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ABSTRACT

This paper describes an investigation of the effects of group interaction and consensus on information processing behavior when information is received sequentially or simultaneously by the information processing unit. Responses were compared to the Bayesian norm and further analyzed to determine the extent to which groups differed from individuals in processing information and how information processing behavior was affected by the mode of message transmission. Findings of the study showed that groups processed information more conservatively than "statistical" groups or individuals. Moreover, group conservatism was partially an artifact of the consensus process. In the aggregate, information received sequentially was also processed more conservatively than information received simultaneously. Neither risk attitudes of the information processing units nor perceived data credibility were related to information processing behavior. A number of statistical tables and graphs summarize various findings of the study. (Author/JG)

# CONSERVATISM IN GROUP INFORMATION PROCESSING BEHAVIOR UNDER VARYING MANAGEMENT INFORMATION SYSTEMS

by

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## ABSTRACT

This experiment investigated the effects of group interaction and consensus on human information processing behavior when information was either received sequentially or simultaneously by the information processing unit. Utilities, subjective probabilities, and perceived credibility of the given information sources were collected from 207 industrial management students at Purdue's Krannert School. Responses were compared to the Bayesian norm, and further analyzed to determine the extent to which groups differed from individuals in processing information, and how information processing behavior was affected by the mode of message transmission. Groups processed information more conservatively than "statistical" groups or individuals. Moreover, group conservatism was partially an artifact of the consensus process. In the aggregate, information received sequentially was also processed more conservatively than information received simultaneously. Risk attitudes (viz., utilities) nor perceived data credibility were related to information processing behavior.

# CONSERVATISM IN GROUP INFORMATION PROCESSING BEHAVIOR UNDER VARYING MANAGEMENT INFORMATION SYSTEMS*

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Most decisions among executives in business, the military, government, research, civic affairs -- indeed, in every sort of organization set up to cooperatively produce a good or service are made "in conference" (Editors, Harvard Business Review, 1960). Technical experts are summoned to give advice; management committees must decide on basic policies; labor teams must plan and regulate their work; staff meetings take place daily at every level. Such committees, councils, panels, commissions, juries, boards, etc. provide vivid testimony of the extent to which such devices for pooling many minds has permeated society in the United States in the belief that, "Two heads are better than one".

In recent years a great deal of attention has been focused on the problem of group decision making, that is, how a group of individuals with different opinions (beliefs) and preferences (tastes) make decisions. Knowledge of the psychology of this process is an important consideration in the design of management information systems (MIS), as MIS reports become the data from which inferences are drawn by the decision maker or decision making group and upon which decisions are based. The purpose of this paper is to report the results of an experiment which investigated the effects of group

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interaction and consensus on human information processing behavior.[1]

Bayesian Decision Theory provides a useful and convenient framework for investigating group decision making in that it permits a decomposition of the decision problem into subjective probability and utility components. Constraints on paper length preclude any discussion of the theory, however, partial coverage can be found in Savage (1954, Ch. 10), Stone (1961), Madansky (1964), and Raiffa (1970). At this point it would be appropriate to briefly review the empirically related literature in order to give proper perspective to the questions addressed in this paper.

Much of the previous research on group decision making has been concerned with the final group decision, hence necessitating considerations of utility rather than subjective probability. See, for example, Bower (1965, 1965) and Clarkson, et. al. (1966). Winkler (1967, 1968), however, addressed the question of obtaining a group prior probability function from a number of individual subjective probability distributions to be used as an input to a formal Bayesian analysis, and tested various amalgamation procedures. Turning to psychology, social psychologists (see, for example, Wallach, Kogan, and Bem, 1962; Wallach and Kogan, 1965; Marquis, 1968, and references cited therein) have devoted much time and energy in purportedly examining group versus individual utilities using Kogan and Wallach's (1964) Choice Dilemmas Questionnaire (CDQ) or a similar version thereof. Their findings have generally shown a shift towards increasing riskiness in choice of risk attitudes (although cautious shifts have been induced as well; see, e.g., Marquis, 1968; Stoner, 1968) as a result of group interaction. More relevant to the "real world," Spetzler (1968) found that group utility functions of business executives also exhibited a risky-shift in relation to the individual utility curves of its members. The risky-shift finding although widely replicated in psychological experiments (yet not fully explained) contradicts the general belief that groups are more reserved and conservative in behavior than individuals (Whyte, 1956).[2] But conservatism in real life may well reside in the group assessment of subjective probabilities. Some evidence to support this view is found in Madaras and Bem (1968) who showed that groups exhibited greater pessimism than individuals about the likelihood of success of risky alternatives. It is therefore important to ask whether such similarly pessimistic and/or conservative behavior extends into information processing tasks involving groups. Let us now consider the specific research questions to be addressed.

## Research Questions

Although results have been somewhat conflicting, most studies on human judgment, learning, memory, and problem solving seem to indicate the superiority of group performance over individual performance (Kelley, 1954; Lorge, et. al., 1958; Goldman, 1966). It thus is appropriate to ask whether groups are superior information processors than individuals. That is,

1. To what extent, if any, is information processed collectively as opposed to individually closer to the Bayesian norm? Alternately stated, do groups more closely approximate the "true" or "ideal" Bayesian than do individuals?

Psychological experiments on subjective probabilities (Peterson & Beach, 1967; Edwards & Tversky, 1967; Peterson & Miller, 1965; Phillips, Hays, & Edwards, 1966; Phillips & Edwards, 1966) have often found that humans, as individuals, process information c ervatively. That is, they revise their subjective probabilities in the same direction but not as far as Bayes' Formula prescribes. Mason and Moskowitz (1970) employing an equivalent instrument as that used in this study, have replicated the same phenomenon, and found that neither an individual's risk taking propensity or his perception of message credibility were explanations of this effect. This leads to the next two questions.

