ARI Research Note 97-37

Enhancing Effective Decision Making by Information Management Techniques

Shlomo Breznitz, Hasida Ben-Zur, and Naomi Wardi

University of Haifa

Research and Advanced Concepts Office
Michael Drillings, Chief

September 1997

United States Army
Research Institute for the Behavioral and Social Sciences

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency Under the Jurisdiction of the Deputy Chief of Staff for Personnel

EDGAR M. JOHNSON
Director

Research accomplished under contract
for the Department of the Army

University of Haifa

Technical review by

Michael Drillings

NOTICES

REPORT DOCUMENTATION PAGE

1. REPORT DATE 1997, September	2. REPORT TYPE Final	3. DATES COVERED (from. . . to) December 1993-September 1994

4. TITLE AND SUBTITLE Enhancing Effective Decision Making by Information Management Techniques	5a. CONTRACT OR GRANT NUMBER DAJA45-93-C-0026 5b. PROGRAM ELEMENT NUMBER 0601102A
6. AUTHOR(S) Shlomo Breznitz, Hasida Ben-Zur, and Naomi Wardi (University of Haifa, Israel)	5c. PROJECT NUMBER B74F 5d. TASK NUMBER 4018 5e. WORK UNIT NUMBER C02
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Ray D. Wolfe Centre for Study of Psychological Stress University of Haifa Mount Carmel, Haifa, Israel 31905	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Research Institute for the Behavioral and Social Sciences ATTN: PERI-BR 5001 Eisenhower Avenue Alexandria, VA 22333-5600	10. MONITOR ACRONYM ARI 11. MONITOR REPORT NUMBER Research Note 97-37

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

COR: Michael Drillings

14. ABSTRACT *(Maximum 200 words)*:

Four experiments varying in complexity of decision tasks were conducted to study the effects of information about expected length of task on decision processes and choices. All experiments utilized a combined between and within subjects design with two initial levels of information (long vs. short expected list of items) and subsequent information change (reducing the long and increasing the short). In two experiments, a computerized process methodology provided detailed data on information search, speed, and strategy used. Individual differences were tested using a battery of personality characteristics. The results indicated that initially encouraging information enhances the quality of decision processes, particularly during the first phase of the task. The impact of information change was less prominent, although it produced full reversals in several indices of decision performance. Personality characteristics interacted with the information manipulations. The role of cognitive resource allocation in decision tasks and several practical implications are discussed.

15. SUBJECT TERMS

Decision making   Scaling   Information management

SECURITY CLASSIFICATION OF			19. LIMITATION OF ABSTRACT	20. NUMBER OF PAGES	21. RESPONSIBLE PERSON (Name and Telephone Number)
16. REPORT Unclassified	17. ABSTRACT Unclassified	18. THIS PAGE Unclassified	Unlimited	81	

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THEORETICAL BACKGROUND.

Decision research.

The vast decision making literature attempts to explicate both the underlying principles for making a particular choice, as well as the process by which that choice is arrived at. The early stages of research focused on attempts to develop formal or structural models, aiming to explicate **decision rules** by which information concerning available alternatives is combined to lead to final choice. More recently, information processing models emphasize the process rather than its outcome, utilizing **process tracing methods** as their main investigative tools. These can vary from on-line monitoring of information search, through post-hoc debriefing of expert decision makers.

Decision rules: Strategies for deciding between several alternatives fall into two chief categories, often described as either compensatory or non-compensatory (e.g., Payne, 1982; Hogarth, 1980; Zakay, 1985). A typical compensatory strategy is the "linear compensatory", or additive model. Rational behavior prescribes that the alternative having the highest value (computed by summing the products of dimension weights and their specific values) should be the one of choice.

The above strategy may well be the optimal one if decision quality prescribes utilization of all available information. It is, however, very demanding in terms of both time and effort. In contrast, non-compensatory strategies involve shortcuts by eliminating alternatives according to some criterion (Tversky, 1972), or by comparing the alternatives on the most important dimension only. (See Hogarth (1980), Klayman (1983), and Montgomery (1983) for extensive reviews).

Process tracing methods: Different methods based on essentially the same logic, are used to assess the type, amount, and order of information sought by the decision maker. Payne (1976) used boards containing information written on cards, Ben-Zur and Breznitz (1981) used an observation display on which the information could be observed by illumination, and Russo and Dosher (1983) traced eye movements. More recently, information acquisition and strategy utilization are studied using specific computer programs. (E.g.: Payne, Bettman, & Johnson, 1988; Bettman, Johnson & Payne, 1990). Such a strategy was used in two studies pertaining to this report as well.

Process tracing methods attempt to mimic the process by which the decision maker (DM) searches for and assesses decision-relevant information, in contrast to the structural models that try to infer choice from the combination of informational cues. Processing patterns and decision strategies are obviously not independent of each other, and it is sometimes possible to infer the latter from the former. Thus, observing only some of the information along one dimension, suggests that an "elimination by aspect" model is used, while observing all information for each alternative suggests an "additive/compensatory" model.

Cognitive resources and decision making.

(a) Time pressure. While there are several different ways to study the role of cognitive resources allocated to a decision making task on the process itself, the most prevalent method is one of **time pressure.** If optimal choices are defined by choosing the alternative with the highest value, i.e., using the compensatory linear strategy (e.g., Payne et al., 1988; Zakay, 1985; Zakay & Wooler, 1984), **under time pressure subjects choose less optimally**. It appears that time pressure leads to usage of simpler decision rules (see Payne et al., 1988; Svenson, Edland & Slovic, 1990).

This is in line with Bettman et. al. (1990) who examined decision strategies as a function of effort. Specifically, strategies that are based on combinations of all informational items are much more time consuming, and demand greater amounts of effort than strategies that are based on assessments of certain dimensions only.

Superimposed upon a major decisional problem, time pressure can amplify the stress emanating from conflict, and from expected failure, and evoke feelings of anxiety and helplessness. This suggests that not only is there under these conditions a preference for simpler ways of reaching a decision, but also that the simplification follows a certain pattern. Ben-Zur and Breznitz (1981) used self- observation of information on pairs of gambles (i.e., amounts to win and lose and probabilities of winning and losing of each gamble) to investigate the way information processing changes under severe time pressure. The data indicated that **under time pressure subjects emphasized the importance of the negative dimensions, i.e., amounts to lose and probability of losing**. Positive dimensions, i.e., amount to win and probability of winning were preferred under less severe time pressure.

Payne et al. (1988) claims that time pressure leads to accelerated processing, as well as to filtering of certain types of informational items. On the whole, subjects tend to observe information by dimensions, rather than by alternatives.

If time pressure affects decision processes and decision strategies, it seems reasonable that it will also affect the type and quality of the decisions themselves. In this context, most of the research dealt with issues of risk taking. Our findings suggest that time pressure reduces risk taking (Ben-Zur & Breznitz, 1981). Similar results were obtained by Carnevale & Conlon, 1988; Wright, 1974. However, in others types of contexts the results were different, (Svenson et al., 1990; Graham, Cook, Cohen, Phelps & Gerkovich, 1985), and this important issue is still an open one.

(b) Cognitive load. There are, of course, many ways to influence cognitive load besides manipulation of the amount of decision time available. Payne (1988) found that as long as the number of alternatives is small, compensatory strategies work well. Beyond a certain number of alternatives, DMs prefer less demanding strategies. In studies manipulating load in a Pac Man type video game, Streufert, Streufert, & Denson, 1983; Streufert, (1986) found that increased load (more "foes" on the screen) led to higher risk taking (venturing closer to a "foe).

In a simulation of military and economic decisions (Streufert, Streufert, & Gorson, 1981) found that time pressure led to less integrative decisions, while the relationship with load was u-curved. **The combination of high load and high time pressure led to increase in decisions based almost exclusively on short term considerations.**

Effects of information on resource management.

The set of studies covered by this report were based on a systematic research effort explicating the role of information management techniques in a variety of contexts. It should be noted that issues related to "mobilization of resources", effective "resource allocation", and "expected effort", appear to be of central importance in all of our studies. Thus, **if information on start is too discouraging, this may lead to insufficient mobilization of resources, and turn into a self-fulfilling prophecy** (Breznitz, 1990; 1992).

Whether our subjects were soldiers embarking on an arduous march, students participating in an experiment on pain tolerance, or in the purely cognitive domain of free recall, **full information about task duration/load was found to facilitate the distribution of effort** (Breznitz, et. al., 1992).

Although resource theory was initially applied in the context of research on attention (Kahneman, 1973), it penetrated other areas of cognitive research. Mitchell and Hunt (1989) define cognitive effort as: "the percentage of the available capacity of or resources allocated to a given task." (p. 338). Consequently, performance depends on the amount of resources allocated to a task, and their effective utilization.

In the context of information management research, information about task duration/load provides the basis for **EXPECTED EFFORT**. Although this hypothetical constructs precludes direct measurement, its systematic impact on performance cannot be denied. Thus, when a task is seen as unmanageable, this reduces the motivation to allocate all available resources. Stated differently, **anticipated failure protects the organism from wasting limited resources**. There are some indications that the relationship between expected effort and initial resource allocation is of the frequently observed inverted U type. If the task consists of a given number of items, **information on start determines the resource per item allocation.** This allocation is subsequently modified on the basis of experience.

The explanatory power of the above concepts is particularly impressive in this type of research, since they help to bridge the conceptual gap between the various domains tested. This last advantage is quite obvious in the context of decision making research.

The load of a decisional task is determined by the nature of the decisional problems, their number, and the amount of time available. Assuming that initial resource allocation is determined by information available at the onset of the task, it follows that **information management techniques should affect decision making performance.**

Information management principles that were found effective in enhancing endurance of stressful tasks were successfully applied to the area of free recall (Breznitz, 1990; Breznitz, Ben-Zur, & Vardi, 1992). Considering the conceptual distance between the domain of physical exertion or pain tolerance, and that of memory, the potential applicability of the specific information management techniques to a broad spectrum of cognitive tasks became a distinct possibility.

