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A REPLICATION AND EXTENSION OF THE INDUCEMENT OF THE AVAILABILITY HEURISTIC

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A Replication and Extension of the Inducement of the Availability Heuristic

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Abstract

The availability of an event in an observer's memory is postulated to be one of the bases for estimates of its frequency of past occurrence or the probability of future occurrence. In a previous study, enhancing every occurrence of an event produced an overestimation of frequency and probability estimations and predictive choices. However, the general finding of overestimation held only for events at the low (3/225) and high (30/225) ends of the test range; in the middle range (12/225) judgments were fairly accurate. The present study sought to replicate the availability bias induced in the previous study and to explore the underlying cognitive processes by manipulating the conditions used to induce the bias. The effect of four different enhancement schedules was investigated in a between-group design. In the first group every occurrence of an event chosen for the enhancement operation was enhanced as in the previous study. In the second group designated events were enhanced only during the first half of the study. In the third group only the final occurrence of each designated event was enhanced. Finally, in a fourth group only the first occurrence of each designated event was enhanced. All four enhancement schedules produced the overestimation effect for both frequency estimations and choices. Since the definition of "overestimation" was with reference to unenhanced control events operated upon by the subjects in the same problem as the enhanced events, this effect is clearly an induced bias. Again, the general finding of overestimation held for events at the low (2/150, 4/150) and high (16/150) ends of the test range, but not in the middle range (8/150) where judgments were fairly accurate. Recognition and recall measures demonstrated some group differences in the cognitive processing of the events despite the fact that there were no group differences in judgments. A single enhanced event appears sufficient to produce the same degree of bias as a series of enhancements.

Over a period of years a growing body of evidence has appeared suggesting that human judgment and decision making is less complete and rational than might be considered optimal. For example, it is well established that under some laboratory conditions decision makers tend to resort to simplified decision rules or "heuristics" rather than formally appropriate alogrithms such as Bayes rules or expected utitlity maximization (Eihorn & Hogarth, 1981; Slovic, Fischhoff, & Lichtenstein, 1977). Similarly, linear models of the human judge often outperform the individual's own solution to multiple-cue prediction or inference problems (Dawes & Corrigan, 1974; Goldberg, 1968). Although a number of questions have been raised about the generality of such phenomena and the implication that man is an inherently irrational or suboptimal information processor (Cohen, 1979; Hogarth, 1981) the fact remains that certain tasks expose consistent human biases with reference to objective standards.

The most influential contribution to this view was a series of publications by Tversky and Kahneman (1971, 1972, 1973, & 1974) which described and illustrated several of these heuristic processing strategies. The decade since has seen an outpouring of studies of a similar nature, most of which have been aimed at verifying the original heuristics in a slightly different context, or expanding the list of biases, defeciencies and illusions through simple demonstrations. Some, for example, draw heavily upon a subject's general knowledge base (e.g. the relative number of deaths in the general population caused by heart attacks vs influenza), the idea being to show the prevalence of bias-induced misperceptions. Others rely on carefully worded problems constructed so as to expose processing deficiencies (e.g. neglect of statistically relevant considerations such as sample size and base rate information).

While serious efforts have been made to infer the cognitive mechanisms responsible for such observed distortions, there have been relatively few attempts to test these inferences proactively-- to manipulate systematically conditions that should result in more or less of the bias if the inferrred process is at work. Rather, as noted above, the tendency has been simply to find problems that yeild consistently non-optimal responding. The broad purpose of the present study, therefore was to attempt the systematic induction of heuristic processing in a realistic task setting.

Of the growing list of hypothesized heuristics, none has more far-reaching implications than that of availability. A person is said to employ this heuristic whenever he estimates event frequency or probability by the ease with which instances or associations can be brought to mind. Since people usually have imperfect records of event histories of actuarial data, they would presumbably resort to this process whenever called upon to make a judgement or decision under uncertainty. For example, one might overestimate the risk of death by air travel following a widely publicized mid-air collision because of the ease of retrieving that particular instance from memory (and, presumably the vividness of the resulting image). Typically, it has been invoked to explain some observed overestimation retrospectively without any independent verification of the strength or nature of the memory trace that is held responsible (i.e. that is preeminently available). To have scientific meaning, a concept such as "availability" must be operationalized. Conditions hypothesized to induce it must be specified, and if possible, verified independently of the phenomenom (viz. overestimation) that it is intended to explain. This is in essence the approach attempted in the present study.