2. Are groups more "conservative" information processors than individuals, or the average of the groups' individual members?

3. Can conservatism (if it exists) be explained, at least in part, by the group's risk taking proclivity (e.g., Do groups who exhibit more risk averse utility functions process information more conservatively as well; by the group's disbelief in the datum itself or the source from which it came?

In making joint decisions, executives generally have an opportunity to become familiar with the problem beforehand, but in some cases do not. Without prior familiarization a person might not want to commit himself to a decision until he had ample time to think about it. This should be especially true if the problem were either complex or important. With a complicated problem, the person might feel he wanted an opportunity to weigh up all the evidence. With an important problem, even a simple one, he might be reluctant to make a hasty judgment or decision. In both cases he might feel inclined to give an initially cautious response, meaning "Don't know" or "Not yet ready to decide." After he had time to study the problem, however, his initial caution might vanish. In studies on the risky shift phenomenon (although recent results conflict; see Teger and Pruitt, 1970), further familiarization with the risk-taking problem led to an increase in riskiness (Bateson, 1966; Flanders and Thistlethwaite, 1967; Marquis, 1968). Such an effect could appreciably counteract the conservatism phenomenon characteristically found in human information processing experiments. This suggests the next question.

4. What effect does prior problem familiarization have on group information processing behavior?

Researchers (Pitz, 1968; Geller and Pitz, 1968) have observed an Inertia Effect when individuals process sequentially received information. This could lead to subjective probabilities which are significantly different from that which are obtained when information is received simultaneously. That is, the mode of message transmission could affect the processing behavior of groups as well as individuals, hence, suggesting the last question.

5. What effect does information, of theoretically equivalent informativeness, received sequentially as opposed to simultaneously (viz., batched or pooled) have on individual and group processing behavior?

## The Basic Models

Although a considerable tradition exists for using Bayes' law as a model for probability revision, it is useful to review several points here that are pertinent to the development which follows. Consider, for example, two mutually exclusive, collectively exhaustive hypothesis, H and H', and a subject's prior probability for these hypothesis P(H) and P(H') such that $P(H) + P(H') = 1$. Let there also be a series of data items that the subject might receive which are relevant to the hypothesis, $D_x$ or $D_{x'}$, $D_y$ or $D_{y'}$, and $D_z$ or $D_{z'}$. The subscripts x, y, z indicate that the data is about different attributes of the situation and $D_{x'}$ represents the negation or denial of $D_x$, etc.. That is, given H either $D_x$ or $D_{x'}$ should obtain. Consequently $P(D_x|H)+P(D_{x'}|H) = 1$.

Bayes' law indicates that upon the receipt of a data item, say $D_x$, the subject should revise his probabilities as follows:

$$\frac{P(H|D_x)}{P(H'|D_x)} = \frac{P(D_x|H) \cdot P(H)}{P(D_x|H') \cdot P(H')} \qquad (1)$$

or more simply,

$$\Omega_1 = L_x \Omega_o$$

where,

$\Omega_o$ refers to the odds in favor of H over H' prior to the receipt of $D_x$.

$\Omega_1$ refers to the revised or posterior odds after the receipt of $D_x$.

$L_x$ represents the likelihood ratio for datum $D_x$.

Upon receipt of an additional data item, say $D_y$, the new odds are calculated by [assuming $D_x$ and $D_y$ are statistically independent, i.e., $P(D_x \cap D_y|H) = P(D_x|H) \cdot P(D_y|H)$]:

$$\Omega_2 = L_y\Omega_1 = L_yL_x\Omega_o = L_xL_y\Omega_o \qquad (2)$$

The far right-hand equality is obtained by the commutative law of multiplication and implies that theoretically, $\Omega_2$ is not affected by the order in which the data, $D_x$ and $D_y$, are received.

There is no general way of determining the likelihood ratio for the negation of a data item (i.e., $L_{x'}$) if one only knows the affirmative $L_x$. However, under conditions of symmetry in which the informativeness of the affirmative is the same as that of negation, $P(D_x|H) = P(D_{x'}|H')$ and $P(D_x|H') = P(D_{x'}|H)$ and this denotes that $L_{x'} = 1/L_x$. This symbolism represents a binary symmetric inquiry source and is summarized by the following likelihood matrix.

| | Data | |
|---|---|---|
| | $D_x$ | $D_{x'}$ |
| Hypothesis H | $P(D_x\|H)$ | $P(D_{x'}\|H)$ |
| H' | $P(D_x\|H')$ | $P(D_{x'}\|H')$ |

More precisely, a subject (or group) is defined to be conservative with respect to $D_x$ if his actual (or imputed) likelihood ratio, $L_x^a$, meets one of the following conditions:

either

$$1 \le L_x^a < L_x \text{ if } L_x > 1 \qquad (3)$$

or

$$L_x \le L_x^a \le 1 \text{ if } L_x < 1 \qquad (4)$$

It should be noted that if $L_x$ - 1 a datum is totally uninformative and should have no impact on the recipient's beliefs. As $L_x$ becomes progressively larger or smaller than 1 a datum becomes more informative and consequently should have an increased impact on the recipient. Thus $L_x$ serves as a measure of the "degree of informativeness" of a data item.