Thus, exact information about task duration (load) was found to be conducive to effective mobilization of resources, as well as their specific within-task allocation. Discouraging information on start often leads to expected failure, and interferes with resource mobilization. Furthermore, successful performance on all the tasks studied so far was directly affected by information induced expectations.

The main objective of this study was to investigate the effects of these techniques in the decision making domain, and measure their potential impact on both decision processes and outcomes.

Since manipulations of time pressure are almost exclusively anticipatory, i.e., the DM is told in advance how much time he has to reach a decision, this research tradition fits well into our more general paradigm. It is of some interest to note that <u>there has been virtually no attempt to study the effects of anticipated number of discrete decisions on decision making performance</u>. This is particularly surprising in view of the obvious relevance of such anticipated decision load to a variety of real life situations. Whether in the military, or in other contexts, several decisions of a certain kind are often a part of the task of a commander/manager. It is suggested that any attempt to move closer to more "naturalistic" decision situations (e.g.: Klein, & Peio, 1989; Klein, Calderwood, & McGregor, 1989) must address the issue of consecutive, rather than discrete decision making.

What are the effects of information concerning the frequency of decision tasks on the quality of the decision making process? <u>Would a person that expects to make many decisions of a particular kind analyze the information differently than someone expecting to make only a few decisions? And would he perhaps choose different alternatives?</u>

On the basis of our earlier studies, and a specific pretest carried out in our laboratory, we hypothesized that expected effort plays a significant role in determining the decision making strategy, and that information management techniques may enhance the quality of the decision making process, as well as its outcomes.

MAIN RESEARCH QUESTIONS.

To increase the generalizability of our findings, the effects of anticipated decisional load on performance were studied utilizing a **variety of problem types.** These ranged from complex problems with several alternatives varying on several dimensions, through preferences between alternatives in a gambling-like situation, and evaluative decisions of a set of problems depicting real-life situations.

The proposed range of problems, varying on decisional load, provide useful information about possible interactions between anticipated frequency of decisions, and their complexity. The inclusion of gambling-like problems can throw light on issues of such obvious military relevance as **the extent to which discouraging or encouraging information affects risk taking.**

Neglect of information pertaining to the decisional problem is yet another form of risk taking, with potentially far reaching consequences. **High anticipated load may lead to selective information processing**, increasing the risks of this type of failure.

In line with our previous research we were particularly interested in studying the effects of **change in expected effort** on both the decision making process, and its outcomes. To what extent is the decision making pattern sensitive to such alterations? Is it possible to protect effective decision making form information induced deterioration? And alternatively, can interventions en route upgrade a superficial decision making process?

METHOD.

The effects of Encouraging/Discouraging information about number of decision tasks was tested with four types of decisional problems:

1. Comparative scaling: Involving anger inducing situations from everyday life, asking subjects to indicate the respective amount of anger they produce. (See: Ben Zur, & Breznitz, 1991). Results will indicate to what extent are scaling decision affected by anticipated load.

2. Choice dilemmas procedure: Following Kogan & Wallach (1964) classic method of measuring risk taking, subjects received dilemmas involving conflict, and were asked to determine the maximal amount of risk they were willing to take in order to

achieve a particular goal. A wide variety of content areas with both military and non-military relevance were sampled.

3. Complex decisions: Presenting problems each of which has information on four relevant dimensions, and four options to chose from. A specific computer program allowed us to closely monitor such indexes of the decision making process as:

(a) Quantity of information considered
(b) Type of information considered
(c) Order of information processing
(d) Time spent on each item of information
(e) Forgetting of information already processed, etc.

This information provided the basis for determining the particular decision strategy (if any) that subjects use.

4. Choice between gambles: The alternatives in these items were presented in a 2 by 2 table indicating probability of gain/loss and amount of gain/loss. In order to determine amount of risk taking, the alternatives differed in the variance of their respective probabilities.

Each type of decisional problem utilized two types of groups:

Encouraging information on start, i.e., small expected load, with subsequent discouraging correction, and Discouraging information on start, with encouraging correction. **This design provided information on initial resource allocation effects, as well as on resistance to change.**

The four studies will be presented separately in the above sequence, and the results of each will be discussed. This will be followed by a general discussion of the entire research program.

I. Comparative scaling of anger evoking situations.

Aims.

The major aim of this study was to explore whether anticipation of a long list of items to be judged will affect cognitive operations in a way different from that of an anticipated short list of items. In addition, the effects of information concerning change in anticipated list length were also studied. We hypothesized that when expecting a long list of items to be judged subjects allocate fewer resources per item, with the possible consequence of a more shallow processing. This may result in making stereotypic judgments.

METHOD.

Sample. Sixty Israeli born students were run, 16 men and 44 women with an average age of 23.55 years (SD = 2.53, range 19-33). Thirty-five were first year psychology students who participated for course credit, and 25 were paid $7.00 for participating in the study.

Materials. An anger inventory including 80 items was prepared in two versions. Each item described an event from everyday life that may evoke anger. They were taken from two anger inventories (having 32 and 48 items respectively) reported in Ben-Zur & Breznitz (1991). Each item was constructed to represent either a low or a high level on certain dimensions. The 32-item inventory was based on three dimensions: Intensity of damage caused by the event, the Intentionality behind the act causing damage, and the Expectedness that damage is going to occur. Thus, each item was characterized by a combination of each of the three dimensions. Since there are eight possible combinations, each combination was represented by four items differing in content, but similar in their underlying dimensions. The 48-item inventory included six dimensions, each batch of 16 items representing a combination of two dimensions i.e., Correctability of damage and Investment in preventing future damage, Preventability of damage and Proximity to a future goal before it was interrupted, and Agent of the damage (self or other) and the presence/absence of Audience.

In order to further check on the effects of event dimensions on anger all 80 items (including the 48 items of the first version) were rated by additional judges (see Ben-Zur & Breznitz, 1991) on the nine dimensions. The two original inventories were merged so that there was an equal representation of all levels of the 9 dimensions in each block of 20 items which were randomly ordered. The new inventory was divided into two 40-item parts, and by reversing their order of presentation, two new versions were created.

Design. Two information conditions were tested: The first group consisted of initial Encouragement with a Discouraging change (**E40/D40**): i.e., subjects received information that the task consists of 40 items in all, but after rating the 40 items, it was followed by information that 40 additional items ought to be rated. The second group consisted of initial Discouragement with an Encouraging change (**D200/E40**): i.e., subjects received information that the task consists of 200 items, but after rating 40 items, they were told that only 40 items more were to be rated. A third group of 41 subjects that did not receive any information about the number of items, (No Information) taken from the earlier study using the anger inventory, served as an additional control for some aspects of this research.

Procedure. Subjects were given the standard anger rating instructions which described the nature of the items to be rated. They were asked to imagine themselves experiencing the specific situation, and then to rate their anger on a 7-point scale (1 = not angry at all, 7 = extremely angry). In addition, they were told about the "number of items" to be rated, i.e., either 40 or 200 respectively. Subjects in the E40/D40 group were told that they have to rate 40 items, and were given a booklet containing 40 items only printed on three pages. However, when they finished they were told that the task was lengthened, and that they had to rate 40 more items. In the D200/E40 group subjects were told that they would have to rate 200 items, and were given a booklet of 15 pages containing 200 item. However, after rating 40 items, they were told that the task was shortened and that they had to rate only 40 items more. Subjects were run individually in a quiet room. The instructions were given both in writing and verbally, and performance time for each part was covertly measured. The two versions of the anger inventory were run in equal numbers in both information conditions, to control for order effects (15 subjects in each version in each condition).

RESULTS.

The E40/D40 and D200/E40 groups did not differ on age (t<1). The frequencies of men and women in each group (9 men in the E40/D40 and 7 in the D200/E40 group, Chi-square<1) were similar, as were the frequencies of paid subjects (14 in the E40/D40 group and 11 in the D200/E40 group, Chi-square<1). The No Information group also did not differ in age or gender, thus facilitating intergroup comparisons.

Intensity of anger judgments.

There was no a priori prediction that anger level itself will be affected by the manipulation. However, anger level may be related to other measures that will be used to assess item processing. Consequently the two groups should be compared.

The anger means were computed separately for the 40 items prior to the information change (Part A) and for the 40 items following the change (Part B) for each group, and they appear in Table 1.

Table 1: Mean Anger (SDs in brackets) according to Groups and Parts.

Groups	Part A	Part B
Group E40/D40	4.20 (0.49)	4.31 (0.57)
Group D200/E40	4.13 (0.83)	4.12 (0.85)

Since each 40-item part includes two 20-item blocks each block representing all the levels of the nine dimensions, we also computed the anger means separately for these smaller parts of the inventory. No significant effects were observed between groups (F<1) or an interaction between groups and the four blocks (F<1), the later showing a somewhat higher range of means (3.99-4.46 for the two groups). The effect of block was significant, with means of 4.06, 4.26, 4.08 and 4.35 for blocks 1-4, respectively [$F(3,174) = 6.63$, $p<.001$].

In addition, several three-way ANOVAs were performed to assess the relationship between subject characteristics and mean anger scores. Thus, we tested additional factors such as sex of subject, age (defined as high or low according to the median) and motivation (course credit vs monetary payment). A three-way, Sex x Group x Part ANOVA, did not reveal significant effects for sex or for its interaction with group. Likewise, no effects were obtained when subject's age or motivation were tested.

Finally, we compared the anger means of the two groups, over the two 40-item parts, to the No Information group. The means obtained for the E40/D40, D200/E40, and the No Information groups were very similar ($M = 4.25$, 4.13 and 4.11, respectively, $F<1$).