In an earlier experiment, we sought to induce an availability bias by enhancing selected stimuli in an event stream, the logic being that the enhanced operation should make retrieval of those events easier than "unenhanced" events, and therefore create the impression of greater frequency (Fontenelle, 1983). Subjects playing the role of dispatcher responded to emergency calls for police and ambulance vehicles from nine hypothetical city precincts. Selected calls were enhanced by attaching vivid descriptive material to the otherwise routine classifications. This procedure resulted in consistent overestimation of the frequency and probability of enhanced events as compared to unenhanced events. Suprisingly, the effect was greatest at the high (N=10) and low (N=1) objective frequencies and all but disappeared at the midrange (N=4) frequency level. The reason for the resistance to overestimation at this level was unclear.

The main objectives in the present study were (a) to attempt to replicate the overestimation effect produced by manipulation, and (b) to establish more clearly the cognitive nature of the obtained bias. The same task and availability manipulation employed in the previous study were used here. However, the objective event frequencies were altered somewhat to focus attention on the middle range where the availability effect was equivocal in the previous study.

In addition, the process by which we sought to induce the bias was manipulated. In the previous study every presentation of an enhanced event was accompanied by the enhancement operation (i.e. a vivid case history and a blinking of the display). Thus it was impossible to determine how many or which of the enhancement episodes were necessary for the overestimation to occur. If, for example, availability rests upon the retrieval of a particular episode, a single enhancement (out of 2, 4, or N event occurences) might produce the same effect as the enhancement of all N events, particularly if the episode were placed later rather than earlier in the sequence. Several researchers have suggested that recency is an important factor in the determination of an event's availability (Nisbett & Ross, 1981). If, on the other hand, it is the strength or the multiplicity of the event's generic representation in memory (rather than a particular episode) that is critical, then a single enhancement-- irrespective of placement-- should not be as effective as the enhancement of all N episodes. Therefore, early-single, late-single, first session-only and continuous enhancement conditions were compared in the present study.

Another objective of the study was to obtain verification of the manipulation of availability independent of the resulting frequency bias. While frequency estimation can be taken as one index of memory, the more common recognition and recall measures provide a better indication of exactly what is retained. In the present context, the descriptive case histories provided a vehicle for examining the link between the content of available events and the overestimation effect through use of multiple retention measures. Availability was thus defined as the ability to recognize enhanced events and to recall the details of the various case histories associated with them. To the extent that overestimation is directly related to the number of enhanced events recognized or to the episode content recalled, one can infer more confidently that availability is invovled in the frequency bias. Moreover, some insight might be gained into the nature of the process.

METHOD

With a few exceptions this experiment was a direct replication of the study referenced earlier (Fontenelle, 1983). A brief description of the basic task together with a more detailed account of the differences in the design and procedure are presented in the following section.

Task and Procedure

Subjects served individually in the role of dispatcher of emergency services for a hypothetical city. The area served was divided into nine precincts: the emergencies were classified as police or ambulance calls and any call represented an actual emergency or a false alarm. Thus defined, each of 18 different kinds of events (i.e. type-location combination, e.g. "police-precinct 6") was programmed to occur at a frequency of 0 to 10 in a fashion dictated by the total number of calls and the distribution of frequencies. Within these constraints, assignment of frequencies to the 18 events was random. The complete set of event occurrences (i.e. all instances of the 18 events) constructed with this method (n = 75) was presented in a new random order during each of two sessions (see Table 1). Therefore, from the subject's point of view, the stochastic process by which the events were generated remained stationary from session to session (i.e. locations with a high or low incidence of a particular kind of call on one session would produce them at the same rate on the next session.) The subject thus acquired experience with the overall pattern of event uncertainties over the two sessions but, given the complexities of the situation and the absence of specific information concerning how event occurrences were generated, they would not be expected to master the entire scenario. A further complication lay in the fact that some of the event occurrences were "enhanced" by the presentation of material describing the particular emergency. Since this was a primary experimental manipulation, enhancement is discussed below.

The subject's primary task was one of responding to each incoming call. Only two options were available: dispatching the required service immediately, or verifying the emergency (to rule out a false alarm). A cost/payoff scheme was devised in which verification became desirable relative to immediate dispatching as the false alarm rate increased (see Table 2). Also each subject was allowed to distribute the limited emergency resources at the start of each session, and there were costs associated with the unavailability of a resource in the case of an emergency at a "depleted" location (see Fontenelle, 1983 for a more complete description). Thus strategy played an important role in overall dispatching performance, and a "score" was computed to reflect the quality of these decisions; it was accumulated over an entire session and displayed continuously to provide the subject with an indication of his on-going performance. This feature, together with an illustration of the entire display format, is presented in Figure 1.