Suppose, now, that there exists a group of individuals whose beliefs regarding the relevant states of nature (hypotheses) and the conditional probability (likelihood) matrix perhaps differ, but must be reconciled. Roberts (1965) showed that the group posterior probability distribution could be determined by using a weighted average of each individual's posterior distribution, i.e.,

$$P_G(H|D_x) = \sum_{i=1}^{n} \lambda_i \frac{P_i(D_x)}{P_G(D_x)} \cdot P_i(H|D_x) \tag{5}$$

subject to

$$\sum_{i=1}^{n} \lambda_i = 1 \text{ (prior probability weights)} \tag{6}$$

$$\sum_{i=1}^{n} \lambda_i \frac{P_i(D_x)}{P_G(D_x)} = 1 \text{ (posterior probability weights)} \tag{7}$$

where

$$P_G(H) = \sum_{i=1}^{n} \lambda_i P_i(H) \tag{8}$$

$$P_G(D_x) = \sum_{i=1}^{n} \lambda_i P_i(D_x) \tag{9}$$

and $P_G(H|D_x)$ = group posterior probability assessment of H given datum $D_x$

$\lambda_i$ = relative weights associated with individual i's prior probability P(H), used to arrive at a group prior probability assessment (if group assessment arrived at democratically, all $\lambda$'s would be equal).

$P_i(D_x)$ = individual i's probability of receiving message or datum $D_x$

$P_G(D_x)$ = group probability of receiving datum $D_x$

$P_i(H|D_x)$ = individual i's posterior probability assessment of H given $D_x$.

From this, the group likelihood ratio (which is equal to the Bayesian likelihood ratio if each individual receives the same data from given information sources and processes it in a Bayesian manner) can be imputed from equation 1.

## The Experiment

Two important features of the experimental instrument were: (1) its attempt to capture realism in the information processing task; (2) that a Bayesian solution to the problem could be calculated. Psychological experiments involving human versus Bayesian revision of probabilities almost always employ random data generating paradigms, such as dice, urns, book bags-and-poker chips, etc.. Although some may argue that such data producing vehicles provide more experimental control, they lack realism and generally require long sampling sequences to generate data of significant informativeness.

Moreover, a recent study (Beach, Wise, and Barclay, 1970) questioned the validity of the results from the book bags-and-poker chips experiments, in that subjects, in such experiments, tend to indicate the proportion of chips in the sample as their posterior probability revisions.

Design

Subjects were given a scenario which placed them in the role of a bank lending officer who was to assess the probability that a loan applicant would become delinquent during the coming year (i.e., H hypothesis "applicant will be delinquent," subject estimated P(H)). Three different and statistically independent binary, symmetric data sources were provided which, although fictionalized, provided <u>objective</u> (relative frequency) conditional probabilities (e.g., $P(D_x|H)$) based on actual historical studies of bank files. These were (1) the bank's own internal records, (2) a credit scoring system based on the borrower's attributes and (3) a credit data service which provided retail credit information (WCDC). With the exception of its summary form and the particular numerical values used the data items are the same as those available to many bank lending officers. In addition to background information the items included statements such as, "This study shows that 80% of the borrowers who had never been delinquent were rated 'G' by WCDC and that 80% of those who had been delinquent were rated 'B'. WCDC has just informed you that Mr. Jones' rating is 'G'." Similar reports were developed for each of the other two sources so that the subject's subsequent information was based on three conditional probability (likelihood) matrices (Table 1).

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Insert Table 1 about here

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After reading the situational scenario the individual or group recorded his prior probability that the borrower would be delinquent on a 99 position scale and then revised his beliefs based on data received from the three independent information sources (Figure 1).

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Insert Figure 1 about here

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Prior to the information processing task a reduced version of Kogan and Wallach's (1964) CDQ was administered to determine the risk-taking propensity of the individuals and groups. At the completion of the processing task the subjects reviewed the information sources and evaluated the trustworthiness of the data provided by each source on a 10 point scale.

The structure of the experiment was a 3x2 factorial design involving a total of 207 subjects (Table 2). Individuals, and both familiarized and unfamiliarized groups received data either sequentially or simultaneously. Responses were also collected on those individuals who first familiarized themselves with the problem prior to being formed into groups. The detailed procedures for conducting the experiments were essentially equivalent to those used by Wallach, Kogan, and Bem (1962) in their investigation of the effects of group interaction on risk and conservatism in decision making (rather than subjective probability revision). All groups succeeded in reaching a consensus. The group discussions were of such a nature as to indicate that the participants were highly involved in the tasks.

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Insert Table 2 about here

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## Subjects and Facilities

Upper division undergraduate industrial management students at Purdue University served as subjects. The individual and small group behavioral laboratories of the Behavioral Science Laboratories at Purdue's Krannert School was used to conduct the experiments. A detailed description of the facilities and equipment is found in Fromkin (1969).

## Data

The experimental design provided for the following basic data from each subject: CDQ score, $P(H)$, $P(H|D_x)$, $P(H|D_x, D_z)$, $P(H|D_x, D_z, D_{y'})$, $T(D_x)$, $T(D_z)$ and $T(D_{y'})$ ($T(D_x)$ is the subject's evaluation of $D_x$ on a 10 point trustworthiness scale).

From the subjective probability data a subject's or group's imputed likelihood ratio was calculated as follows:

$$\frac{P(H|D_x)}{1-P(H|D_x)} = L_x^a \frac{P(H)}{1-P(H)}$$

$$L_x^a = \frac{P(H) \cdot (1-P(H|D_x))}{1-P(H) \cdot (P(H|D_x))}$$

This inferred likelihood ratio was then compared with the Bayesian standard by using the concept of the accuracy ratio. An individual's or group's accuracy ratio with respect to X is defined as:

$$A_x = \frac{\log L_x^a}{\log L_x} \tag{10}$$

The accuracy ratio is 1.0 when subjective revision equals Bayesian revision and decreases below 1.0 as the individual or group is more conservative.

