectively, congruent with the two behaviors. Assuming that there exists external pressure to choose B_1 rather than B_2, Messick suggests that observers believe actors holding A_1 are most likely to choose the congruent behavior B_1, that is, $P(B_1|A_1) \approx 1.0$. However, due to the external pressure, observers also think, according to Messick, that there is some probability, say s, of actors holding the incongruent attitude A_2 also choosing B_1, that is, $P(B_1|A_2) = s$. Assuming that $\sum_{j=1}^{2} P(B_j|A_i) = 1.0$, it follows that the probability of B_2 being chosen by actors holding the incongruent attitude A_1 is close to zero, i.e., $P(B_2|A_1) \approx 0.0$, and that there is some probability, $1\text{-}s$, of B_2 being chosen by actors holding the congruent attitude A_2, i.e., $P(B_2|A_2) = 1\text{-}s$. These conditional probabilities are displayed in Table 1.

According to the Bayesian model, the diagnostic values (likelihood ratios) of B_1 and B_2 are $\frac{1.0}{s}$ and $\frac{1\text{-}s}{0.0}$ (or their logarithms), respectively. That is, the diagnostic value of B_2 is infinitely larger than that of B_1. Accordingly, after observing B_2, a Bayesian information processor

TABLE 1
CONDITIONAL BEHAVIOR PROBABILITIES ASSUMED BY THE ASYMMETRIC CERTAINTY PRINCIPLE

		Behaviors	
		B_1	B_2
Attitudes	A_1	1.0	0.0
	A_2	s	$1 - s$

would revise his prior opinions about an actor to complete certainty that the actor holds A_2; after observing B_1, however, he would still remain uncertain about the actor's attitudes. Stated otherwise, B_2 (e.g., noncompliance) is associated with a much higher diagnostic value and, therefore, a much greater actual revision from priors to posteriors than those associated with B_1 (e.g., compliance), because B_2 is expected to be chosen only by an actor holding A_2, whereas B_1 is expected to be chosen by an actor possessing either A_1 or A_2. Messick used the phrase *asymmetric certainty principle* to refer to these stochastic contingencies and the inferences to which they lead.

INFERENCES FROM IN-ROLE AND OUT-OF-ROLE BEHAVIORS

Recently, Trope (1974) analyzed observers' perceptions of the high inducement condition in a forced compliance situation in terms of the asymmetric certainty principle. It was shown that this principle adequately portrayed their views of the diagnostic values of compliance and noncompliance, before observing the actor's decision. In that study, however, observers saw only compliance. Therefore, only revisions in light of compliancd were studied. One of the purposes of the present experiment was to test the asymmetric certainty principle with regard to the diagnostic values and actual revisions associated with both kinds of behaviors. Also, instead of the forced compliance set-up, an experimental paradigm similar to that employed by Jones, Davis, and Gergen (1961) was employed. This paradigm consists of two situations. In the first, there was pressure to choose one behavior, say B_1, rather than the other, say B_2, whereas in the second situation the pressure was in the opposite direction. Thus, the preceding theoretical analysis would suggest that in the first situation the diagnostic value and actual revision associated with B_1 should be larger than those associated with B_2, whereas in the second situation the reverse should hold.

Both situations described above involve external pressure to engage in certain behaviors (e.g., in-role acts) and to avoid engaging in other behaviors (e.g., out-of-role acts). The perceived stochastic contingencies produced by the in-role/out-of-role manipulation can best be evaluated by comparing them with those produced in a situation where there is no external pressure (e.g., a situation in which the person engages in role-neutral acts, ones which are neither socially prescribed nor proscribed). Actually, such comparisons can be made within the same setting, where pressure may exist in relation to one set of behaviors and attitudes, called role-relevant, but not in relation to another set of behaviors and attitudes, called role-neutral (see, for example, Katz & Burnstein, 1973). For the latter, it can be assumed that observers believe each possible type of actor will choose the behavior which is congruent with the atti-

tude he holds. Thus, we would expect that in the absence of external pressure any and all behaviors engaged in will be associated with high and equal diagnostic values as well as with high and equal revisions in light of their occurrence.

THE EFFECT OF PRIOR ODDS

It has often been argued in attribution literature that the lower the prior probability of behavior, the more informative it is (e.g., Jones & Gerard, 1967, p. 265; Ajzen, 1971). Since prior attitude probabilities affect behavior probabilities, this proposition can be taken to mean that the lower the prior probability of a given attitude, the higher the diagnostic value of the behavior which is congruent with that attitude. However, the Bayesian analysis presented above indicates that the diagnostic values of behaviors are independent of prior attitude probabilities. Furthermore, no assumption about prior attitude probabilities is made by the asymmetric certainty principle. Hence, in a situation where there is pressure to choose, say B_1, the high diagnostic value of B_2 and the low diagnostic value of B_1 should be obtained regardless of the form of the prior probability distribution over the attitudes. By experimentally manipulating prior attitude probabilities, the present study empirically tested this proposition.

EFFECTS OF SPECIFICITY OF INFORMATION AND OBSERVERS' ATTITUDES

In this study, the *BLLR*'s had been assessed *before* observers learned how the actor actually behaved. These estimates can be given with regard to a summary statement about the possible behaviors (e.g., "the actor will behave favorably toward X" or "the actor will behave unfavorably toward X"); alternatively, these estimates can be given with regard to a complete detailed description of the possible behaviors. Edwards, Phillips, Hays, and Goodman (1968) noted that detailed descriptions of evidence lead to an attenuation of their dagnostic values. They maintained that due to its richness in detail a complete description of evidence is seen as more probable under *all* the hypotheses considered and is therefore judged as less diagnostic. In the present study, part of the observers provided estimates of diagnostic values of summary statements of the possible behaviors (summary conditions) and part of the observers provided such estimates with regard to complete descriptions of the possible behaviors (complete conditions). It was expected that diagnostic values would be higher in the former than in the latter condition.