The purpose of the entire allocation-decision scenario, of course, was simply to generate a variety of different frequentistic events to which the subjects would be forced to attend in a setting that appeared realistic and intrinsically motivating. The critical part of the task, from an experimental point of view, came at the end of the second session when the uncertainty measures were obtained.

At the end of the second session, subjects were asked to estimate how many times each of the events had appeared (see Appendix A). Following the estimation task, subjects were presented a list with 12 predictive choice pairs and instructed to circle the event in each pair which was more likely to occur. Finally, all subjects performed a recognition-recall task with respect to the particular events that had been "enhanced" over the two sessions (see below). In the recognition phase of the task, a precinct map similar to the one presented in the estimation task was used. Subjects were instructed to circle all events, by precinct number and type of event, which had been accompanied by additional information (i.e. enhanced) at any time during the two sessions. They were then instructed to list the event categories which they had circled and to recall as many details as possible of the specific emergency call or calls which acccompanied each circled event (i.e. the recall phase). Finally, subjects were instructed that if they were able to remember the details of a call but not the specific event to which it belonged, they were simply to list the details of that call (see Appendix A).

Number of Event Occurrences

Specific events (i.e. type-location combinations, e.g. "police-precinct 6") occurred at different assigned frequency levels: 1, 2, 4 and 8 within each session or 2, 4, 8 and 16 across both sessions (see Table 1). All subjects experienced all of the event occurrences[1] of each of the events.

Enhancement Operation

Designated events were enhanced in two ways to make them more available in memory. First, the display of the call, for example "police-6", blinked on and off for eight seconds, in contrast to unenhanced events which were displayed steadily. Secondly, subjects were instructed that the blinking of the call indicated that additional information was available. This information was presented on 5 X 8 inch index cards (see Appendix B for examples). Each card presented a brief transcript of a telephone call reporting an emergency and was identified by the precinct number and the description of the primary land use of that precinct, for example, "A4-residential low income". The case histories were constructed from actual emergency calls received at the Central Alarm of the City of Houston, Texas, Fire Department. Specific case histories were selected randomly for each subject from a pool of case histories. The cards were presented in the order of appearence of the corresponding enhanced events. Subjects were told that the case histories were important and that they might be asked to remember them at the end of the experiment. This instruction was designed to insure that the subjects read and paid attention to the case histories.

Four out of 18 events were designated to recieve the enhancement operation in accordance with a particular enhancement scheldule (discussed below): P6, A1, A9 and P7. Each of these occurred at a different assigned frequency: 1, 2, 4 and 8, respectively. Events which occurred at the same frequency as those designated to recieve the enhancement operation served as comparison or control events in the data analyses. All subjects viewed both enhanced and unenhanced events.

Enhancement Schedule

Each of four groups was presented with enhanced events in accordance with four different schedules. In the first group, events chosen for the enhancement operation were enhanced each time they occurred in both sessions for a total of 30 enhanced event occurrences. This continuous condition replicated the enhancement schedule recieved by all subjects in the previous study (Fontenelle, 1983). For the second group of subjects, designated events were enhanced each time they occurred in the first session only for a total of 15 enhanced event occurrences. In this first session-only condition, designated events were not enhanced at any time in the second session. In a third group, the late-single condition, designated events were enhanced only on their final occurrence in the last session for a total of four enhanced event occurences. Finally, in the early-single condition, designated events were enhanced only on their first occurrence in the first session for a total of four enhanced event occurences.

Subjects and Design

Forty-six volunteers from several undergraduate psychology courses served in exchange for course credit. They were assigned randomly to four enhancement conditions: 16 subjects to the continous condition, 15 to the first session-only condition, 15 to the late-single condition and 15 to the early-single condition.[2] All subjects completed all three tasks: frequency estimation, predictive choice and the recognition-recall task.

The basic design for the frequency and predictive choice measures involved two within-subject variables, enhancement (enhanced and unenhanced) and number of event ocurrences (2, 4, 8 and 16), in addition to one between-subject variable, enhancement schedule (continuous, first session-only, late-single and early-single). Analyses of the recognition and recall measures involved planned comparisons between the various enhancement schedules.