Quality of anger judgments

The main purpose of the present study was to test the effects of information on the level of processing of anger-evoking events. The underlying assumption was that if subjects are affected by information conveying a long, multiple item list, they will invest less effort in the processing of each item, and therefore the individuals in group D200/E40, who expected a long list, will tend to make judgments that are more uniform or stereotyped in the first part of the list than those in group E40/D40, and this trend will be reversed following the change in instructions in the middle of the list. This claim was tested empirically by using several measures of variability.

We also tested the effects of the manipulation on the overall time needed to complete each part of the inventory. A more superficial processing could be carried out faster than a more thorough one.

Finally, quality of judgments was analyzed by comparing the effects of the underlying dimensions on anger judgments for each group, since shallow processing may lead to emphasizing the most prominent dimensions (such as Intensity of damage) and to allocating less processing resources to the more subtle aspects (such as Intentionality in causing damage).

Performance time. Time was analyzed first, since we used it in subsequent analyses of judgment stereotypy. The means of the two groups on the time needed to complete each part of the inventory are presented in Table 2. The data were log transformed and then analyzed by a two-way, Group x Part ANOVA, which yielded a significant effect for Part [$F(1,52)=4.20$, $p<.05$], and a marginally significant effect for group [$F(1,52)=2.99$, $p<.09$], with no significant interaction ($F<1$). As can be seen in the table, group D200/E40 was somewhat faster than group E40/D40, and both groups performed faster in the second than in the first part of the inventory.

Table 2: Mean Time (Sds in brackets) according to Groups and Parts.

Groups	Part A	Part B
Group E40/D40 (n = 24)	440.3 (128.5)	423.1 (130.2)
Group D200/E40 (n = 30)	390.7 (102.4)	375.9 (117.7)

In addition, several three-way ANOVAs were carried out to assess the relationship between subject characteristics and the time measure. A three-way, Age x Group x Part ANOVA, showed only an age effect [$F(1,50) = 3.79$, $p=.057$], with older subjects performing more slowly than the younger ones. No effects were found when gender was included in the analysis, but motivation was significant [$F(1,50) = 6.97$, $p<.01$], with paid subjects being slower than credit subjects. However, there is a confounding between age and motivation here since paid subjects were also older (Chi-square = 10.62, $p<.001$).

Variance in anger ratings within subjects. The first measure of variance used was the Variance (VAR) within parts A and B of the inventory computed for each individual subject, which represented the dispersion of his/her anger ratings around the mean (as in the usual variance calculations, the mean of the squared deviations was used). The VAR means are depicted in Table 3. A two-way Group x Part ANOVA yielded a significant effect for the difference between Part A and Part B [$F(1,58)=18.75$, $p<.0001$], with no effect for group ($F<1.70$) or for the Group x Part interaction ($F<1.70$). As can be seen in the table, the two groups VAR means decrease in Part B as compared with Part A.

Table 3: Mean VAR (Sds in brackets) according to Groups and Parts.

Groups	Part A	Part B
Group E40/D40	3.02 (0.61)	2.46 (0.68)
Group D200/E40	3.25 (1.43)	2.94 (1.52)

To better understand the meaning of the VAR measure we divided subjects into fast and slow respondents on the basis of the median of average time needed to complete the two parts of the inventory, and ran a three-way, Time x Group x Part ANOVA on this measure. The effect of time was marginally significant [F(1,50) = 2.83, p<.10] -- Faster subjects' variance was lower than that of the slower ones (M = 2.71 and 3.16, respectively). Thus, the association between performance time and the VAR measure while in the expected direction, is a weak one. This suggested that the VAR measure may reflect other operations apart from the amount of processing, since we would expect people with low VAR to perform much faster.

Inspection of the raw data suggested that subjects in the D200/E40 group used more often the more extreme anger rating categories of 1 and/or 7 than subjects in the E40/D40 group. Indeed, when we transformed the VAR measure into absolute Z scores, thereby testing a U-shaped relationship, <u>a highly significant effect was obtained for the group factor, with group D200/E40 much higher than group E40/D40 [F(1,58) = 20.77, p<.0001]</u>. Testing this measure in a three-way ANOVA including time as a factor revealed significant effects for time, with faster subjects having a higher absolute VAR mean than the slower ones [F(1,50) = 7.53, p<.01].

<u>Thus, in the initially discouraging condition (D200/E40) subjects either rated the items in a uniform way, or they used the two extreme categories</u>. It seems that fast, shallow processing of the material may have led to the use of fewer categories, but not necessarily around the middle point of the scale. This idea is tested more systematically below.

<u>Variance in using anger rating categories within subjects.</u>

Since the linear VAR measure did not show any group effects, we tried for a more specific measure of variance that takes into account the frequency in which each category of judgment (on the 1-7 rating scale) was used. The CATVAR measure was based on the following calculations: There were 40 items in each part of the inventory and therefore, utilizing each of the seven categories of ratings equally often would lead to a frequency of 5.71 (40:7). This number was used to assess category variance, that is, the mean of the squared deviations: For each subject in each 40-item part, we counted the number of times each category was used, subtracted it from 5.71, and then calculated the mean of the 7 squared deviations. A low CATVAR score represents high differentiation since it is based on small deviations, and the reverse is true for a high CATVAR.

A two-way Group x Part ANOVA on the CATVAR measure revealed significant effects for group [F(1,58) = 5.21, p<.05] and for part [F(1,58) = 15.89, p <.001], but the interaction was not significant (F<1). Aa can be seen in Table 4 group E40/D40 CATVAR level was lower than that found for group D200/E40 (M = 11.73 and 17.09, respectively), suggesting better differentiation, and the level of differentiation was higher during the first than the second part of the study (M = 11.90 and 16.92, respectively).

Table 4: CATVAR Means and Sds according to Groups and Parts.

Groups	Part A	Part B
Group E40/D40	9.04 (3.91)	14.42 (9.57)
Group D200/E40	14.76 (11.67)	19.42 (13.51)

A three-way Time x Group x Part ANOVA on the CATVAR measure showed, as above, significant effects for group and part, as well as a significant effect for time [F(1,50) = 11.62, p<.005]. Subjects who worked faster had higher CATVAR scores, and therefore lower differentiation, than subjects who performed more slowly (M = 19.41 and 10.33, respectively). Not only does this result confirm our main hypothesis, but it also validates CATVAR as a measure of processing depth.

Correlations between time, variance and mean anger.

For each group and part we computed the correlations between the main variables used in the present study. Table 5 presents the correlations between anger mean, performance time, and the VAR, absolute value of VAR, and CATVAR measures.

Table 5: Correlations between the Main Variables studied.

	Anger Mean	Time (Log)	VAR	absolute
Group E40/D40				
Part A				
Time (Log)	.00			
VAR	-.15	.05		
VAR absolute	-.07	-.06	-.17	
CATVAR	.37*	-.22	-.61*	.38*
Part B				
Time (Log)	.10			
VAR	.27	.31		
VAR absolute	-.22	-.27	-.64*	
CATVAR	-.12	-.22	-.79*	.73*

	Anger Mean	Time (Log)	VAR	absolute
Group D200/E40				
Part A				
Time (Log)	-.22			
VAR	-.19	.18		
VAR absolute	.13	-.12	.29	
CATVAR	.23	-.22	-.33	.50*
Part B				
Time (Log)	-.07			
VAR	.06	.31		
VAR absolute	-.14	-.26	.40*	
CATVAR	-.06	-.35*	-.68*	.04

*$p < .05$ ($n = 30$; for time $n = 24$ in group E40/D40)

As already noted in the ANOVAs, the associations between performance time and the VAR measure are weak but positive suggesting that longer processing times led to higher variance. In addition, the correlations between the CATVAR measure and performance time are all negative suggesting that longer performance times led to better differentiation. The relationship between the VAR and CATVAR are all negative, suggesting that low CATVAR (high differentiation) is related to high variance. Finally, there is one case in which there is a reversal in the correlations between parts and groups -- the association between the absolute value of the VAR measure and the CATVAR is higher in group E40/D40 in part B than in part A while for group D200/E40 this trend is reversed. A positive association means that subjects who were less differentiating (high CATVAR) were also characterized by either very high or very low level of VAR (absolute value). Thus there is more coherence between these measures in the discouraging conditions.

Anger judgments and dimensions of anger-evoking events.

If information affects item processing, it may also cause certain dimensions to be more prominent than others. To test for this possibility, we analyzed the effects of dimensions on level of anger using the original classification of items according to the various dimensions in the original inventories. For each 40-item part of the present versions, the level of anger for each level of each dimension was averaged over the two items that represented it.

The first comparison tested the effects of Damage, Intentionality, and Expectancy for the two groups. A five-way, Group x Part x Damage x Intentionality x Expectancy ANOVA, where group was a between-S factor and the rest within-S factors, showed significant effects for Damage [$F(1,58) = 403.49$, $p<.0001$], Intentionality [$F(1,58) = 21.17$, $p<.0001$], and Expectancy [$F(1,58) = 31.23$, $p<.0001$], in the same directions found in previous studies (see Ben-Zur & Breznitz, 1991): High damage led to more anger than low damage, intentions led to more anger than no intentions, and unexpected events led to more anger than expected ones. The Intentionality x Expectedness interaction was marginally significant [$F(1,58) = 3.59$, $p<.06$], and the Group x Intentionality x Expectedness was also significant [$F(1,58) = 6.44$, $p<.02$]. This last interaction stems from the tendency of Intentionality to be most effective under the no expectations level, in Group E40/D40.

In addition, the Part x Damage was significant. [$F(1,58) = 4.31$, $p<.05$]. Table 6 depicts the anger means for the levels of damage in each group and each part.

Table 6: Anger Means of High and Low Damage according to Groups and Parts.