Finally, the relationship between the observers' attitudes toward the object of the actor's behavior and their inferences were investigated.

One recent study (Katz & Brunstein, 1973) found that observers' own attitudes affected their estimates of likelihoods that actors hold the same attitudes. The Bayesian concepts of diagnostic value and actual revisions provide useful quantitative dimensions which allow us to determine the effects of observers' attitudes on the inference process with greater precision than in the past. In addition, a determination of the relationship between observers' attitudes and the discrepancy between diagnostic values and actual revisions would enable us to assess the effect, if any, of observers' attitudes on the optimality or accuracy in processing information relevant to their attitudes.

METHOD

Subjects and Design

One hundred and seventy undergraduate students at The University of Michigan (98 males and 72 females) participated in the experiment as observers in groups ranging in size from five to ten. The theoretical analysis calls for two situations in which the same two kinds of behaviors, B_1 and B_2, are considered. One situation has to include pressure to choose B_1 rather than B_2, whereas the opposite has to hold for the other situation. Accordingly, descriptions of two job interview situations were prepared. One was an interview for a teaching position in a Jewish private school, the other was an interview for a teaching position in an Arab private school. The role-relevant set of behaviors consisted of arguing in favor (B_1) or against (B_2) Israel. Thus, arguing in favor of Israel in the Jewish school and arguing against Israel in the Arab school were regarded as in-role behaviors; arguing against Israel in the Jewish school and arguing in favor of Israel in the Arab school were regarded as out-of-role behaviors (see Jones, Davis, & Gergen, 1961; Messick & Reeder, 1972). A joint manipulation of the situations (Jewish versus Arab school) and the behaviors (arguing in favor versus against Israel) produced the basic 2×2 design of this study. The same situations have been used by Katz and Burnstein (1973).

This design was replicated under a *summary* and a *complete* condition. Recall that in the former subjective estimates of diagnostic values are given with regard to summary statements of possible behaviors; in the latter, these estimates are given with regard to complete descriptions of the possible behaviors. In this way, the factor of specificity of information (summary versus complete) was crossed with the other two factors in a $2 \times 2 \times 2$ factorial design. Fifty-six observers were assigned to each of the two specificity of information conditions. In both, 28 observers were assigned to each of the two situations (Jewish school and Arab school). Each observer considered both B_1 and B_2, in that order.[1] Hence, situations and specificity of information (or specificity, for short) served as between-subjects factors, and behaviors served as a within-subjects factor.

In the experimental conditions described above, the description of the background of the applicants included characteristics which should induce high prior probabilities that the applicants to the Jewish school held a pro-Israeli attitude and that the applicants to the Arab school held an anti-Israeli attitude. In these conditions (extreme conditions), the prior odds should therefore be rather high or extreme. In order to induce more moderate prior odds, another group of 58 observers received a description of the background of the

[1] A pilot study in which counterbalancing was employed indicated that the order of the behaviors did not systematically affect the results.

applicants which should produce more ambiguity about the applicants' attitudes. In this moderate condition, 29 observers were assigned to each of the two situations (Jewish school and Arab school), and each observer viewed B_1 and then B_2. These observers were all given summary descriptions of the behaviors.

Finally, in addition to the role-relevant behaviors of arguing in favor of or against Israel, each observer considered the behaviors of arguing in favor of or against the European Common Market. These were considered as role-neutral, that is, there is no appreciable external pressure to argue for or against the Common Market in this setting.

Procedure

Practice example. The experimental session started with a brief oral introduction. The experimenter informed the observers that they would be asked to make judgments about the characteristics of others from information about the others' behaviors. The experimenter added that since these judgments would be in the form of probability estimates, the experiment would start with a practice example which was designed to familiarize observers with such estimates. The practice example concerned the inference of the attitude toward American intervention in Vietnam which some typical University of Michigan student may hold, in light of information about his politcal party affiliation. The practice involved three steps: First, observers estimated (a) prior attitude probabilities and (b) conditional probabilities of the various possible party affiliations given the alternative attitudes. Second, observers were informed about the student's actual party affiliation. Third, observers estimated posterior probabilities of the attitudes given the information about the student's party affiliation. In each step, the meaning of the various probability estimates was explained by interpreting the estimates as statements of subjective degrees of certainty which are based on estimated relative frequencies. No hint was given, of course, as to the way the prior attitude probabilities and the conditional probabilities associated with the party affiliation should be combined into posterior attitude probabilities.

Description of interview situations and applicants' background. The experimental inference tasks followed the example in a booklet titled, "A Study on the Accuracy with which People Perceive Attitudes of Others." The booklet began with a description of the job interview situations and the backgrounds of two applicants for each of the jobs. In the Jewish school conditions, the situation was described as an interview for a position teaching current affairs in a Jewish Sunday school in Detroit. In the Arab school conditions, the situation was described as an interview for the same kind of job in a private school for the children of Arab nationals who reside in New York City. The descriptions of the backgrounds of the two applicants also varied according to conditions. In the extreme conditions, the applicants for the job in the Jewish school had typical Jewish names (Cohen and Levy) and were described as having been raised in a Jewish neighborhood in Detroit; the applicants for the job in the Arab school were given typical Arab names (Mohraz and Hasan) and were described as having been raised in an Arab neighborhood in New York City. In the moderate conditions, the applicants, both in the Jewish and Arab schools, were given typical American names, neither Jewish nor Arab (Clark and Long), and were described as having been raised in Lansing, Michigan.