Results

Frequency estimation. Accuracy of frequency estimation was computed for each event using a relative error index in which both the judged and presented frequency were converted to proportions and then compared. Formally,

$$RE_i = \frac{\overline{F_i}}{\Sigma \overline{F_i}} - \frac{F_i}{\Sigma F_i}$$

where $\overline{F_i}$ is the judged and F_i is the presented frequency for an event. Underestimation is refelected by RE < 1.0; overestimation, by RE > 1.0.

As predicted, the enhancement manipulation resulted in consistent overestimation of enhanced events (mean RE=2.03) as compared to unenhanced events (mean RE=1.55), $\underline{F}(3,57)=55.07$, $\underline{p}=.000$. However, as can be seen in Figure 2, this finding was not consistent across all four assigned frequency levels. For events with an assigned frequency of 1, 2 and 8, enhanced events (mean RE of 4.51, 1.78, and .89, respectively) were judged to have occurred more often than unenhanced events (mean RE of 3.03, 1.15, and .64, respectively). However, at frequency 4, unenhanced events (mean RE=1.36) were judged to have occurred more often than enhanced events (mean RE=.94), $\underline{F}(3,171)=533.44$, $\underline{p}=.000$.

Statistical analyses support these conclusions. The interaction of enhancement by number of event occurrences was significant, $\underline{F}(3,171)=35.74$, $\underline{p}=.000$. There were no significant differences between the means of any of the enhancment schedules (continuous (mean RE=1.77), first session-only (mean RE=1.79), late-single (mean RE=1.81) or early-single (mean RE=1.79)) nor any significant interactions of condition with any of the other variables.

Predictive Choice Pairs. Enhanced events were paired with unenhanced events of the same assigned frequency to yield eight comparisons (i.e. two pairs for each level of occurrence) and these eight were presented along with four distractors (i.e. in which neither member had been enhanced) in the predictive choice task. If the subject chose the enhanced member of a pair as more likely to occur, the response was coded +1.0. If he or she chose the unenhanced member, it was coded -1.0. This score was summed across the two comparisons at each frequency level. Thus subjective indifference between enhanced and unenhanced members would yield a score of 0.0: consistent preference of the enhanced member, 2.0; of the unenhanced member, -2.0.

As predicted, and consistent with the estimation data, the effect of enhancement was to inflate perceived frequency: this is indicated by the positive direction of the grand mean (M=.55). However, as can be seen in Figure 3, this finding was not consistent across all four levels of assigned frequency. For comparisons composed of events which occurred one, two and eight times, subjects chose the enhanced member as more likely to occur (M=.37, M=1.53 and M=1.13, respectively); in contrast, they chose the unenhanced member for comparisons at frequency four (M=-.83), $F(3,168)$=38.19, p=.000. There were no significant differences between the means of any of the enhancement schedules (continuous (M=.72), first session-only (M=.57), late-single (M=.36) or early-single treatment (M=.53)) nor any significant interaction of enhancement scheldule with any other variable.

Recognition and Recall Task. The recognition and recall measures served as manipulation checks for the enhancement operation. These measures provided an index of availability independent of the frequency estimation and predictive choice peformance. In the recognition task, if the subject recognized an event as having recieved the enhancement operation the event was coded 1.0. Thus failure to recognize any of the enhanced events would yield a score of 0.0 ; correct recognition of all four enhanced events would yield a score of 4.0. Performance on the recognition task varied with the particular enhancement schedule, $F(3,57)=4.81$, $p=.0048$. Subjects in the continuous group ($M=3.44$) recognized more of the events which had received the enhancement operation than either the first session-only ($M=2.93$), the late-single ($M=2.60$) or the early-single group ($M=2.00$). Post hoc comparisons performed using Tukey's test demonstated that the differences between the mean of the continuous group compared to the means of the late-single and early-single groups were significant. The differences between means of the first session-only and the early-single group were also significant.

In the recall task, if the details of the case history were recalled correctly the case history was scored 1.0. The continuous group ($M=11.69$) recalled more case histories than the first session-only ($M=7.0$), the late-single ($M=3.13$) or the early-single ($M=2.66$) group. These means represent the absolute number of case histories recalled. The total number of case histories presented varied across groups: 30 for the continuous group, 15 for the first session-only group, 4 for the late-single group and 4 for the early-single group. If these results were presented as proportions of the total number of case histories presented, the results would be in the opposite direction. However, for the present purpose the concern is the absolute number of case histories recalled as an index of avaialability. The logic is that as the number of instances that are available in memory increases, the the degree of overestimation should increase. Therefore, an absolute measure of what is available is of greater interest than a relative measure of the overall quality of retention.