	Part A		Part B	
	Damage Intensity			
	Low	High	Low	High
Groups				
Group E40/D40	2.99	5.50	3.40	5.29
Group D200/E40	3.00	5.34	3.22	5.28

As can be seen in the table, the effect of damage is weaker in the second part of the inventory, suggesting that subjects may have attended less to this dimension in the second part. A comparison of the effect of Damage on anger in the present research with the Control Group data revealed very similar effects: Previous research showed high damage to lead to an average of 5.31 as compared with a much lower average of 2.96 for a low level of damage, while in the present research the overall means were 5.35 and 3.15, respectively.

Additional ANOVAs tested the effects of the other 3 combinations of dimensions. The Investment x Correctability combination showed significant effects for Investment [$F(1,58) = 119.33$, $p<.0001$], and Correctability [$F(1,58) = 85.72$, $p<.0001$], with similar effects to those originally found, and the Investment x Correctability interaction was also significant [$F(1,58) = 5.11$, $p<.05$]. Investment led to more anger than no investment, and not being able to correct the damage led to more anger than ability to correct it. A Part x Investment interaction was also found [$F(1,58) = 5.38$, $p<.05$], with a similar trend to that found for level of damage (i.e., less differentiation in the second part), but no effects were found for the interactions with group. The Preventability x Proximity combination revealed a significant effect for Preventability [$F(1,58) = 69.92$, $p<.0001$] repeating the original finding that being able to prevent damage led to more anger. Proximity was also significant [$F(1,58) = 10.36$, $p<.005$] as was the Preventability x Proximity interaction $F(1,58) = 47.38$, p<.0001], with no interactions with group or part. The Audience x Blame combination showed significant effects for blame [$F(1,58) = 7.74$, $p<.01$, with anger being higher when others were to blame, for the Blame x Audience interaction [$F(1,58) = 49.12$, $p<.0001$], and we also observed several interactions with group: The Group x Blame was significant [$F(1,58) = 6.27$, $p<.05$], as was the Group x Audience x Blame interaction [$F(1,58) = 4.81$, $p<.05$], and the Group x Part x Blame [$F(1,58) = 6.27$, $p<.05$]. This last interaction stems from a reverse in the effect of the blame dimension in the first part across groups.

In sum, the effects of the various dimensions did not change in a very prominent way as a function of the information manipulation and in most cases they repeat the original findings.

Summary

The main finding of this study indicates that **Discouraging Information at start, indicating that a task consists of long a list of items, reduces the number of categories subjects use in their ratings**. This is in line with our basic hypothesis concerning information effects on cognitive resource allocation. Subsequent change in information did not alter this effect, suggesting that once established, its robustness resist change.

Furthermore, **the reduced categories used in categorization tend to be the extreme ones, indicating that the reduced sensitivity is coupled with more risky judgments.**

The extensive analyses presented above show that the main findings are independent of content and content related factors, as witnessed by absence of significant interactions with both level of anger and the impact of the specific dimensions underlying anger evoking events.

II. Choice dilemmas study.

Aims.

The second study aimed at investigating the effects of information about task length on risk taking judgments in situations involving conflict. These situations depicted problems from everyday life, and subjects had to decide between two courses of action. Specifically, they had to choose the level of probability of in which they would take a given course of action involving risk: The lower the level of that probability, the higher the risk taking, since it means that the person chooses the course of action in spite of the low chances of success. The major aim of the study was to test the effects of information about the number of dilemmas to be judged on subjects' risk taking as indicated by their choices of probability levels. In addition, effects of encouraging or discouraging information change were also studied. In contrast to the first study (i.e., anger judgements), we wanted here to strengthen the manipulation as much as possible. Thus, the change included information that was completely reversed, and therefore the expected number of dilemmas differed for the two groups.

METHOD.

Sample. Sixty two Israeli born students were run, 28 men and 34 women with an average age of 24.35 years (SD = 2.75, range 20-35). All students were paid approximately $10.00 for participation.

Materials. The task included 30 situations of conflict and was prepared in two versions. The items were based on those used by Kogan and Wallace (1964), and each item depicted a conflict. They were constructed according to three dimensions: (a) content dimension -- the dilemma consisted of either a basic ego-related or a basic health-related issue, (b) activity dimension -- it consisted of either two active or one active alternative, and risk taking was related to either an active course of action, or to passive acceptance (three types of choices), and (c) negative/positive dimension -- the basic situation was either positive or negative. These dimensions were not fully crossed with each other.

For each dilemma, 10 response options were prepared. These options included 9 probabilities (chances of 1:10 - 9:10 that the risky choice would be successful) and one sure thing (indicating that the risky option would not be chosen under any circumstances).

The items were grouped into two 15-item parts, and by reversing their order of presentation, two versions ensued.

Design. Two information conditions were tested: (a) Initial Encouragement with a Discouraging change (E15/D70): This condition consisted of information about 15 items to be judged, but after processing and deciding on 15 items, it was followed by information about 70 additional items. The number of items actually presented in this second part was identical to the first, that is, 15. (b) Initial Discouragement with an Encouraging change (D85/E15): This condition consisted of information about 85 items to be judged, but after making 15 choices, subjects were told that only 15 items more were to be judged. As in the former group, the number of items actually presented in this second part was identical to the first, i.e. 15. Thus, in both groups subjects always made their choices on 15 conflict situations first, and after the change in information, on 15 more. The initial information and the change in information in the middle made the two groups "equal" in the reversed parts of the task: Group E15/D70 subjects faced, in the first part, the same number of items as subjects in the second part of group D85/E15.

Procedure. Subjects were given instructions which described the nature of the items they had to judge. They were told that they would be presented with two possible courses of action. One course of action involved significant advantages over the other, but the former also involved some risk. They had to read each dilemma, and imagine that they were giving advice to the person faced with the dilemma. They had to indicate the lowest probability level of success of the preferred risky alternative, in which they were still prepared to choose it. For each dilemma they had to choose from 9 probability levels (1:10 - 9:10), and an additional option including a statement that the risky action is not to be taken under any circumstances.

Subjects had three training trials, which were followed by the specific information instructions. Subjects in Group E15/D70 were told initially that they would be presented with 15 dilemmas to solve, and were then given 15 items, each appearing on a separate page. Following this task, they were given additional instructions telling them that the task was lengthened, and that they had to work on 70 items more. Group D85/E15 was told that they would have to solve 85 dilemmas. However, following 15, they were told that the task was shortened and that they had to work on only 15 additional items.

Subjects were run individually in a quiet room. The instructions were given as well as verbally, and performance time for each item, as well as the time taken to complete each 15-item part, was covertly measured. The two parts included representation of all levels of the three dimensions. The two versions were run in similar numbers in both information conditions, to control for order effects (15 and 16 subjects in each condition).

RESULTS.

The two groups differed somewhat on age (mean age = 25.13 and 23.58, respectively, $p<.05$). The frequencies of men and women in each group were similar (16 men in group E15/D70 and 15 in D85/E15, Chi-square<1).

Performance time.

We analyzed first the completion time data, The means of the two groups on the time needed to complete each part of the task (over 15 situations) are presented in Table 7.

Table 7: Mean time (SDs in brackets) according to Groups and Parts.

Groups	Part A	Part B
Group E15/D70 (n = 31)	61.05 (30.99)	50.08 (22.25)
Group D85/E15 (n = 31)	46.45 (21.78)	43.78 (19.77)

The data were log-transformed and then analyzed by a two-way, Group x Part ANOVA, which yielded a significant effect for part [F(1,60)=29.17, p<.0001], a significant effect for group [F(1,60)=5.96, p<.05], as well as a significant interaction (F(1,60)=8.45, p<.005). Similar results were obtained for the untransformed scores. As can be seen in the table, **Group D85/E15 was faster than group E15/D70, and both groups performed faster in the second than in the first part of the inventory.** This finding again supports the notion that expected duration affects level of information processing.

Furthermore, in line with our argument, **the difference between the groups was greater during the first part than during the second**, and indeed t-tests performed on each part separately showed a significant effect for the first part (p<.01) but not for the second (p = .13). Similar results were obtained for the total time calculated for each part of the experiment. The groups differed significantly on the time needed to complete the first part [the means were 945.16 (SD = 270) and 722.54 (SD = 240), for groups E15/D70 and E85/D15, respectively, t(60) = 3.42, p = .001], but not the second [means of 771 (SD = 228) and 681 (SD = 239), respectively, t = 1.50, p>.10].

Since for each item time was measured separately, we could analyze the effect of information on time variance. It was hypothesized that if our information manipulation affected cognitive resources, the more shallow processing associated with anticipated long list of items would lead to greater uniformity, and consequently to reduced variance. A two-way ANOVA, performed on the variance of the time scores, calculated for each 15-item part, revealed a **significant effect for group [F(1,60) = 6.81, p = .01] and part [F(1,60) = 5.58, p<.05], the variance being larger in group E15/D70, and on the first part.** These results, while supporting our analysis, should be viewed with some caution since the variance effect may be confounded with the level of the average scores, that differed for the two groups.

Risky choices.

For each part of the task the probabilities chosen for each dilemma were averaged, and a two-way, Group X Part, ANOVA was performed. It should be remembered that the higher the score, the less risky the choice, since a high probability means that the subject would not take chances unless the odds of success were high. The mean probabilities are presented in Table 8.

Table 8: Means and SDs of Risk Taking Means according to Groups and Parts.

Groups	Part A	Part B
Group E15/D70	6.49 (2.86)	6.88 (2.65)
Group D85/E15	6.54 (2.74)	6.65 (2.76)

No effects were obtained for group, or for the double interaction. As can be seen in Table 8, choices became less risky in part B [$F(1,60) = 4.62$, $p<.05$]. No other effects were obtained when age or sex were added as a third factor in the analysis.