Probability estimates before observing behavior. In all conditions, observers were told that the interviewer asked the applicants questions about such issues as the Israeli–Arab conflict and the European Common Market and that on the basis of the applicants' discussion they would be asked to infer the applicants' real attitudes on these issues. With regard to the applicant's attitudes on the issue of the Israeli–Arab conflict, observers were asked to consider two possibilities: he can either hold a pro-Israeli attitude or an anti-Israeli attitude. Furthermore, observers were told that an applicant holding any of these attitudes may, in principle, argue during the interview either in favor of or against Israel. Observers

were told that each of the possible attitudes could be assigned a subjective prior probability and that each of the possible behaviors given each of the attitudes could be assigned a conditional probability. Observers were informed that before they read the content of the actual interview, they would be asked to indicate their subjective estimates of these probabilities. In the summary conditions, observers then indicated their prior attitude probabilities, $P(A_i)$, and their conditional behavior probabilities, $P(B_j|A_i)$, for both applicants. The probability estimates were assessed by a method similar to that devised by Ajzen (1971). To indicate prior attitude probabilities, observers estimated how many out of 100 applicants similar to those considered in the interview situation held a pro-Israeli attitude and how many held an anti-Israeli attitude. Contional behavior probabilities given each of the attitudes were then assessed. Specifically, observers estimated how many out of 100 applicants who held a given attitude would argue in favor of Israel, and how many would argue against Israel in the interview situation (a more detailed description of the method of assessment of these probabilities can be found in Trope, 1974). In the complete conditions, before indicating their estimates, observers were told that they would first read examples of transcripts of two interviews in one of which some applicant argued in favor of Israel and another in which some applicant argued against Israel. Observers in the complete conditions then read these transcripts, each of which was two and a half pages long. Both transcripts contained strong argumentations by the applicant, in one case favoring the Israeli side and in the other favoring the Arab side. After reading the transcripts, observers in the complete conditions indicated their probability estimates in the same fashion as in the summary conditions.

The same procedures, for the summary and complete conditions, respectively, were repeated with regard to the issue of the European Common Market. For this issue, observers considered pro- and anti-European Common Market attitudes, and the behaviors considered were arguing in favor of or against the European Common Market during the interview.

Probability estimates after observing behavior. After indicating their probability estimates for the European Common Market issue, observers in the summary conditions read the transcripts of the *actual* interviews with the two applicants. In one the applicant argued in favor of Israel; in the other the applicant argued against Israel. In both transcripts the applicants argued in support of the European Common Market. These transcripts were the same as those given as examples of interviews to observers in the complete conditions. In the complete conditions, after indicating their estimates for the European Common Market issue, observers were simply told that one applicant argued in favor of Israel, that the other argued against Israel, and that both argued in favor of the European Common Market. These observers were also told that what the applicants actually said was the same as what they read in the example transcripts. Within each of the schools, the same applicats were associated with the same behaviors across observers. For instance, all observers in the Jewish school in the extreme condition were told that Mr. Cohen argued in favor of Israel and that Mr. Levy argued against Israel.

After learning about the applicants' actual behaviors, observers in all conditions indicated, for each applicant separately, their posterior attitude probabilities, $P(A_i|B_j)$, with regard to the issues of the Israeli–Arab conflict and the European Common Market. Ajzen's (1971) method was used to assess the posterior attitude probabilities. Specifically, observers were instructed to choose two numbers between 1 and 99 that sum to 100 to indicate their estimates of the chances that the applicant held the attitudes considered, given his behavior during the interview.

Finally observers were asked to indicate their own attitudes on the two issues by checking one of nine alternatives, ranging from very strongly pro-(Israeli or European Common Market) to very strongly anti-(Israeli or "European Common Market").

RESULTS

Diagnostic Values of In-Role and Out-of-Role Behaviors

From each observer's conditional behavior probabilities, $P(B_j|A_i)$, concerning the role-relevant issue (the Israeli–Arab conflict), Bayesian log likelihood ratios (diagnostic values) associated with arguing in favor of and against Israel were computed as follows: $BLLR(B_1) = \log\left(\frac{P(B_1|A_1)}{P(B_1|A_2)}\right)$ and $BLLR(B_2) = \log\left(\frac{P(B_2|A_2)}{P(B_2|A_1)}\right)$, respectively, B_1 and B_2 denote arguing in favor of and against Israel, respectively, and A_1 and A_2 denote pro- and anti-Israeli attitudes, respectively. It was predicted that $BLLR(B_1) < BLLR(B_2)$ in the Jewish school conditions and that $BLLR(B_1) > BLLR(B_2)$ in the Arab school conditions. Table 2 presents the means of these diagnostic values in the various experimental conditions.