It is also of some interest to compare retention for specific event occurrences, thus taking into account the confounding effect of differences in the number of case histories presented to the different groups. The exact position of each case history in the sequence of events for both sessions was recorded. Thus it was possible to compare the recall of case histories which had been used in the enhancement operation for specific occurrences of designated events. Table 3 presents all comparisons made between the various enhancement schedules and indicates the level of significance of the differences between the means using a two-tailed T-test. For the various comparisons, the continuous group consistently exhibited the poorest performance. Subjects in the first session condition also exhibited poorer performance than the early condition.

DISCUSSION

The present results confirm the main findings of the previous experiment, including the puzzling discrepancy between the effect of enhancement at middle and extreme frequency levels. Once again, there was a significant tendency to overestimate the frequencies of enhanced events at all but the middle (n=4) level of objective frequency. This finding was replicated for both the estimation and predictive choice tasks.

Unlike the previous study, however, the present one provided some independent evidence that availability of events in memory was indeed implicated. Both the recognition and recall measures indicated that individuals do remember which events were enhanced and can recall details of episodes used in the enhancement operation. However, there were differences in the performance on these measures for individuals receiving different enhancement schedules. The contiunous group demonstrated the highest level of retention for the absolute number of events recognized and case histories recalled, followed by the first session-only, the late-single and the early-single group, respectively.

Comparisons were performed also for the recall of case histories associated with specific events. However, these results are of questionable theoretical importance because they are easily explained by proactive and retroactive interference. Due to the fact the continuous and first session-only group experienced at least twice as many enhancement episodes as the various comparison groups, one would expect poorer recall performance for selected comparison episodes.

The finding of differences between enhancement schedules on the recognition and recall measures appears contradictory to the finding of no difference in the degree of overestimation among these groups. Despite the fact that this study was able to provide independent verification that enhanced events and enhancement episodes were differentially available to subjects due to different enhancement schedules, these schedules did not produce differences in the overestimation effect. One possible explanation is that the multiplicity of the enhancement episodes recalled did not affect the cognitive processes which underlie the overestimation bias. From a theoretical standpoint, such an explanation would cast doubt on the original conception of the availability heuristic and warrants further research.

Regardless of the cognitive nature of the bias, it is clear that the bias can be produced by a single enhancement as well as a series of enhancements. This finding has implications for the design of decision tasks. For example, highlighting or enhancing relevant content material has commonly been proposed as a solution to the overload problem inherent in increasingly complex information displays (Engel & Granada, 1975). This study together with the previous one (Fontenelle, 1983) show that enhanced information tends to be percieved as more frequent, thus judgments and decisions based on impressions of event likelihood may be seriously biased. Further studies should explore the relative effectiveness of various modes of enhancement, simultaneously addressing the question of the basic cognitive processes which underlie such bias.

Footnotes

1. For the purposes of clarity in exposition, the term event will be used to denote particular kinds of calls (defined by type and location) that occurred at specific frequencies. The term event occurrence will denote particular instances of that event.

2. This condition was administered subsequent to the rest of the experiment using new subjects from the same general pool. Analyses were carried out both with and without the inclusion of these data. The results were very comparable, the more inclusive version is used throughout the report.

References

Cohen, L. J. (1979). On the psychology of prediction: Whose is the fallacy? Cognition, 7, 385-407.

Dawes, R. M., & Corrigan, B. (1974). Linear models in decision making. Psychological Bulletin, 81, 95-106.

Engel, S. E., & Granada, R. E. (1975). Guidelines for man/display interfaces, (TR 00.2720). Poughkeepsie, N.Y.: IBM, Poughkeepsie Laboratory.

Eihorn, H. J., & Hogarth, R.M. (1981). Behavioral decision theory: Processes of judgment and choice. Annual Review of Psychology, 32, 53-88.

Fontenelle, G. A. (1983). The effect of task characteristics on the availability heuristic for judgments of uncertainty (Report No. 83-1). Office of Naval Reseach, Rice University.

Goldberg, L. R. (1968). Simple models or simple processes? Some research on clinical judgment. American Psychologist, 23, 483-496.

Hogarth, R. M. (1981). Beyond discrete biases: Functional and dsyfunctional aspects of judgmental heuristics. Psychological Bulletin, 90, 197-217.

Kahneman, D., & Tversky, A. (1972). Subjective probability: A judgment of representativeness. Cognitive Psychology, 3, 430-454.