## Results

Table 3 and Figure 2 show the cell and marginal effects in terms of mean accuracy ratios ($A_z$, $A_x$, $A_y$) for each of the main factors controlled for when information was processed sequentially: A = group type (Nominal, unfamiliarized, familiarized) and B - informativeness of item (i.e., magnitude of Bayesian likelihood ratio).[3] Since no significant differences in the prior probabilities were observed among the groups, no attempt was made to control for this factor.[4]

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Insert Table 3 about here

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Insert Figure 2 about here

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An analysis of variance (ANOVA) using a 3x3 factorial design with repeated measures and unequal cell sizes was performed on the data of Table 3. The results showed a significant group effect

(F = 5.10; df = 2,39; p < .02), data item effect (F = 15.00; df = 2,78; p = .00) but no significant interaction effect. The Newman-Keuls test (Winer, 1962, p. 309) was used to probe the nature of the differences among the group means. No statistical significance was found between interacting groups with and without prior problem familiarization. This was further supported by an ANOVA performed on these same groups only.

An ANOVA using a 2x3 factorial design with unequal cell sized (Table 2) was performed on all the experimental data for each of the main factors controlled for: A = mode of message transmission (presentation) and B = group type. The results showed a significant presentation effect (F = 4.60; df = 1,61; p = .03) group effect (F = 2.88; df = 2,61; p > .05) and no interaction effect. Again, no significant differences were found between the unfamiliarized and familiarized groups based on the Newman-Keuls test (Winer, 1962, p. 80) and an ANOVA performed on these same groups only. Figures 3 and 4 depict the cumulative probability distributions of the aggregate accuracy ratios by group and presentation. It is interesting to note from these figures that with respect to the initial apriori beliefs, only 5% (3 out of 57) of all groups' final aposteriori beliefs shifted toward the delinquency hypothesis (indicated by a negative accuracy ratio). Of the 95% which shifted toward the non-delinquency hypotheses, 82% had accuracy ratios greater than 20. Significantly greater shift tendencies occurred with the sequentially processed data than with the simultaneously process data (Figure 5). The Bayesian calculations, however, indicated only a slight movement toward the non-delinquency hypothesis; that is, in the aggregate the data actually received was almost useless ($L_{xzy'} = 1.03$). This accounts for subjects' large aggregate accuracy ratios, as the logarithm of 1.03 (the denominator of equation 10) is 0.012.

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Insert Figure 3 about here

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Insert Figure 4 about here

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The attempt to explain the phenomenon of conservatism, by the CDQ test score failed in that no correlation with the accuracy ratios was found for either individuals or groups. Moreover, no significant shifts in risk attitudes were observed between groups or individuals within the groups, although the former responses on the average tended to favor a shift in the risky direction. Furthermore, both individual and group evaluations of the trustworthiness of the data also failed to correlate with accuracy ratios. No significant differences in trustworthiness were observed among groups or between data presentations. Consequently it was inferred that these factors did not influence the observed tendencies toward conservatism.

## Discussion

The results of this experiment is summarized as follows:

1. Interacting, consensus groups processed information more conservatively than statistical groups (or individuals).

2. Hence, when processing information of relatively low informativeness groups are closer to the Bayesian norm, and the converse is true for highly informative data.

3. Groups with prior problem familiarity did not process information significantly differently from unfamiliarized groups.

4. Significant differences in information processing behavior occurred between sequentially versus simultaneously received information for all types of groups and individuals.

5. Individual or group risk taking propensities or perceived credibility of the data did not affect information processing behavior.

Let us now briefly attempt to interpret part of these results and give some of their implications.

The higher degree of conservatism found in interacting groups can be at least partially attributed to the consensus mechanism employed (as determined during the post mortem discussion of the experiments and upon observation of the responses). That is, some groups appeared to achieve a consensus simply by equally weighting their previously formed individual prior and posterior beliefs. Such a procedure will tend to result in imputed likelihood ratios which are less informative than those for the nominal groups. Moreover, the consensus process actually employed was not as simple as that suggested above, as significant interactions occurred within 72% (= 10/14) of the groups sampled. That is, in comparing the individual members' responses to the group response, 38% (= 16/42) of the latter's responses were outside the range of the responses of its individual members. Of these, 63% (= 10/16) were on the conservative side. Although it is difficult to speculate on the specific cause of this interaction effect, its magnitude is vivid testimony of the impact of group discussion. The finding of increased conservatism of group to individual information processing behavior indicates that group subjective probabilities counterveil the risky-shift in group versus individual utilities, thus more nearly agreeing with Whyte's (1956) observations of decision making in actual committees. The finding that groups are more nearly Bayesian when dealing with relatively uninformative data (a consequent of their more conservative behavior), obviously suggests their use under such conditions. But, is this not usually the case when committees are formed or experts are summoned? The existence of the conservative bias also raises the question of how it might be attenuated. Perhaps there exists a consensus mechanism (i.e., mathematical, voting, heuristic) for amalgamating divergent opinions which may vitiate this effect.

The lack of any significant difference in behavior between familiarized and unfamiliarized groups could perhaps be partially attributed to the 1/2 hour preparation time alloted, although this seemed adequate. The nature of the task might be another factor.

The difference in processing behavior between sequentially versus simultaneously received data in both individuals and groups is attributed to the existence of an 'Inertia Effect' first suggested by Pitz, et. al. (1967) and later explained by Geller and Pitz (1968).

Whether this effect will prevail or be offset by other factors, as group size and data quantity are varied is an interesting question.

## Future Research

The experiment reported in this paper is one of a series on group information processing behavior. Other studies currently in progress are addressing the following additional issues: 1) the effect of order presentation on group processing behavior (i.e., the primacy/recency issue), 2) the symmetry issue (consistency in revising beliefs upwards versus downwards [see, Madaras and Bem, 1968]), 3) the effect of social interaction on individual and group behavior, and 4) the testing of various consensus mechanisms (Figure 5).

From a management perspective, the results of these investigations should provide useful guidelines for information systems design and use of committees and teams for decision making.

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FOOTNOTES

(1) The author gratefully acknowledges the contributions of my research assistant, Peggy Arnett, who assisted in the preparation of the computer programs for analyzing the experimental data.