Inspection of Table 2 reveals that the predicted pattern of results was obtained in the extreme-summary, extreme-complete, and moderate-summary conditions. In terms of the analysis of variance, we would expect situations and behaviors to interact. To test this prediction, separate two-way analyses of variance, with situations and behaviors as factors, were conducted for the extreme-summary, extreme-complete, and moderate-summary conditions. In each of the three analyses of variance, robust situations × behaviors interactions effects were obtained ($F = 132.75$, $p < .005$; $F = 61.00$, $p < .005$; and $F = 318.33$, $p < .005$, respectively). In the extreme-summary condition, however, $BLLR(B_2)$ tended to be higher than $BLLR(B_1)$ ($F = 4.25$, $p < .05$) and the diagnostic values in the Jewish school tended to be higher than those in the Arab school ($F = 5.24$, $p < .05$). But even in the extreme-summary condition, although significant, these main effects were very small compared to the interaction effect.

TABLE 2
MEAN DIAGNOSTIC VALUES AND ACTUAL REVISIONS

	Extreme-summary				Extreme-complete				Moderate-summary			
	Behavior				Behavior				Behavior			
	B_1		B_2		B_1		B_2		B_1		B_2	
Situation	Diag. value	Actual revision	Diag. value	Actual revision	Diag. value	Actual revision	Diag. value	Actual revision	Diag. value	Actual revision	Diag. value	Actual revision
Jewish school	0.47	−0.25	1.36	2.40	0.42	0.03	0.98	1.95	0.34	0.05	1.27	1.60
Arab school	0.95	1.79	0.33	−0.11	0.74	1.57	0.19	−0.08	1.30	1.53	0.25	0.38

TABLE 3
MEAN CONDITIONAL BEHAVIOR PROBABILITIES FOR THE JEWISH SCHOOL IN THE SUMMARY CONDITION

		Behaviors	
		B_1	B_2
Attitudes	A_1	0.97	0.03
	A_2	0.50	0.50

The component conditional behavior probabilities from which the diagnostic values were computed were in line with the asymmetric certainty principle. As an example, Table 3 displays the means of these conditional behavior probabilities for the Jewish school in the summary condition. It is apparent that almost all applicants possessing a positive attitude toward Israel, A_1, but also many of those who held the opposite attitude, A_2, were expected to argue in favor of Israel, B_1 (in-role behavior). However, those who were expected to argue against Israel, B_2 (out-of-role behavior), were almost exclusively applicants who held a negative attitude toward Israel.

The fact that the same pattern of results was obtained in both the moderate and extreme (summary and complete) conditions is worth noting. Recall that in designing the moderate conditions an attempt was made to induce more moderate prior odds than in the extreme conditions. Indeed, in the extreme conditions, the prior probabilities that the applicants were pro-Israeli were 0.88 in the Jewish school and 0.21 in the Arab school, whereas the corresponding means for the moderate conditions were 0.77 and 0.54. The t tests on the log prior odds derived from these probabilities, $L\Omega_0 = \log\left(\frac{P(A_1)}{P(A_2)}\right)$, indicated that the prior odds were much more extreme in the extreme than in the moderate conditions ($t = 3.10$, $p < .005$ and $t = 5.02$, $p < .005$, for the Jewish and Arab schools, respectively). Thus, the fact that situations interacted with behaviors in the extreme as well as moderate conditions implies that in the Jewish school the higher diagnostic value of B_2 compared to B_1 is not dependent upon the prior probabilities of the corresponding attitudes.

Effect of Specificity of Information on Diagnostic Values

In order to investigate the effect of specificity of information (summary versus complete), a three-way analysis of variance was performed on the diagnostic values in the extreme conditions, with specificity, situ-

TABLE 4
ANALYSES OF VARIANCE OF DIAGNOSTIC VALUES AND ACTUAL REVISIONS FOR THE EXTREME CONDITIONS

Source	*df*	*MS*		*F*	
		Diagnostic value	Actual revision	Diagnostic value	Actual revision
Between subjects					
Specificity of information (I)	1	2.06	0.45	4.29*	<1
Situations (S)	1	3.73	3.19	7.77*	4.31*
I × S	1	0.02	0.002	<1	<1
Error	108	0.48	0.74		
Within subjects					
Behavior (B)	1	0.29	3.71	2.23	2.61
I × B	1	0.22	0.82	1.69	<1
S × B	1	23.90	231.31	183.84**	162.89**
I × S × B	1	0.57	3.26	4.38*	2.29
Error	108	0.13	1.42		

* $p < .05$.
** $p < .005$.

ations, and behaviors as factors. The results are presented in Table 4. It was predicted that a rich, detailed description of the possible behaviors would lead to an attenuation of their diagnostic values. Consistent with this prediction, diagnostic values were significantly higher in the summary than in the complete conditions. We expected that the smaller diagnostic values in the complete condition would be due to an increase in both the conditional behavior probabilities in the numerator and the denominator of the likelihood ratio. Inspection of these component conditional probabilities revealed that for both behaviors the numerator decreased and the denominator increased. However, the increase in the denominator was larger than the decrease in the numerator.

Table 4 also shows that the strongest effect was associated with the expected interaction between situations and behaviors. In addition, there was a significant tendency for the behaviors to be perceived as more diagnostic in the Jewish than in the Arab school. Another interesting result is the significant triple interaction between specificity, situations, and behaviors. This result may be interpreted as reflecting a stronger situations × behaviors interaction under the summary than under the complete conditions. Stated otherwise, the complete descriptions not only attenuated the overall magnitudes of the diagnostic values but also decreased the differences between the diagnostic values of in-role and out-of-role behaviors.