Nisbett, R. E., & Ross, L. (1980). Human inferences: Strategies and shortcomings of social judgments. Englewood Cliffs, N.J.: Prentice Hall.

Slovic, P., Fischhoff, B., & Lichtenstein, S. (1977). Behavioral decision theory. Annual Review of Psychology, 28, 1-39.

Tversky, A., & Kahneman, D. (1971). Belief in small numbers. Psychological Bulletin, 76, 105-110.

Tversky, A., & Kahneman, D. (1973). Availability: A heuristic for judging frequency and probability. Cognitive Psychology, 5, 207-232.

Tversky, A., & Kahneman, D. (1974) Judgments under uncertainty: Heuristics and biases. Science, 185, 1124-1131.

Table 1

Assignment of Frequencies to the 18 Events

Per Session	Total	Events: Police	Events: Ambulance
0	0	P3	A7, A8
1	2	P6*	A2, A5
2	4	P2	A1*, A3
4	8	P4, P9	A9*
8	16	P1, P7*	A6
10	20	P5, P7*	A4

*These four events were chosen for the enhancement operation. All other events served as unenhanced events.

Table 2

Point System

	Vehicles Available		Vehicles Not Available	
	True Emergency	False Alarm	True Emergency	False Alarm
Dispatch	1	-1	-1	-2
Verify	-1	1	-2	0

Table 3

The Mean Number of Case Histories Recalled
For Specific Comparisons Between Enhancement Scheldules

	Recall of the Case Histories Associated With ...		
Enhancement Schedule	Every Occurrence of Enhanced Events in the First Session (N=15)	Last Occurrence of Each Enhanced Event (N=4)	First Occurrence of Each Enhanced Event in the First Session (N=4)
Continuous (n=16)	4.86 ⌉ *	2.26 ⌉	1.47 ⌉
First Session-Only (n=15)	7.00 ⌋	*	2.38 ⌉
Late-single (n=15)		3.13 ⌋	* | *
Early-single (n=15)			2.67 ⌋ ⌋

* p < .05
** p < .001

Response? Score:0

P	A	P	A	P	A
3	3	6	4	1	3
9	2	8	1	2	7
Ambulance- 4					
4	9	3	0	4	1

Figure 1. Example of the display format asking subjects to dispatch or verify the incoming call.