Though the effect of the manipulation was not significant for the measure of risk calculated for all of the items, it was significant when we looked at extreme risky choices. When the proportion of 1:10 probability choices was tested, the effect was significant for part [$F(1,60) = 8.56$, $p<.01$, and the Group X Part was also significant [($F(1,60) = 4.69$, $p<.05$]. Group E15/D70 means were .082 and .028 for the first and second part respectively, while the corresponding means of group D85/E15 were .051 and .043. Thus, **initially encouraging information led subjects to a relatively high frequency of extreme risky choices.** While the proportion of choices of no risk (that is, under no chances would the person select the risky choice) showed no significant effects, the trend was reversed, as it should be -- the means of Group E15/D70 were .200 and .241 for the first and second part, respectively, while the means of group D85/E15 were .235 and .234, respectively.

It could be the case that subjects were affected by the information only on the first items following the manipulation. Consequently, we divided the 15-item parts into 3 blocks each. The triple interaction was marginally significant [$F(2,120) = 2.81$, $p=.06$], and the effect for block was significant [$F(2,120) = 8.79$, $p<.001$], suggesting that risk- taking diminished also within each part, with the processing of more items. The results for the first block showed a significant Group X Part interaction [$F(1,60) = 4.81$, $p<.05$]. Thus, there was some effect of information on risk taking. **During the first part of the experiment Group E15/D70 was making more risky choices than group D85/E15, and the reverse was true for the second part.** No such effects were shown for the second or third block. Similar trends, though weaker, were observed for the time measure.

Dimension effects.

For each of the three dimensions we calculated the average of probability choices for each level, and analyzed the effects in three-way ANOVAs including part and group as factors. The effects of the three dimensions were significant, but none showed a triple interaction with group and part. Table 9 presents the averages of dimension levels on both risk and time.

Table 9: Dimension effects on risk taking and time measures.

	Content		Activity			Negative/Positive	
	Ego	Health	Both active	Risk active	Risk passive	Posit.	Negat.
Risk	6.01	7.36	6.34	7.00	6.69	6.88	6.49
Time	53.27	47.24	47.15	48.97	54.65	52.60	47.92

The data indicate that choices became less risky when the dilemma involved health-related rather than ego-related situations [$F(1,60) = 76.51$, $p<.0001$], while the time spent on the former was shorter [$F(1,60) = 39.15$, $p<.0001$]. For the positive/negative dimension, choices were found to be less risky for the positive option [$F(1,60) = 5.50$, $p<.05$], while the time needed to make these decisions was longer [$F(1,60) = 32.47$, $p<.0001$]. Finally, for the activity dimension, choices were most risky in the case were the two alternatives were active [$F(2,120) = 8.57$, $p<.001$], while time was the longest in the case were risk taking involved the passive alternative [$F(2,120) = 42.53$, $p<.0001$]. It should be noted that the same trends were observed for the proportions of most risky choices.

Correlations between measures.

The correlations between the measures of time and risk taking were computed for each part and for the separate parts, for each one of the groups. Performance was reliable between parts for the two groups for both measures ($r = .77$ and $.93$ for the time measures, groups E15/D70 and D85/E70, respectively; $r = .64$ and $.71$ for the risk measure, respectively). However, there was no significant association between time and risk taking on the individual level, and these data, together with the dimension effects data, suggest that the two measures may be affected independently by experimental manipulations.

Summary.

Our previous research (Ben-Zur & Breznitz, 1981) suggested that in a gambling task time pressure led to less risky choices. Consequently, we hypothesized that expecting high task load would make subjects spend less time on each of the dilemmas, and also produce less risky choices. **These hypotheses were confirmed, particularly for the first items following the information manipulation.**

III. Complex Decisions.

Among the four studies planned under this contract, the one dealing with in-depth analysis of complex decisions is undoubtedly the most interesting, and was the most difficult to carry out. Its main purpose was to investigate the effects of information about task length on processing decision relevant information, as well as on the type of decision made.

Specifically, we were interested in finding out how initially encouraging or discouraging information about the number of expected decision problems (few or many, respectively) would affect subjects' decision outcomes, as well as the ways in which those decisions were reached. In addition, in line with our general experimental program, the study investigated the effect of **information change** about task length on decisional performance. Finally, we utilized several personality inventories measuring individual differences that were thought relevant to both the information manipulations, and to the various task components involved.

The decision problems depicted situations taken from everyday life of a typical student, and the subjects had to decide between four alternatives that differed from each other on four dimensions. The relevant information for each of the various alternatives that constituted a decision problem was presented on a computer monitor in a 4 X 4 matrix, and subjects could peek into each of the 16 information "windows" for as long as they wished, and as often as they wished before making a choice. Each move was automatically registered for both its location and "window" exposure time, **providing all information necessary for subsequent reconstruction of the entire decision making process.**

Furthermore, choices could be analyzed in terms of their compatibility with either a compensatory or a non-compensatory model. The "linear-compensatory" or additive model is tested in the following way: Each dimension has a weight that is represented by the subject's own ratings, and each alternative in the decision problem possesses a value on each dimension. The overall value of each alternative is arrived at by summing over all weighted values (Hogarth, 1980), i.e., *Value of alternative = Sum of [relative weight x scale value] of all dimensions.* Thus, subjects' approximation of the overall "best" choice, or choice according to the most important dimension could be measured. In addition, **the various information processing measures provide independent corroboration of the type of decision making strategies used.**

METHOD

Sample. Sixty Israeli born students participated in the experiment; 30 men and 30 women, with an average age of 23.18 years (SD = 2.13; range 19.5-32). All were paid IS50 (approximately $17) for participation.

Materials. The decision problems were taken from everyday life of students (e.g., choosing a course for study, renting an apartment, etc.). Each problem included four alternatives that were characterized by specific values on four relevant dimensions relatively independent of each other. The various alternatives on each dimension could possess any of five values. These values could be either real numbers (for example, the distance between a rented apartment and the university could be expressed in kilometers) or verbal indicators (e.g., high, low).

The problems were chosen on the basis of a specific pretest utilizing judges. Seven judges assessed 24 decision problems. Each problem was described in a sentence or two, and included a list of the 4 dimensions and a scale of 5 possible values that each dimension could possess. The judges were asked to indicate:

(a) any unclear aspects in the problem description, its dimensions, or their scale, suggesting suggest replacements where necessary.

(b) to mark irrelevant or unimportant dimensions, and suggest replacements.

(c) to determine whether the scales used were unambiguous in terms of their ordinality, to estimate whether the intervals between the scale values were similar, suggesting replacements if necessary.

(d) to indicate the most appropriate basic scale structure out of several possibilities.

On the basis of these judgements twenty decision problems were chosen for the experiment, and two were assigned for training trials.

The values attached to each alternative in each problem were determined randomly, with the following constraints: That no alternative will contain more than two of the lowest dimension values or more than three of the second lowest values; that no alternative will contain more than three of the highest dimensions values, and that there will be no problem where more than two alternatives will include two of highest dimension values. These constraints were used in order to prevent many undue simplification of the decisional conflict.

<u>Personality Inventories</u>. The Hebrew versions of the following 6 personality inventories were used:

(a) Maudsley Obsessional-Compulsive Inventory (MOC;Rachman & Hodgson, 1980). This measure depicts 30 items that describe checking, cleaning, repeating and doubting behaviors and thoughts (these four types of behaviors form 4 subscales). Each item is checked as true or false, and the scores of the 4 subscales are computed by summing over the answers in the direction of obsession-compulsion tendencies. (b) Locus of Control (LOC; Rotter, 1966). This measure assesses people's tendency to believe that what happens in life is caused by either external or internal causes or factors. The original test includes 29 items depicting occurrences that are either externally or internally controlled, but eight of them are distractors and are not included in the final scoring. The scoring is done by summing over all answers in which the external cause is marked.

(c) Intolerance Of Ambiguity (IOA; Budner, 1962). This inventory estimates the tendency of people to typically perceive or interpret ambiguous situations as sources of threat. It includes 16 sentences which are to be answered on a 6-point scale (7=strongly agree, 1= strongly disagree, no middle point), and which tap the person's attitudes towards conflicting, complex or new situations.

(d) Type A Behavior Pattern (TABP), using the Jenkins Activity Survey (JAS; Jenkins, Zyzanski, & Rosenman, 1979), adapted by Glass (1977) for students. The student version (SJAS) includes a

21-item scale for assessing the A-B Scale.
(e) Social Desirability (SD; M-C Scale; Crowne & Marlowe, 1964) measuring the tendency to behave according to social norms, and is sometimes used to assess general defensiveness. The test includes 33 items which depict behaviors with either a normative or a non-normative phrasing, with which the person agrees or disagrees, and the score is the sum of all items in which the answer denotes social desirability.
(f) Impulsiveness (Barratt Impulsiveness Scale;BIS, Barratt, 1965), includes 48 items assessing the person's tendency to think or behave in an impulsive manner.

Apparatus and tasks. A PC AT computer with a colored display and a mouse was used for instructions and stimulus presentation for all tasks. Each decisional problem was described on the upper part of the monitor. Beneath it, the windows matrix represented the 4 x 4 problem space. The columns represented the four alternatives while the lines indicated the four dimensions. Each dimension was described in 1-4 words, and each alternative was numbered. Upon presentation of the problem the windows appeared empty, and subjects were instructed to reveal information by clicking the mouse over the item of interest. Decisional choices were also indicated by clicking the mouse over the number of the respective alternative. Following each choice, subjects indicated their level of confidence in the decision taken, using a 7-point confidence scale.

The main task was preceded by a mouse training period. Subjects had to reach a specific criterion in moving the mouse from one rectangle to another. The post-task ratings of the importance of the various dimensions was also performed using the computer display.

The data set included each subject's demographics and experimental conditions. The mouse training data included the time needed for each of the moves. The decision data for each problem included the alternative chosen, the level of confidence, the exposure duration of each window, the sequence of viewing information, and ratings of the dimensions themselves. Viewing times (including times for reading the decisional problem) were measured in milliseconds.