It should be noted that the present study does not rule out the possibility that the content of the opinion statements given in the complete description was weaker than that of the summary description. Hence the effects of the specificity variable may be attributed to the level of detail and/or the content of the descriptions.

Actual Revisions in Light of In-Role and Out-of-Role Behaviors

Actual revisions from prior to posterior odds in light of arguing in favor of and against Israel, $SLLR(B_1)$ and $SLLR(B_2)$, respectively, were computed as follows: From each observer's prior and posterior attitude probabilities, prior and posterior odds, respectively, were computed. The logarithms of the prior odds ($L\Omega_0$) and of the posterior odds ($L\Omega_1$) were used to compute actual revision as follows: $SLLR(B_j) = L\Omega_1 - L\Omega_0$. In computing $SLLR(B_1)$, the prior and posterior log odds in favor of the possibility that the applicant is pro-Israeli were used. For $SLLR(B_2)$, the prior and posterior log odds in favor of the other possibility were used.

Situations and behaviors were expected to have the same effects on actual revisions as on the diagnostic values. That is, we expected that $SLLR(B_1) < SLLR(B_2)$ in the Jewish school and that $SLLR(B_1) > SLLR(B_2)$ in the Arab school, which should be manifested in an interaction between situations and behaviors. Mean values of actual revisions are presented in Table 2. The two-way analyses of variance designed to investigate the effects of situations and behaviors confirmed our expectations perfectly. In the extreme-summary, extreme-complete, and moderate-summary conditions, the only significant effects were interactions between situations and behaviors ($F = 95.24$, $p < .005$; $F = 68.03$, $p < .005$; and $F = 49.64$, $p < .005$, respectively). Again, the fact that the same pattern of results was obtained in the extreme and moderate conditions implies that the prior odds were not responsible for the predicted interaction effect. The three-way analysis of variance performed on actual revisions in the extreme conditions, including specificity, situations, and behaviors as factors, also support the hypothesis. The results of this analysis are displayed in Table 4. It is apparent that the greatest proportion in variance of actual revisions was associated with the predicted situations × behaviors interaction. In addition, since observers in the summary and complete conditions received the same information before estimating posterior trait probabilities, we expected and in fact observed that specificity did not affect actual revisions. Regarding the effect of situations, the unforeseen result initially observed in the analysis of diagnostic values was also obtained here. Specifically, actual revisions were larger in the Jewish than in the Arab school.

Accuracy

As mentioned earlier, the degree of accuracy in processing information can be determined by comparing the actual revisions to the diagnostic values. Note that, theoretically, actual revisions can approximately range from -4 to $+4$, while diagnostic values can approximately range from -2 to $+2$. However, in order for inferences to be accurate or optimal, actual revisions should be identical to diagnostic values. Accordingly, the absolute difference between actual revision and diagnostic value was computed for each behavior, i.e., $|SLLR(B_j) - BLLR(B_j)|$. The larger the deviation of the actual revision from the diagnostic value, the lower the accuracy. A three-way analysis of variance (specificity $\times$ situations $\times$ behaviors) was performed on this accuracy index in the extreme conditions. This analysis disclosed a strong situations $\times$ behaviors interaction effect ($F = 23.41$, $p < .005$). The pattern of the means indicated that the interaction was due to greater accuracy for in-role than for out-of -role behaviors. Furthermore, the same interaction effect ($F = 80.7$, $p < .005$) was obtained in an analysis of the algebraic difference between actual revisions and diagnostic values (i.e., $SLLR(B_j) - BLLR(B_j)$). Inspection of the means of these scores revealed that for in-role behaviors the actual revisions were smaller than those prescribed by the diagnostic values and that the opposite held for out-of-role behaviors. In other words, the results indicated conservative revisions (i.e., $SLLR(B_j) < BLLR(B_j)$) in light of in-role behaviors and excessive revisions (i.e., $SLLR(B_j) > BLLR(B_j)$) in light of out-of-role behaviors. Analyses of variance (situations $\times$ behaviors) of the absolute and algebraic differences between *SLLR* and *BLLR* in the moderate conditions led to essentially the same conclusions ($F = 9.62$, $p < .005$ and $F = 3.23$, $p < .10$, respectively).

Comparison Between Inferences from Role-Relevant and Role-Neutral Behaviors

It was hypothesized that the applicants' role-neutral behaviors would have more similar and higher diagnostic values than his role-relevant behaviors. (Arguing for or against the European Common Market are henceforth denoted by B_{1E} and B_{2E}, respectively to distinguish them from the corresponding role-relevant behaviors regarding the Israeli–Arab conflict.) It should be noted at the start that the analyses of variance on these diagnostic values revealed that in both the extreme and moderate conditions $BLLR(B_{1E}) < BLLR(B_{2E})$ in the Jewish school and that $BLLR(B_{1E}) > BLLR(B_{2E})$ in the Arab school. (In all analyses the situations $\times$ behaviors interaction effect was significant.) It seems, then, that B_{1E} had features of in-role behavior and B_{2E} had features of

out-of-role behaviors in the Jewish school and that the reverse held for the Arab school. We expected, however, that the differences between the two role-relevant behaviors would be much greater than the difference between the two role-neutral behaviors. This hypothesis was tested by a four-way analysis of variance on the diagnostic values in the extreme conditions, with specificity, situations, behaviors, and issues as factors. A significant second order interaction between situations, behaviors, and issues was anticipated and, in fact, obtained ($F = 63.20$, $p < .005$), implying that the situations × behaviors interaction was more pronounced for the Israeli-Arab issue than for the Common Market. Furthermore, as predicted, the overall diagnostic values of the role-neutral behaviors was higher than those of the role-relevant behaviors. This was demonstrated by a significant main effect for issues ($F = 5.58$, $p < .025$). A similar analysis of variance, excluding, of course, specificity as a factor, was conducted on the moderate conditions. The same triple interaction observed in the extreme conditions was obtained here ($F = 122.00$, $p < .005$). However, although the means differed in the expected direction, the main effect for issues was not significant.