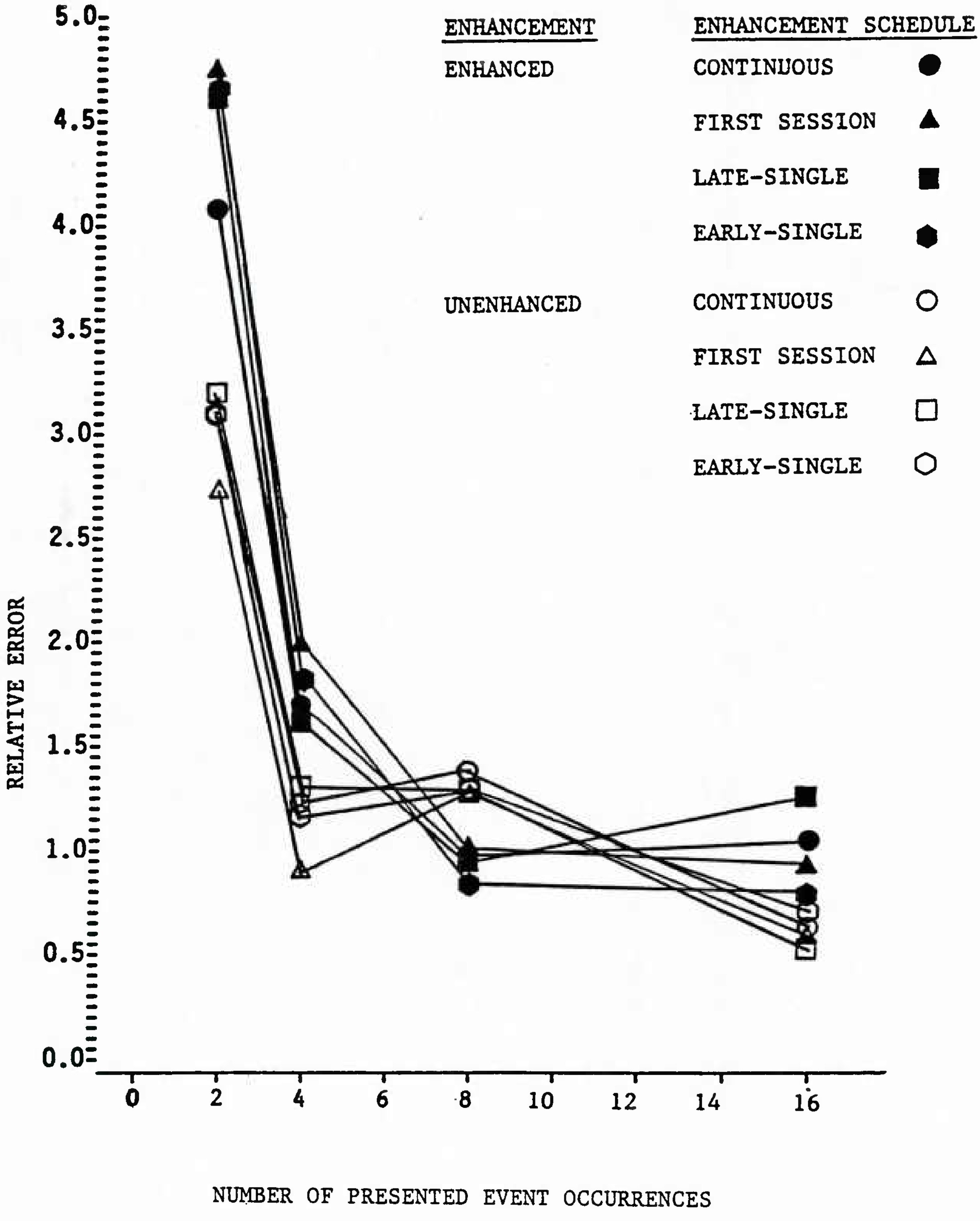

Figure 2. Mean error scores for the various frequency levels and enhancement schedules.