Design. Two information conditions were tested:
(a) Initial Encouragement with later Discouragement **(E10/D30)**: In this condition subjects were told to expect 10 decisional problems in all, but immediately following the last problem they were told that they have to do 30 more. However, the task was terminated after the 20th problem, making the number of problems before and after the informational change identical.
(b) Initial Discouragement with later Encouragement **(D40/E10)**: In this condition subjects were told to expect 40 decisional problems, but after the 10th this was changed to 20, i.e., just 10 more.

Procedure. Considering the complexity of this study, and in order to facilitate its replication in the future, the procedure is presented in some detail. Subjects were run individually, and were allocated to groups so that each group included men and women in similar proportions. The two groups were run in parallel.

Upon entry of the subject the experimenter recorded the personal data: name, age, sex, telephone number, place of study, and subject number, as well as existing experience with mouse. Next, subject was told briefly how to deal with the mouse and the computer screens.

General Instructions:

"Your first task is decision making. The decision problems, as well as the instructions, the explanations, and training of the task will all be presented on the computer monitor. Your work on the decision problems and the move between the different screens will be done by using the left button of the mouse. Take Notice that throughout the task it will not be possible to cancel a hasty move by pushing the mouse button, and once you initiated the order to continue the task (by pressing the button), you will not be able to change your mind and go back to the previous screen. Therefore, make sure that you understand the procedures well. If there is something you don't understand prior to starting the task, do not hesitate to ask the experimenter any question that you might have. Once you have started working on the task itself, you will not be able to ask the experimenter any additional questions; so make sure that before you begin working you perfectly understand the decision-making task. Before proceeding, we would like you to exercise your control of the mouse. Press the left button in order to receive the instructions explaining the nature of the exercise."

Instructions for Mouse Control Exercise:

"With the start of the exercise, a display of rectangles similar to the one you will work with will appear on the screen. Most of the screen area will be occupied by 16 identical rectangles, one of which will be highlighted. Your task is to reach the highlighted rectangle with the cursor by moving the mouse. Once the cursor is within the boundaries of the highlighted rectangle, click the left button of the mouse. Once this is done, the light will "jump" to another rectangle. Move the cursor to the new highlighted rectangle and click the left button again. The light will "jump" again to another rectangle, and the process will repeat itself over and over again... This training will discontinue automatically once you have learned how to quickly move from one rectangle to another. If everything is understood, click the left button of the mouse to start the exercise. If not, turn to the experimenter for assistance."

Here the subject practiced until he/she performed on three non-consecutive trials in less than 1.5 seconds each. Then followed the instructions that explained the nature of the decision task, the structure of the problems and the characteristics of the dimensions values. Following two examples, the task began, with subjects in the E10/D30 and the D40/E10 groups receiving different information accordingly.

Instructions for Practicing the Decision-Making Task:

"Among the common decisions in the life of the average student are decisions such as - choosing a job, renting an apartment, choosing an academic course, and so on. Your task is to make this kind of decisions. In each decision-making problem you will be presented with 4 alternatives (4 job offers, 4 apartments, 4 courses...), and among those you will have to choose the alternative that you prefer. The alternatives differ from one another in terms of a number of characteristics (dimensions). For example -- in the decision problem containing a choice of a job, the first job offer includes a net salary of 3400 Shekels but the level of interest in the job is quite low, while in the second job offer the net salary is 2200 Shekels but the job is very interesting. There are many characteristics and factors involved in decision- making of this kind, but in the descriptions of the problem alternatives that will be presented only 4 of these characteristics/dimensions will be included. You should base your decision only on the characteristics mentioned. (If you are bothered by a characteristic that is not mentioned, you should assume that it has the same value for all of the alternatives). As in the example of choosing a job, each alternative has a value indicated by numbers such as 3400 or 2200 Shekels, or by words such as: quite small / very large... on each of the different dimensions. Each characteristic is described on an equal-interval, 5-point scale. The following scales will not be displayed in every decision-making problem, but for demonstration purposes, observe the scales contained in the problem of deciding between jobs:

Scale

Dimension	1	2	3	4	5
Opportunities for advancement	very limited	quite limited	medium	quite diverse	very diverse
Net salary	1000	1600	2200	2800	3400
Distance from home	very distant	somewhat distant	medium	somewhat close	very close
Level of interest	very low	quite low	medium	quite high	very high

Turn to the experimenter for additional explanation."

Here the experimenter explained the difference between the numerical and the verbal scales. Next, subject was given a printed paper with an example of a decision problem.

The following instructions were read:

"The decision problems will be presented on separate screens. Observe the sheet that is used for the demonstration display. On the top of the screen appears the serial number of the problem, which allows you to know the number of decisions already made. Underneath the serial number appears a short description of the decision problem. Under the description, 4 headings indicate the numbers of the choice alternatives. Each alternative is described by 4 information cells, arranged in a column underneath the heading of the alternative. Each cell contains the value of the alternative on a particular dimension. Every 4 cells on the horizontal lines refer to the dimension named to their right. The information cells are closed, and in order to observe the information which they contain you should bring the cursor within their boundaries using the mouse, and click the left button in order to open the cell and see the information. As in the practice exercise which you have preformed, once you move into a certain information cell and open it by pressing the button, the previous information cell will shut. Thus, you may observe only one cell at a time.

Upon presentation of the screen which contains a decision-making problem, read the description of the problem. Then start opening the information cells that interest you in order to choose the alternative that you prefer from among the 4 alternatives. You can decide to open or not open information cells, to open cells as many times as you wish, and to work in any order and speed that are convenient for you. After you have seen the information and reached a decision, bring the cursor within the field of the heading of the alternative which you have chosen, and click the left button. Following your choice the screen will change and you will be asked to indicate the level of confidence you have in your choice. You will do so by bringing the cursor to one of seven squares which indicate levels of confidence in the decision, the range being -- "absolutely unsure" to "absolutely sure". Once having clicked the left button of the mouse within the square that indicates your level of confidence, the screen will change and a new decision- making problem will appear.

Is everything clear? Do not hesitate to ask the experimenter any question right now or during the practice session. Remember, once you begin the task itself you will be unable to ask additional questions. To begin the practice session of the decision making task, click the left button of the mouse now."

At this point the instructions differed for the two groups, and they were both presented on the computer screen and verbally stressed by the experimenter. For group E10/D30 the specific instructions were:

"Is everything clear? In a moment we will begin the decision-making task. **Take notice, you have 10 decision-making problems**. Turn to the experimenter for further instructions."

For group D40/E10 they were:

"Is everything clear? In a moment we will begin the decision-making task. **Take notice, you have 40 decision making problems.** Turn to the experimenter for further instructions."

In order to control for sequence effects, each subject in each group was presented with a different order of the 20 problems. There were 20 different sequences, that changed between subjects by moving one problem from top to bottom so that each subject started with a different problem. Following the performance on the first 10 problems, each group was interrupted for further instructions that were repeated verbally. For group E10/D30 those were: "We have decided to lengthen the task. Instead of finishing now, you have 30 more decision-problems before the task will end. Click the left button of the mouse to continue."

For group D40/E10 they were:

"We have decided to shorten the task. Instead of 30 more decision problems, you have only 10 more, and then the task will end. Press the left lever of the mouse to continue." After finishing 20 items subjects proceeded to the ratings of the dimensions:

"In the decision making problems which you have just completed, the alternatives were described by a number of dimensions. These dimensions differ in their level of importance in relation to your final choice. Thus, for example - in the problem of choosing a refrigerator, price can be a very important factor in comparison to the other factors. Obviously, the relative importance of the various dimensions differs from one person to another, depending on his or her personal taste, financial means, etc. In the present task, the dimensions which characterized the different alternatives in the decision making problems will be displayed to you again, and your task is to rate their importance in affecting the decision you made. There is no such thing as "correct" rating, and we are interested in your opinion as to the importance of the various dimensions. Rate them according to their relative importance, from the most important dimension to the least important one. The most important should be ranked as 1, the second in its importance will be ranked as 2, the third as 3, and the least important as 4. Do not give the same rank to two different dimensions.

The rating will be done in the following way: The description of the decision problem will be presented on the screen, and underneath it a list of the characterizing dimensions. To the left of each dimension appear 4 numbered squares indicating the relative importance in reaching the decision: 1="the most important characteristic", 4="the least important characteristic". Choose the square which indicates the level of importance that you assign to the first characteristic, and highlight it by clicking the left button of the mouse. Having done that, go on and rank the rest of the characteristics. Keep in mind that the computer will not allow you to rate two characteristics with the same rank. As soon as you repeat a rank, the computer will regard this as if you have changed your mind, and it will cancel the previous identical rank. You may change your mind as long as you haven't clicked the "O.K." square. The sign "O.K." signals the computer that you have finished the ratings and that it should present you with the next problem. You should realize that once you have signaled "O.K." you will unable to go back and change the rating. If anything is not clear, turn to the experimenter at any time. Now click the mouse to start the rating task."

Subjects were also told verbally that they should rate according to the importance they assigned each dimension during the decision-making task, and then rated the dimensions of the 20 problems. To facilitate recall, the items were presented in the same order as during the decision making task. Following the rating task subjects answered several questions about their performance and then were seated in another room, filled in the 6 personality inventories, were paid for participation, and signed a promise not to talk about the details of the experiment.

RESULTS.

Description of output data. The computer output data for each subject included demographic information, previous experience with the mouse, registration of the time taken by each move during the mouse training period, and registration of the time the subject spent on each segment of the instructions. The main search measures for each of the 20 problems and 2 training examples included type of each window viewed, viewing duration, information search sequence, final decision, confidence level, and rating of dimensions.