As to the comparison between the two issues on actual revisions, it should be noted that in all conditions both applicants argued in favor of the European Common Market. Actual revisions in light of this behavior by the applicant who behaved in an in-role fashion and by the applicant who behaved in an out-of-role fashion with regard to the Arab–Israeli issue are denoted by $SLLR(B_{1E})$ and $SLLR(B'_{1E})$, respectively. (Parenthetically, in all conditions, $SLLR(B'_{1E})$ was greater than $SLLR(B_{1E})$, but the difference was significant only in the Arab school in the moderate condition. The implications of this effect will be amplified in our discussion below.) Now, since arguing in favor of the European Common Market had features of in-role behavior in the Jewish school and out-of-role behavior in the Arab school, $SLLR(B_{1E})$ and $SLLR(B'_{1E})$ were compared to $SLLR(B_1)$ in the Jewish and Arab schools. That is to say, in the Jewish school the two issues were compared on actual revisions in light of in-role behaviors, and in the Arab school the two issues were compared on actual revisions in light of out-of-role behaviors. In the Jewish school in the extreme conditions, both $SLLR(B_{1E})$ and $SLLR(B'_{1E})$ were higher than $SLLR(B_1)$ ($t = 7.05$, $p < .001$ and $t = 6.26$, $p < .001$, respectively). These comparisons in the Jewish school in the moderate conditions yielded similar results ($t = 5.10$, $p < .001$ and $t = 6.35$, $p < .001$, respectively). In the Arab school, $SLLR(B_{1E})$ and $SLLR(B'_{1E})$ were lower than $SLLR(B_1)$ in both the extreme and moderate conditions. (For the extreme conditions, $t = 4.69$, $p < .001$ and $t = 4.93$, $p < .001$, respectively; for the moderate conditions, $t = 4.54$, $p < .001$ and $t = 2.98$, $p < .01$, respectively.) In short, in-role behavior with regard to

the issue of the European Common Market led to greater actual revisions than did such behavior with regard to the issue of the Israeli–Arab conflict. However, out-of-role behavior with regard to the issue of the Israeli–Arab conflict led to larger actual revisions than did such behavior with regard to the issue of the European Common Market.

Effects of Observers' Attitude

To assess the effect of attitudes on attribution processes, correlation coefficients were computed between the former, on one hand, and log prior odds, diagnostic values, actual revisions, and the two measures of accuracy, on the other hand. These were computed for both issues and separately for the Jewish and Arab schools in the extreme and in the moderate conditions. Out of all these correlations, only a few of those between attitudes and log prior odds were significant. Specifically, for the issue of the Israeli–Arab conflict in the extreme conditions, a positive correlation was obtained between the observer's attitude favorability and log prior odds in the Jewish school ($r = .28$, $p < .05$); for the issue of the European Common Market, attitude favorability was correlated with log prior odds in the Jewish School in both the moderate and extreme conditions ($r = .53$, $p < .01$ and $r = .43$, $p < .01$, respectively). Evidently, the effect of the observer's own attitude was limited to the estimation of prior odds; it did not have any effect in the processing of new information bearing upon the prior odds.

Relationship Between Diagnostic Values and Actual Revisions

The analysis of the accuracy measures clearly indicate that observers' probability revisions deviate considerably from those prescribed by the Bayesian model. That is, the diagnostic values and actual revisions were not of the same magnitude (see Table 2). Inspection of the means reported in Table 2 reveals, however, that actual revisions tend to be proportional to diagnostic values. Indeed, the product moment correlation between the means of diagnostic values and actual revision given in Table 2 is 0.90 (see Peterson, Schneider, & Miller, 1965, for similar correlations between *SLLR* and *BLLR*). It seems, then, that a rather large proportion of the variance in actual revisions can be accounted for by a linear function of the Bayesian diagnostic values. To further examine the relationship between Bayesian and actual revisions, correlation coefficients between diagnostic values and the latter were computed across individual observers for all experimental conditions combined. For the behaviors regarding the Israeli–Arab conflict, B_1 and B_2, these correlations were .40 and .49 respectively, and for the behaviors regarding the Common Market, B_{1E} and B_{2E}, they were .40 and .42, respectively. Thus, as would be expected, these correlations are lower than those

based on group means; they are nevertheless moderate in magnitude and highly significant ($p < .01$).[2]

DISCUSSION

A Bayesian analysis was applied to inferences of attitudes from in-role and out-of-role behaviors. Consistent with Messick's probabilistic model of the perception of such behaviors—the asymmetric certainty principle—out-of-role behavior had much higher diagnostic value than in-role behavior. Moreover, according to this principle, if the observer processes information optimally, he should revise his initial opinions much more following out-of-role than following in-role behavior, and this is precisely what he does. Thus, the assymetric certainty principle seems to provide a useful simulation of how situational pressures on an actor are represented in the observer.