1. By group, is meant an interacting face-to-face group (i.e., involving group meeting, discussion, and consensus) with common goals (viz., team). The group information processing function includes both the forming of individual beliefs and their amalgamation into a group subjective probability.

2. As Theil (1963) pointedly comments, "Committee decisions have had to be made since time immemorial, and since the number of revolutions to which they led is not excessively large, we might infer that reasonable men are usually able to arrive at reasonable decisions."

3. To compensate for the group biases inherent in previous comparisons of individual and group performances (Marquart, 1955; Brim, et. al., 1962) nominal groups were formed by averaging the individual accuracy ratios of the three members in each group.

4. This is consistent with experimental findings. Phillips and Edwards (1966) found that conservatism was largely unaffected by prior probabilities over restricted ranges. This is also true of Peterson and Miller's (1965) results as they apply to the range of prior probabilities and likelihood ratios used in this experiment (although Peterson and Miller demonstrated that prior probabilities can be influential in other ranges).

TABLE 1

INFORMATIVENESS OF INFORMATION SOURCES

| Hypothesis | Data Item | | Data Item | | Data Item | |
|---|---|---|---|---|---|---|
| | X | X' | Y | Y' | Z | Z' |
| H (Deliquent) | .20 | .80 | .10 | .90 | .30 | .70 |
| H' (not deliquent) | .80 | .20 | .90 | .10 | .70 | .30 |
| Likelihood Ratio | 1/4 | 4 | 1/9 | 9 | 3/7 | 7/3 |

TABLE 2

EXPERIMENTAL DESIGN

| Group | Mode of Message Transmission | | |
|---|---|---|---|
| | Sequential | Simultaneous (Pooled) | Total (Group) |
| Individual (Nominal) | $n_1$ = 16 | $n_2$ = 8 | 24 |
| Group (without prior familiarization) | $n_3$ = 12 | $n_4$ - 11 | 23 |
| Group (with prior familiarization) | $n_5$ = 14 | $n_6$ = 8 | 22 |
| Total (Message) | 42 | 27 | 69 |

Note: $n_i$(i = 1, 6) denotes sample size of individuals and groups.

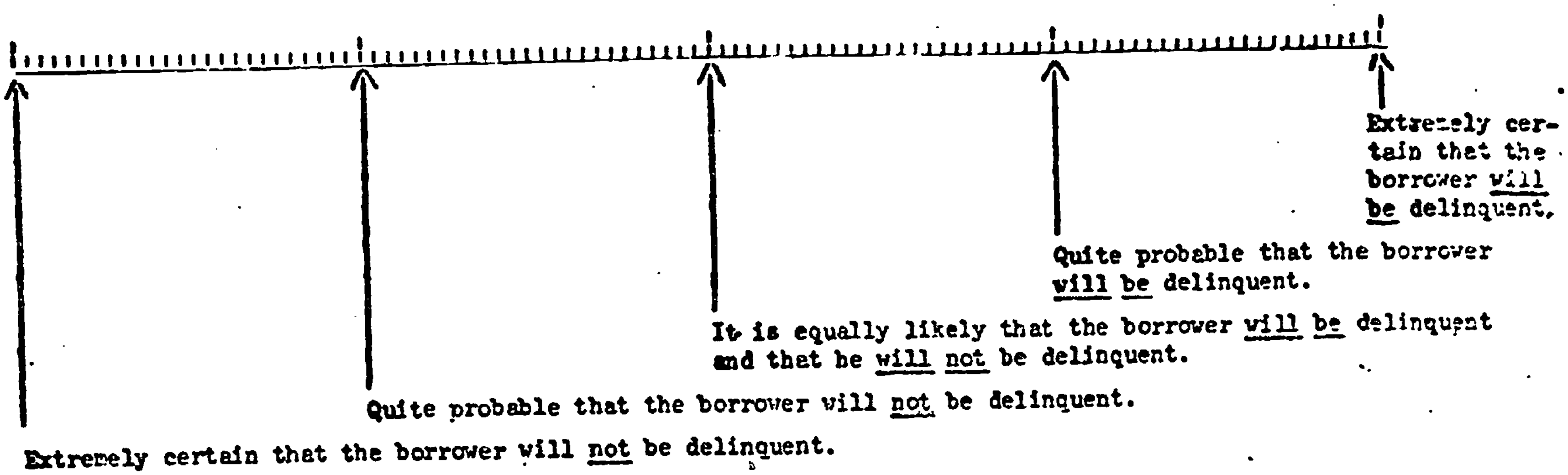
Each actual group or nominal group consisted of 3 individuals.

TABLE 3

MEAN ACCURACY RATIOS BY DATA ITEMS AND GROUPS
Sequential Presentation (x z y') - (Group size = 3)

| A - Group Effect | B - Data Items Effect | | | A - Marginals |
| --- | --- | --- | --- | --- |
| | z | x | y' | |
| Individual(Nominal Group) ($G_1$ = 16)* | 1.25 | .83 | .61 | .90 |
| Group w/o famil. ($G_2$ = 12) | .79 | .73 | .35 | .63 |
| Group w famil. ($G_3$ = 14) | 1.04 | .56 | .25 | .62 |
| B - Marginals | 1.03 | .71 | .41 | .72 |

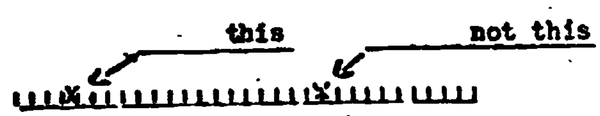
Note: *Number of groups. Total Subjects (42 x 3) = 126; Total Group - Observations (42 x 3) = 126.