Table 10 shows two examples of the output data produced during a single trial by two subjects, number 502 (group E10/D30) and number 603 (group D40/E10). The information from left to right indicates:

a - type of decision made
b - confidence level
c - the time it took to observe a certain window (in sec)
d - number of the specific window that was opened (1-16 possible windows). The pattern of windows in relation to the display is:

	alternative	4	3	2	1
dimension	1	1	2	3	4
	2	5	6	7	8
	3	9	10	11	12
	4	13	14	15	16

e - number of the specific problem
f - subject number
g - number of problem with which the subject started
h - cumulative number of the window
i - number of trial

The last line indicates reading time of the instructions.

As can be seen in Table 10, the strategy of subject 502 (group E10/D30) on this particular trial is, at the beginning, to move from one window to another horizontally, a pattern that is compatible with processing according to dimensions. Then there is a mixture of information processing by alternatives and by dimensions. There are also several repetitions of observations of informational items. This subject observed all information before making a choice, and made a total of 35 moves. Alternative 1 was finally chosen, and as can be seen in the output, the subject observed all the information available for this alternative (windows 27-30), then observed all information available for alternative 2, finally looking at window 8, the last one of the chosen alternative 1, before making a choice.

<u>Table 10. Output data of subjects 502 and 603.</u>

Subject 502 [trial 4(part A)]

a	b	c	d	e	f	g	h	i*
1	6	1.3644	4	6	502	3	1	4
1	6	2.5766	3	6	502	3	2	4
1	6	2.3325	2	6	502	3	3	4
1	6	3.8083	1	6	502	3	4	4
1	6	1.1244	8	6	502	3	5	4
1	6	2.6920	7	6	502	3	6	4
1	6	2.0508	6	6	502	3	7	4
1	6	2.0581	5	6	502	3	8	4
1	6	1.6998	1	6	502	3	9	4
1	6	2.6556	5	6	502	3	10	4
1	6	1.8719	9	6	502	3	11	4
1	6	1.2194	10	6	502	3	12	4
1	6	0.9774	11	6	502	3	13	4
1	6	3.4121	12	6	502	3	14	4
1	6	1.2462	16	6	502	3	15	4
1	6	1.1069	15	6	502	3	16	4
1	6	1.6548	14	6	502	3	17	4
1	6	4.2252	13	6	502	3	18	4
1	6	1.2576	9	6	502	3	19	4
1	6	2.8624	5	6	502	3	20	4
1	6	3.3427	1	6	502	3	21	4
1	6	1.1547	2	6	502	3	22	4
1	6	2.0264	6	6	502	3	23	4
1	6	7.3105	10	6	502	3	24	4
1	6	1.9642	9	6	502	3	25	4
1	6	1.3414	11	6	502	3	26	4
1	6	1.4937	12	6	502	3	27	4
1	6	3.7165	8	6	502	3	28	4
1	6	2.2132	4	6	502	3	29	4
1	6	1.7779	16	6	502	3	30	4
1	6	1.6358	15	6	502	3	31	4
1	6	2.8746	11	6	502	3	32	4
1	6	1.2780	7	6	502	3	33	4

```
1 6   1.0752 3 6 502 3 34 4
1 6   7.3989 8 6 502 3 35 4
1 6  12.2409 0 6 502 3 0 4

    subject 603 [trial 12(part B)]
2 6   2.5295 8 15 603 4 1 12
2 6   1.0794 7 15 603 4 2 12
2 6   1.0214 6 15 603 4 3 12
2 6   2.2774 5 15 603 4 4 12
2 6   1.8783 1 15 603 4 5 12
2 6   2.6699 3 15 603 4 6 12
2 6   1.6932 11 15 603 4 7 12
2 6   2.4219 9 15 603 4 8 12
2 6   2.6758 15 15 603 4 9 12
2 6   2.6211 13 15 603 4 10 12
2 6  11.9702 0 15 603 4 0 12
*see text for description of each code
```

Subject 603 (group D40/E10) also uses a dimensional processing, but of a different nature. This subject starts with looking at a certain dimension, and then compares two alternatives only (2 and 4) on the rest of the dimensions, before choosing alternative 2. There are no repetitions, and actually 6 informational items are not observed at all before making a choice.

Table 10 demonstrates the complexity of the data. It suggests that information processing preceding a choice may prove to be quite consistent, and that the moves subjects make may to some degree simulate the types of cognitive processes involved in this type of decision making.

<u>Control measures</u>.

<u>Demographics</u>: The proportion of men and women in each of the two information groups was identical, and they did not differ significantly on prior experience with the mouse. (yes/no answers, Chi-square<1.10). The two groups differed somewhat on age (M=23.8 and 22.6 for the E10/D30 and D40/E10 groups, respectively, t= 2.32, p<.05).

<u>Mouse training</u>: Each subject completed a different number of steps in the mouse training period. Two measures were computed: the number of moves needed to reach the criterion, and the average time needed to move from one rectangle to another over all moves. Number of moves was between 3 and 146, suggesting large differences between subjects on mouse experience, but no significant differences were observed between the two groups on the number of moves needed to reach the criterion (M=31.80 and 36.00 for groups E10/D30 and D40/E10, respectively, t<1), and the same non-significant results were observed for average time (M=2.10 and 1.99 sec, respectively, t<1), as well as for log-transformed time (t<1). Thus, the two groups did not differ on mouse training measures.

Descriptive statistics.

As described in the Method section, on each trial subjects could open as many windows as they wished, as many times as they wished, and observe each item of information contained in each window for as long as they wished. Subjects made between 2 through 71 window viewings per trial before making a choice, with a mean of 21.02, which is higher than 16, the maximal number of different windows. Thus, on the average, subjects repeated some of the observations at least once. The possible number of repetitions over trials was between 1 and 8 (indeed, one subject repeated the viewing of the same item eight times!), with a mean of 1.24. The range of observation times was between 0.27 and 45.27 sec, with mean observation time of 2.37.

Types of measures.

The data provided several different types of measures: (a) **Depth measures**, which tap the amount of information processed, sometimes relying on its formal characteristics (i.e., dimensions or alternatives), but without relation to its specific content, (b) **Order measures**, that include strategic and pattern variance measures, and tap the patterns observed in information processing, again without relation to its specific content, (c) **Decision making and confidence level measures**, related to the type of decision made, and (d) **Content measures**, which take into account information processing of specific contents, and explore the association between information processing and decision making.

Depth measures.

As described above, these involve the extent of information processing without content specification, and are based on time and frequency of observations of each item of information on each trial.

Three types of depth measures were analyzed: micro measures, macro measures, and global measures.

Micro measures: These are the measures that are based on analyzing information pertaining to individual windows or to their combinations. The following frequency measures were analyzed:

(a) Number of 16-window observations - for each subject and each trial, the overall number of the different windows that were observed was counted. Then each trial was given a score of 1 if all 16 different windows were opened at least once, and 0 otherwise. This measure indicates whether or not all information was observed on the specific trial.

Figure 1 depicts the proportions of subjects in groups E10/D30 and D40/E10 that opened all 16 different windows as a function of trial and part. As can be seen in the figure, **Group E10/D30, the group that started with information on relatively few decision problems, has a higher proportion of observations of all 16 windows than group D40/E10, especially on part A,** and the same but weaker trend is observed on part B. A two-way, Group X Part Analysis of Variance (ANOVA), revealed a significant effect for Group [F(1,58)=5.82, p=.02], with means of 0.49 and 0.30 for groups E10/D30 and D40/E10, respectively. The effect for Part was also significant [F(1,58)=5.56, p=.02], indicating that **the level of observing the entire information was higher (M=0.42) on the first than on the second part (M=0.36).** The interaction was not significant (F<1.47).

(b) Number of unopened windows - this number reflects the amount of missing information on each trial. In contrast with the first measure, it shows the extent of information that was neglected. For each trial, its range was between 0 and 14, so that at least two informational items were always observed before making a choice. Figure 2 describes the mean number of unopened windows according to Trial, Part and Group. As can be seen in the figure, **Group D40/E10 had more unopened windows than group E10/D30 at the beginning of the task**, and the same, but weaker trend, is observed in part B. A two-way, Group X Part ANOVA, revealed a marginally significant effect for group [F(1,58)=3.80, p<.06; M=2.35 and 3.62 for groups E10/D30 and D40/E10, respectively], and a significant effect for part [F(1,58)=6.82, p=.01; M=2.77 and 3.20 for parts A and B, respectively], with no interaction [F(1,58)=2.53, p>.10]. Figure 2 indeed shows that on part B the E10/D30 group views less windows than on part A (M=2.00 and 2.70, respectively), while group D40/E10 shows the same trend but weaker, over the two parts (M=3.54 and 3.71, respectively). (c) Repetitions - Since subjects could repeat any observation at will, we looked at the average number of repetitions made on each trial. The effect of group was the only significant effect in this analysis [F(1,58)=6.19, p=.02; M=9.70 and 6.16 for groups E10/D30 and D40/E10, respectively]. The group effect was weaker for the average number of all levels of repetitions (range 1-8; M=1.26 and 1.17 for groups E10/D30 and D40/E10, respectively, F(1,56)=3.52, p<.07; other Fs<1; the repetition variance was also checked, with no significant effects].

When the number of first repetitions, that is, how many windows were observed for the second time, were analyzed, a two-way ANOVA revealed a significant effect for group [F(1,58)=8.68, p<.005] as well as an interaction effect [F(1,58)=5.06, p<.05]. The means were 6.94 and 6.10 for parts A and B, respectively, in group E10/D30, and 4.16 and 4.37, respectively, for group D40/E10. Thus, subjects in the first group observed more windows twice, and viewing the same information twice was affected in both groups in a reversed manner, in aline with the information manipulation. The effect of group was also significant for the analysis of second repetitions [third viewing of windows, F(1,58)=5.13, p<.05, M=2.59 and 1.30, for group E10/D30 and D40/E10, respectively].