Recall also that in-role and out-of-role behaviors were contrasted in similar fashion regardless of prior odds, which implies that such effects depend on the perception of the situational pressures rather than on the prior odds. This finding is also consistent with the asymmetric certainty principle since the latter is based on the structure of the conditional probabilities relating behaviors to attitudes instead of prior attitude probabilities. Furthermore, this principle would suggest that if there is pressure to choose, say, B_1 rather than B_2, the former, compared to the latter, will be associated with low diagnostic value and little actual revision, even when the attitude congruent with B_1 has lower prior probability than the attitude congruent with B_2. Clearly, B_1 may have a lower prior probability than B_2 due to the lower prior probability of the attitude corresponding to B_1. Under these circumstances, the asymmetric certainty principle (or, actually, the Bayesian inference model) leads to a prediction which is at variance with that made by attribution theory, namely that a behavior with lower prior probability will have smaller informational value than a behavior with high prior probability. It is true, however, that ordinarily the higher the prior probability of one behavior compared to the other, as determined by the behaviors' conditional probabilities (i.e., for constant prior trait probabilities), the lower the diagnostic value of the former compared to the later.

The impact of in-role and out-of-role behaviors on observers differed in still another respect. Following in-role acts, actual revisions were smaller than required by the diagnostic values (conservatism), while the reverse (excessive revisions) held following out-of-role acts. Moreover,

[2] It may be noted that probably due to the small variation within experimental conditions, the correlations between actual revisions and diagnostic values within experimental conditions were small and mostly insignificant.

the deviation of the actual revisions from the diagnostic values was larger in the latter than in the former case. This implies that the processing of information concerning out-of-role behavior was less optimal or less accurate than the processing of information concerning in-role behavior. Though interesting, it is not entirely clear how these results should be interpreted theoretically. One possibility is that they are artifactual. That is to say, the attitude favored by in-role behavior had a high prior probability, while the attitude favored by out-of-role behavior had a low prior probability; consequently, following the former behavior, observers had little room for revision and might have been reluctant to use the extreme probabilities justified by the diagnostic value (see DuCharme, 1970). This analysis, however, does not account for the excessive revisions made in light of out-of-role behavior. Another alternative would suggest that observers gave little weight to prior trait probabilities, so that their posterior trait probabilities essentially reflected the diagnostic value of the behaviors (see Kahneman & Tversky, 1973). It follows that, if the prior probability of the attitude favored by the behavior is high (as in the case of in-role behavior), the revisions in light of this behavior should be conservative; and if the prior probability of the attitude favored by the behavior is low (as in the case of out-of-role behavior), the revisions in light of this behavior should be excessive. While compatible with the observed conservative revisions and excessive revisions made following in-role and out-of-role behaviors, respectively, this interpretation does not account for the fact that the latter were more pronounced than the former. More importantly, this interpretation (as well as the one mentioned earlier) does not account for the fact that the same pattern of deviations of actual revisions from diagnostic values was obtained in the moderate condition where the prior attitude probabilities were closer to 0.5 (particularly in the Arab school). Thus, although these results may be partly due to insensitivity to prior trait probabilities, it may be worthwhile to consider the possibility that they reflected assimilation and contrast effects (Sherif, Sherif, & Nebergall, 1965). That is to say, since in-role behavior requires a small change in the observer's initial opinion, it may fall within the observer's latitude of acceptance and therefore, when actually observed, be assimilated to his initial expectation. Hence, posterior odds would not be as distant from the prior odds as predicted by the behavior's diagnostic value. Since an out-of-role act requires a large change in the observer's expectations, it may fall within the observer's lattitude of rejection. As a result, when such behavior is seen to occur, it may be subjected to a contrast effect, resulting in a greater displacement of the posterior odds from the prior odds than would be justified by the behavior's diagnostic value (see Jones, Worchel, Goethals, & Grumet, 1971). In order for this analysis to fit the

data, it also has to be assumed that the distortion due to the contrast effect was more pronounced than the distortion due to the assimilation effect.

The diagnostic values of role-relevant behaviors (arguing for or against Israel) were compared to those of role-neutral behaviors (arguing for or against the Common Market) in order to further illustrate the asymmetry involved in perception of the former. Contrary to our expectations, observers believed that what we considered role neutral behaviors were in fact subject to external pressure and thus had in-role/out-of-role characteristics. This was manifested in a considerable difference between the diagnostic values of the two behaviors with regard to the Common Market issue. Fortunately, however, these differences were much more pronounced for the Israeli–Arab issue. In other words, although the actor's stand on the Common Market was not devoid of external pressure, the latter was less than that exerted on the actor regarding his stand on the Israeli–Arab conflict. Moreover, as anticipated, the combined diagnostic values of our role-neutral acts were higher than those of our role-relevant acts.

The effect of observing role-relevant behavior upon inferences from subsequent neutral behavior is a theoretical issue which deserves some amplification. Recall that the two actors argued in favor of the Common Market. However, one actor was previously seen engaging in in-role behavior while the other actor was seen engaging in out-of-role behavior with respect to the Israeli–Arab issue. One might well expect that a stronger attribution of a positive attitude toward the Common Market would be made to the latter than to the former actor. This seems to be consistent with Messick and Reeder's (1972) suggestion that strength of inference from a behavior is mediated by the perceived trustworthiness of the actor or the likelihood that he will represent his true attitude. According to these authors, an actor who engages in in-role behavior is perceived as less trustworthy than an actor who engages in out-of-role behavior. This raises the possibility that the previously established degree of trustworthiness will generalize to subsequent behaviors as well as to inferences drawn form such behaviors. Indeed, Messick and Reeder found that deceitful behavior by an actor diminished his trustworthiness and, consequently, the strength of inference based on subsequent behaviors he might display. As reported earlier, the results of the present study only partially confirm these contentions. In all conditions, actual revisions in light of the role-neutral behavior were greater for the actor who previously engaged in out-of-role behavior than for the actor who previously engaged in in-role behavior. But the difference reached the conventional level of significance only in one of the conditions (the Arab school in the moderate condition).