Important:

1. Place your "X" in the middle of the spaces not on the bounderies.

   Example:

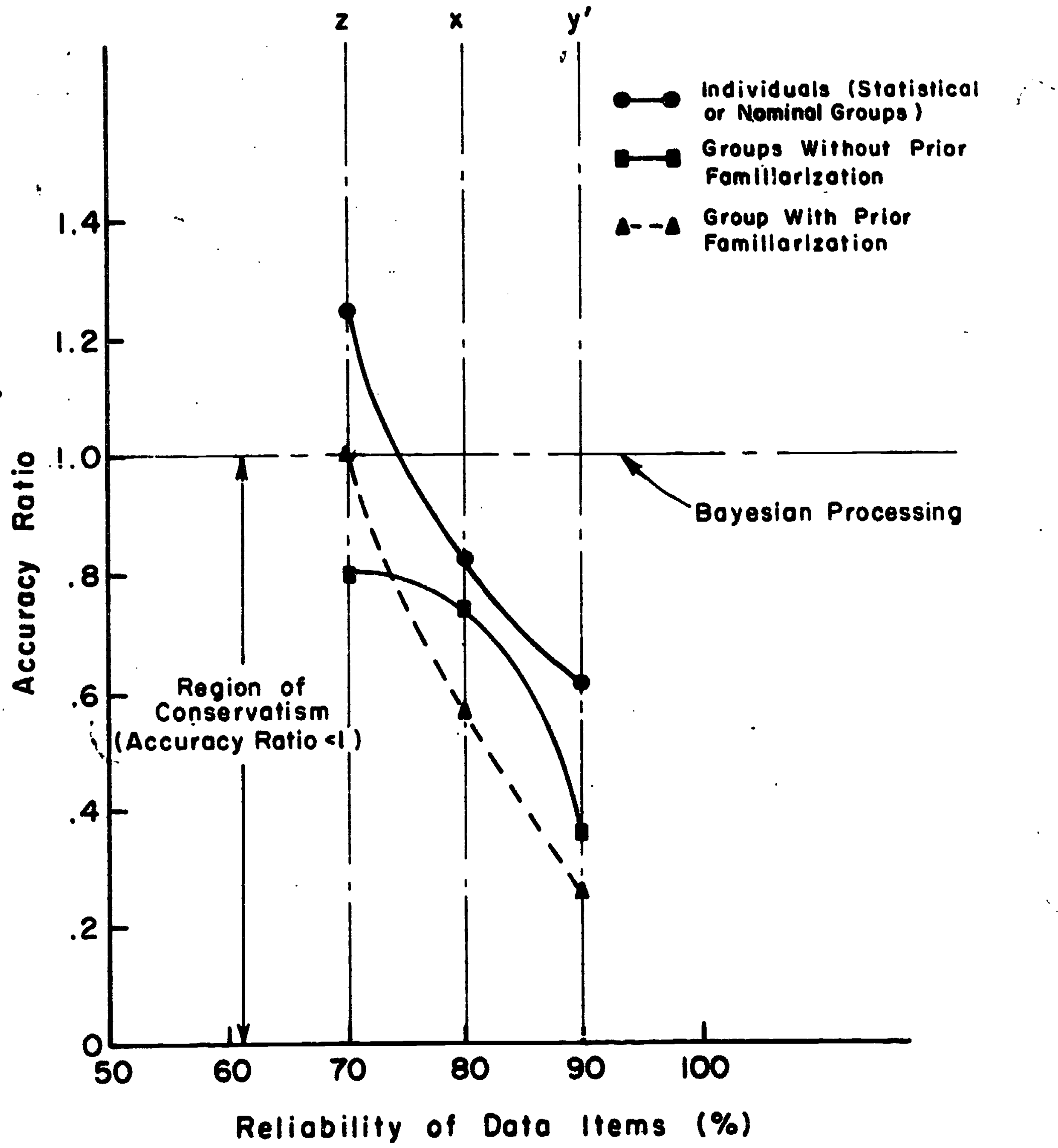


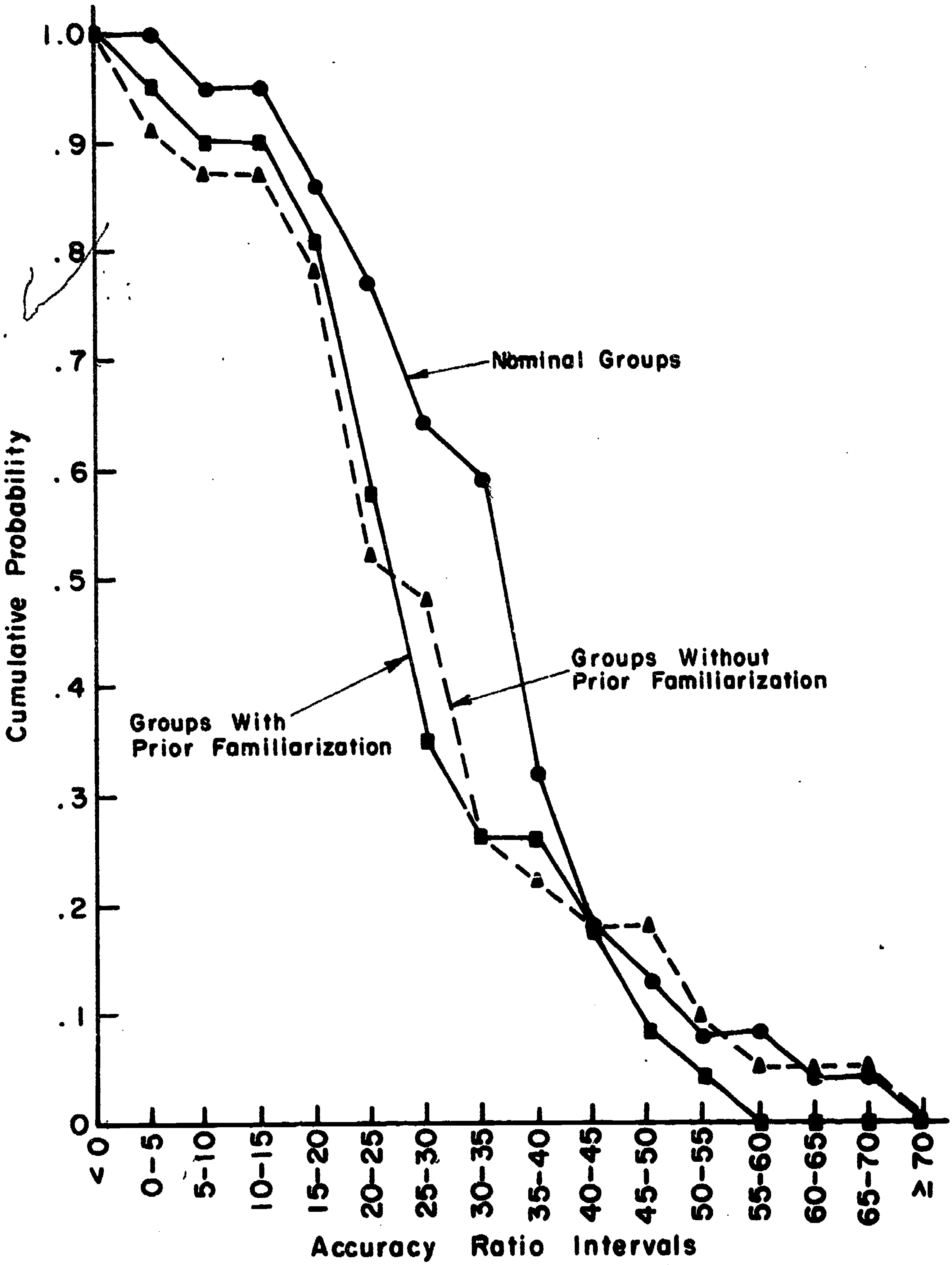