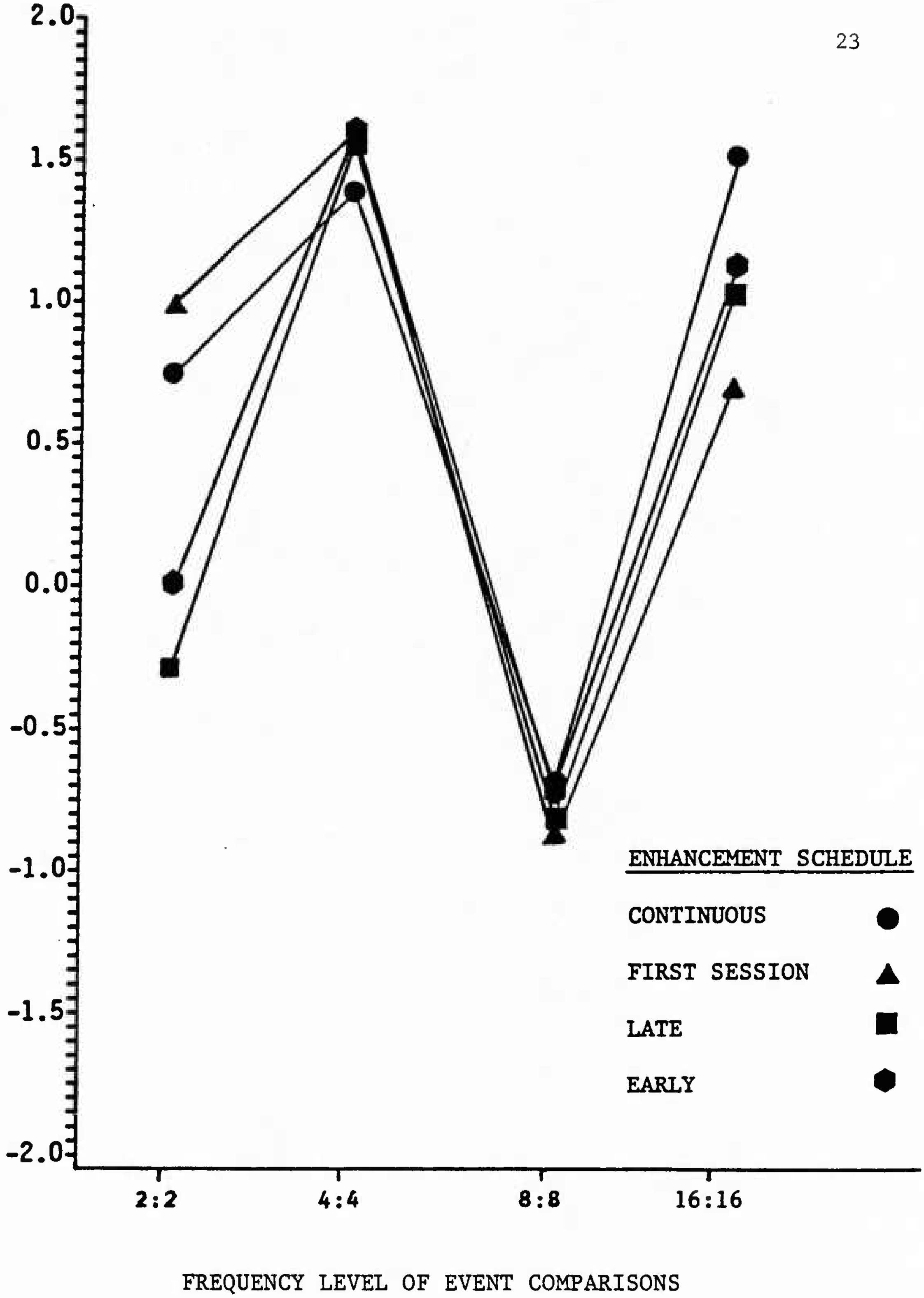

Figure 3. Means of the number of enhanced events chosen as compared to unenhanced events for comparisons at the various frequency levels.

APPENDIX A

FREQUENCY ESTIMATIONS

Please base your estimations on the total number of events that you experienced over all three sessions.

1. How many total police calls did you receive? __________
2. How many total ambulance calls did you receive? __________
3. Using the grid presented below indicate number of police and ambulance calls your received in each district.

1 ____ ____ Police Ambulance	2 ____ ____ Police Ambulance	3 ____ ____ Police Ambulance
4 ____ ____ Police Ambulance	5 ____ ____ Police Ambulance	6 ____ ____ Police Ambulance
7 ____ ____ Police Ambulance	8 ____ ____ Police Ambulance	9 ____ ____ Police Ambulance

THE FOLLOWING IS A LIST OF PAIRS OF EVENTS. P STANDS FOR POLICE. A STANDS FOR AMBULANCE. THE NUMBER THAT FOLLOWS INDICATES THE DISTRICT IN WHICH THE POLICE OR AMBULANCE EVENT OCCURRED. PLEASE CIRCLE WHICH OF THE EVENTS IS MORE LIKELY TO OCCUR.

A9	P9			A6	P3
A2	P6			P3	A2
A1	P2			P7	P1
A5	P6			A7	A1
A9	P4			P4	A8
A3	A1			P7	A6

THE FOLLOWING IS A LIST OF THE DIFFERENT TYPE OF EVENTS AS THEY APPEAR ON THE SCREEN. PLEASE CIRCLE ALL EVENTS WHICH WERE ACCOMPANIED BY ADDITIONAL INFORMATION AT ANY TIME DURING EITHER SESSION.

1 police ambulance	2 police ambulance	3 police ambulance
4 police ambulance	5 police ambulance	6 police ambulance
7 police ambulance	8 police ambulance	9 police ambulance

IN THE SPACE BELOW LIST THE EVENTS WHICH YOU HAVE CIRCLED.BELOW FOLLOWING THE EVENT (GIVE BOTH PRECINT NUMBER AND TYPE OF EVENT) LIST THE DETAILS OF THE SPECIFIC CALLS WHICH OCCURRED AT THAT LOCATION. RECALL AS MANY DETAILS AS POSSIBLE.

EVENT DETAILS

EVENTS DETAILS

IF YOU ARE ABLE TO RECALL THE DETAIL OF A CALL BUT UNABLE TO RECALL WHERE THE CALL OCCURRED OR WHETHER IT WAS A POLICE OR AMBULANCE CALL SIMPLY LIST THE DETAILS BELOW.

APPENDIX B

EXAMPLES OF CASE HISTORIES

Example 1

Can you send an ambulance to the 6th Ward neighborhood pool? We've got a kid who has just been pulled out from the bottom of the deep end. No one knows how long he was down there. Three lifeguards are working on him now. It looks bad, please hurry.

A4 Residential-Low Income

Example 2

Something terrible has happened! My son came home this morning around 4:00 a.m. He had blood all over his clothes. He took them in the back yard and burned them. He's carrying a gun with him. Please do something before he hurts himself or someone else.

P6 Residential-Middle Income

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