A number of reasons can be offered for the weaker effect of previously observed behavior in this study than in Messick and Reeder. The most obvious one is that the clear instance of deceit observed by Messick and Reeder's subjects probably had a greater impact upon perceived trustworthiness than the corresponding information in this study, that is, in-role behavior. In any case, it is certainly important to test further Messick and Reeder's proposition that "*any* factor which influences one's perceived sincerity will mediate attributions made to that person on other dimensions" (p. 489).

From a Bayesian standpoint, the mediating effect of the actor's perceived sincerity on attitude inference should be reflected in the extent to which a behavior is more likely to be produced if the actor holds the appropriate attitude than if he does not hold the attitude. In other words, the established sincerity of an actor should be reflected in the diagnostic value of his behavior. If so, it would be interesting to find out how information about presently existing situational demands and past information about the actor's behaviors combine to determine the diagnostic value of his currently observed behavior.

In conclustion, the significance of the Bayesian probabilistic information processing framework is that it suggests a set of formal concepts – prior odds, posterior odds, diagnostic value, and actual revision – which identify measurable and manipulable aspects of the attribution process. In this study, the application of these concepts to inferences from actors' behaviors in situations involving social pressure permitted an explicit characterization of the various facets of the attribution process. The correlations between Bayesian diagnostic values and observers' actual revisions indicated that the Bayesian model can be quite useful in predicting observers inferences. That is to say, given the complexity of the information processed and the crudeness of the measurement instruments, these correlations, as well as similar ones reported by Ajzen (1971) and Trope (1974), although moderate, demonstrate that the Bayesian model is applicable to the process by which attitudes are inferred from behavior.

REFERENCES

Ajzen, I Attribution of a disposition to an actor: Effect of perceived decision freedom and behavioral utilities, *Journal of Personality and Social Psychology*, 1971, **18**, 149–156.

Bem, D. An experimental analysis of self persuasion. *Journal of Experimental Social Psychology*, 1965, **1**, 199–218.

DuCharme, W. M. A response bias explanation of conservative human inference. *Journal of Experimental Psychology*, 1970, **85**, 66–74.

Edwards, W., Phillips, L. D., Hays, W. L., & Goodman, B. C. Probabilistic information processing systems: Design and evaluation. *IEEE Transaction on System Science and Cybernetics*, 1968, *SSC-4*, 248–265.

Heider, F. *The psychology of interpersonal relations.* New York: Wiley, 1958.

Jones, E. E., & Davis, K. E. From acts to dispositions. *In* L. Berkowitz (Ed.), *Advances in experimental social psychology,* Vol. 2. New York: Academic Press, 1965. Pp. 219–266.

Jones, E. E., Davis K. E., & Gergen, K. J. Role playing variations and their informational value for person perception. *Journal of Abnormal and Social Psychology,* 1961, **63,** 307–310.

Jones, E. E. & Gerard, H. B. *Foundations of social psychology.* New York: Wiley, 1967.

Jones, E. E., Worchel, S., Goethals, G. R., & Grumet, J. F. Prior expectancy and behavioral extremity as determinants of attitude attribution. *Journal of Experimental Social Psychology,* 1971, **7,** 59–80.

Kahneman, D. & Tversky, A. On the psychology of prediction. *Psychological Review,* 1973, **80,** 237–251.

Katz, S., & Burnstein, E. *Is an out-of-role act credible to biased observers and does it affect the credibility of neural acts?* Unpublished manuscript. The University of Michigan, 1973.

Kelley, H. H. Attribution theory in social psychology. *In* D. Levine (Ed.), *Nebraska symposium on motivation.* Lincoln: University of Nebraska Press, 1971.

Messick, D. M. *Logical aspects of social inference.* Paper presented at the Third Research Conference on Subjective Probability, Utility, and Decision Making. Brunel University, Uxbridge, England, 1971.

Messick, D. M., & Reeder, G. Perceived motivation, role variations, and the attribution of personal characteristics. *Journal of Experimental Social Psychology,* 1972, **8,** 482–491.

Peterson, C. R., Schneider, R. J., & Miller, A. J. Sample size and the revision of subjective probabilities. *Journal of Experimental Psychology,* 1965, **69,** 522–527.

Sherif, C. W., Sherif, M., & Nebergall, R. E. *Attitude and attitude change: The social judgment-involvement approach.* Philadelphia: W. B. Saunders, 1965.

Thibaut, J. W., & Ricken, H. W. Some determinants and consequences of the perception of social causality. *Journal of Personality,* 1955, **24,** 113–133.

Trope, Y. Inferential processes in the forced compliance situation: A Bayesian analysis. *Journal of Experimental Social Psychology,* 1974, **10,** 1–16.

Trope, Y. *The informational values of behaviors and social situations: A Bayesian analysis of attribution processes.* Pater presented at the Forty-fifth Annual Meeting of the Midwestern Psychological Association. Chicago, Illinois, 1973.

(Received April 16, 1974)