2. Be sure to record an "X" each time you are asked to indicate your degree of belief.
3. Never put more than one "X" on a single scale.

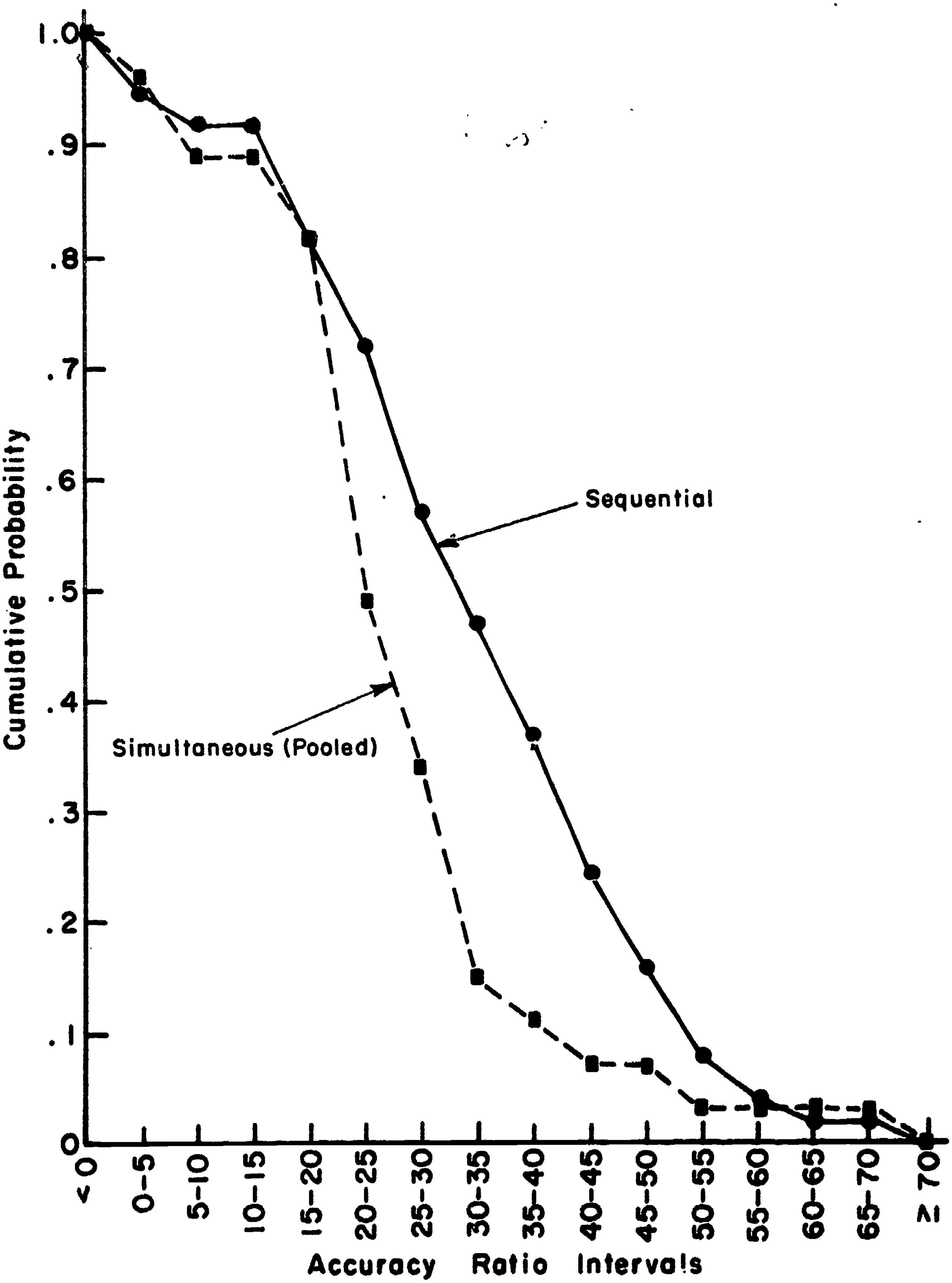
# STOP!

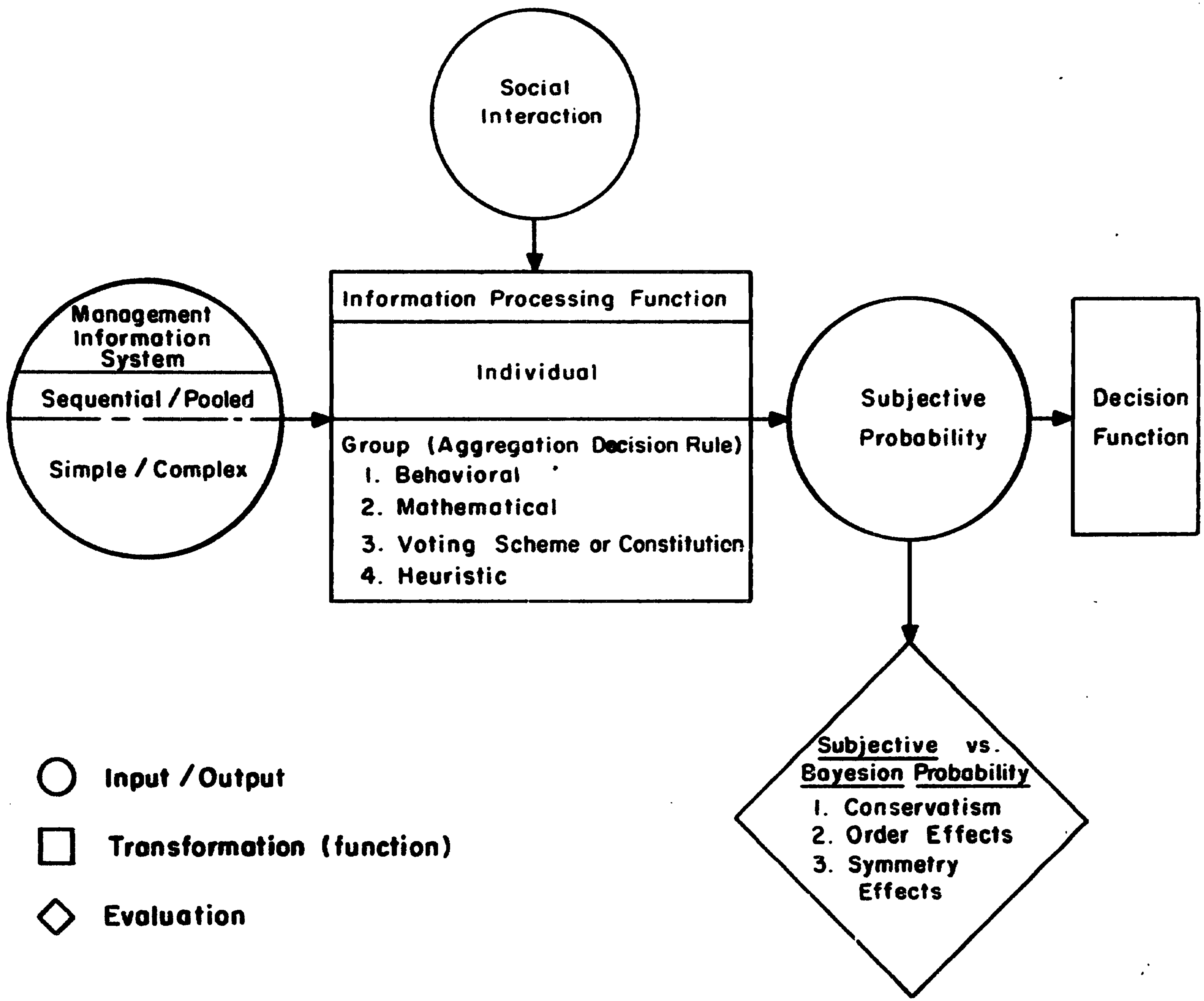
Please do not turn this page until asked to do so.

Thank you.


z
x
y'
Individuals (Statistical or Nominal Groups)
Groups Without Prior Familiarization
Group With Prior Familiarization
1.4
1.2
1.0
.8
.6
.4
.2
0
Accuracy Ratio
Bayesian Processing
Region of Conservatism (Accuracy Ratio <1)
50
60
70
80
90
100
Reliability of Data Items (%)


Cumulative Probability
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
Nominal Groups
Groups Without
Prior Familiarization
Groups With
Prior Familiarization
<0
0-5
5-10
10-15
15-20
20-25
25-30
30-35
35-40
40-45
45-50
50-55
55-60
60-65
65-70
≥70
Accuracy Ratio Intervals


Cumulative Probability
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
Sequential
Simultaneous (Pooled)
<0
0-5
5-10
10-15
15-20
20-25
25-30
30-35
35-40
40-45
45-50
50-55
55-60
60-65
65-70
≥ 70
Accuracy Ratio Intervals


Social
Interaction
Management
Information
System
Sequential / Pooled
Simple / Complex
Information Processing Function
Individual
Group (Aggregation Decision Rule)
1. Behavioral
2. Mathematical
3. Voting Scheme or Constitution
4. Heuristic
Subjective
Probability
Decision
Function
Subjective vs. Bayesion Probability
1. Conservatism
2. Order Effects
3. Symmetry Effects
Input / Output
Transformation (function)
Evaluation

## FIGURE CAPTIONS

Fig. 1. Measurement scale.

Fig. 2. Information processing behavior of groups versus individuals - sequential data.

Fig. 3. Cumulative probability distributions of aggregate accuracy ratios by group - sequential and simultaneous data.

Fig. 4. Cumulative probability distributions of aggregate accuracy ratios by data transmission mode.

Fig. 5. Group Bayesian information processing research directions.

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