Thus, when subjects expect fewer decision problems, they make more repetitions on informational items than subjects expecting many decision problems. Considering the fact that it is practically impossible to memorize the contents and location of all 16 windows in a single trial, serious consideration of that information requires repetition to take place. It follows that higher frequency of repetitions indicates a more thorough information processing pattern.

To inquire further into the repetition pattern, we looked at the number of windows viewed prior to the first repetition. No significant effects were observed, while as reported above, the number of total windows observed at least once (the complement of the number of unopened windows) was greater in group E10/D30. This means that subjects in this group continued to look at new information after looking again at least once at an already observed window.

Analyzing the number of trials on which subjects looked at all 16 windows in sequence, without any repetitions, the effects of group [$F(1,58)=3.95$, $p<.05$), and part [$F(1,58)=3.99$, $p<.05$], were significant. **Thus, group E10/D30 made more full 16 windows observations with no repetitions than group D40/E10 (M= 0.137 and 0.070, respectively), suggesting a more systematic approach to the problem.** Furthermore, this type of processing was more frequent during the first rather than the second part (M= 0.122 and 0.085, respectively).

It should be noted that when the above analyses were repeated using blocks of 5 trials within each part, the effects were similar.

<u>Time variables</u>. Since the time data contained several very long observations, the time score for each window viewing was log-transformed. The following analyses were all carried out using the log-transformed scores, while group averages are given in their original scale (i.e., seconds).

(a) <u>Mean viewing time per window</u> - A two-way, Group X Part ANOVA applied to the average time per window showed no group or interaction effects ($F<1.25$), but a significant effect was obtained for part [($F(1,58)=50.81$, $p<.0001$]. For both groups, average time spent on each window decreased from the first to the second part (M=2.42 and 2.13 seconds for the first and second part, respectively for group E10/D30, 2.58 and 2.35 seconds for group E40/D10).

Since subjects repeated their observations of at least one window on over 80% of the trials, we looked at the time spent on each window when it was first observed, with similar results. The average time spent on first repetitions (the second observation of the windows) showed, again, the same results [$F(1,58)=21.03$, $p=.0001$, for part, no other effects], and the second repetition a similar trend, as well as the average time spent over all repetitions [$F(1,56)= 22.95$, $p<.0001$ for part, no other effects].

(b) When viewing time was averaged for each window prior to calculating the overall mean, in addition to the effect of part [$F(1,58)=34.82$, $p<.0001$], **a significant interaction effect**

[F(1,58)=4.09, p<.05] was observed. As can be seen in Figure 3, subjects in the E10/D30 group started with allocating a relatively overall longer time to each specific informational item during Part A (M=4.06), which decreased in part B (M=3.50), while the difference in group D40/E10 was smaller (M=3.61 and 3.32, respectively).

No group or interaction effects were observed when we analyzed the total time allocated to first observations only, but when we looked at the **total time allocated to first repetitions (i.e., second observations of the windows), the effects were significant for both Group F(1,58)=8.08, p<.01, and Group X Part interaction, F(1,56)=5.80, p<.05.** Group E10/D30 showed averages of 17.69 and 14.75 for parts A and B respectively, while the means for Group D40/E10 essentially did not change (11.60 and 11.83). [It should be recalled that this effect depends on the number of repetitions made after initially viewing the information contained in the windows].

When the above time analyses were repeated without the last-observation time, and without both last and first observation times, the same results were obtained.

We also analyzed the time it took to view the first window, the last window, and the differences between them. No effects were obtained for either groups or the interactions between group and part. The correlations between viewing times and the serial number of these windows were found to be very low, discounting a simple alternative explanation based purely on notions of training and experience.

(c) Time variance - An significant interaction effect was observed for the time variance. For each trial we computed the variance of the observation times, and analyzed this measures in a two-way ANOVA. The effect of group was significant [F(1,58)=3.88, p=.05], as well as the double interaction [F(1,58)=8.84, p<.005]. Thus, the mean time variance of subjects in group E10/D30 decreased from the first to the second part [M=3.61 and 2.94, respectively, while for group D40/E10, the effect was reversed (M=4.06 and 4.86, respectively). Thus, **the effect of the information manipulation was to change the uniformity of processing between the first and second parts in accordance with the expectation of few or many problems.**

Correlations between measures over trials. The main depth measures analyzed were the mean number of unopened windows, the number of times all 16 windows were observed, the average time per window (mean time), time variance, and the total number of windows opened (including repetitions). Table 11 presents the correlations between these measures according to Group and Part.

Table 11: Correlations between micro measures.

	16 window observation	mean time	time variance	total number observation
Group E10/D30, part A				
Unopened windows	-.82***	.19	.00	-.84***
16 windows viewed		-.07	.02	.77***
Mean time			.23	-.23
Time variance				.02
Group E10/D30, part B				
Unopened windows	-.79***	.02	-.14	-.84***
16 windows viewed		-.05	.21	.76***
Mean time			.38*	.07
Time variance				.23
Group D40/E10, part A				
Unopened windows	-.85***	.43*	.43*	-.81***
16 windows viewed		-.31	-.17	.79***
Mean time			.20	-.39*
Time variance				-.18
Group D40/E10, part B				
Unopened windows	-.80***	.51**	.53*	-.90***
16 window viewed		-.24	-.36*	.84***
Mean time			.48**	-.32
Time variance				-.40*

Note: *** $p < .001$ ** $p < .01$ * $p < .05$

As can be seen in Table 11, the associations between frequency measures, i.e., total number of observations, number of unopened windows, and 16-window observations are consistently high and in the same direction for groups and parts. The time measures, however, show no relationships with the frequency measures for group E10/D30, while in group D40/E10, there are several significant associations.

Macro measures.

These consist of measures that are based on analyzing the two main types of categories relevant to the decision making task, i.e., **dimensions and alternatives.**

(1) Observations of whole dimensions or alternatives. These measures were based on counts of the number of dimensions (or alternatives) all of which windows were opened during a specific trial, but not necessarily in

consecutive steps. A two-way, Group x Part ANOVA showed a significant effect for the whole dimension measure for group, [F(1,58)=4.45, p<.05], with **group E10/D30 observing a larger number of whole dimensions than group D40/E10 (M=2.88 and 2.41, respectively).** The effect of part was marginal [F(1,58)=3.76, p<.06], with subjects observing a larger number of whole dimensions during the first as compared with the second part of the experiment (M=2.71 and 2.58, respectively). No interaction effect was observed.

The whole alternative measure was also analyzed in a two-way ANOVA with similar results [F(1,58)=6.27, p<.05 for group, F(1,58)= 7.27, p<.01 for part, no interaction]. Thus, **subjects in group E10/D30 also observed more whole alternatives than those in group D40/E10 [M=2.89 and 2.24, respectively), and more whole alternatives were observed during the first (M=2.66) than during the second part (M=2.47).** Thus, not only did Group E10/D30 made many more observations than group D40/E10 (see the first section), but they were also more systematic.

The total time each whole dimension or whole alternative were observed showed significant effects for group, and parts, in the same direction as the count measures. Thus, Group E10/D30 observed both full dimensions and full alternatives for overall longer periods of time than group D40/E10.

(2) <u>Consecutive within dimension/alternative moves</u>. The second type of measures took into account the number of window scans done before or following any observation of another window in the same dimension, or the same alternative. A two-way ANOVA applied to the dimension scan measure showed a significant group effect only [F(1,58)=4.68, p<.05], with **Group E10/D30 making more such scans than group D40/E10** (M=16.49 and 13.32, respectively). The alternative scan measure showed a marginal effect for group [F(1,58)=3.58, p<.07], with group E10/D30 making more such scans than group D40/E10 (M=11.25 and 8.36, respectively), a significant effect for Part [F(1,58)=10.96, p<.01], with means of 10.66 and 8.95
for parts A and B, respectively), and no interaction effect.

Thus, overall, there were relatively more alternative scans and less dimensional scans during the first part of the experiment, and the reverse is observed during the second part, suggesting **a change from an alternative to a dimensional type of processing.**

(3) <u>Intra-dimensional and intra-alternative moves</u>. The numbers of intra-dimensional or intra-alternative moves are the total numbers of moves subjects made within dimensions or alternatives, respectively. The number of dimensional moves calculated showed a significant effect for Group [F(1,58)=4.82, p<.05; M=11.65 and 9.26 for groups E10/D30 and D40/E10, respectively), indicating that **encouraging information was conducive to dimensional processing.**

The number of intra-alternative moves showed a Part effect [F(1,58)=10.69, p<.01; M=7.37 and 6.06 for parts A and B, respectively], and no interaction. Thus, **dimensional processing was elevated during the second part of the experiment.** It can be also seen that the number of moves within dimensions was higher overall than the number of moves within alternatives in both groups ($t=5.44$, $p<.0001$ for the sum scores, $t=3.91$, $p<.001$ for the averaged scores).

(4) Correlations with depth measures. The main macro measures, i.e.: number of intra-dimensional and intra-alternative moves, and the difference between them were intercorrelated with the main micro measures. The results are presented in Table 12.

Table 12: Correlations between micro and macro measures according to Group and Part.

	intra-dim. moves	intra-alt. moves	dim-alt diff
	Group E10/D30, part A		
total num obs	.71***	.70***	.00
unopened win	-.52**	-.62***	.08
16 window obs	.43*	.61***	-.13
total time	.47**	.82***	-.26
mean time	-.53**	.19	-.51**
	Group E10/D30, part B		
total num obs	.84***	.79***	.10
unopened win	-.72***	-.61***	-.15
16 window obs	.63***	.52**	-.14
total time	.76***	.80***	-.03
mean time	-.08	.21	-.25
	Group D40/E10, part A		
total num obs	.67***	.76***	-.14
unopened win	-.44*	-.67***	.23
16 window obs	.27	.82***	-.45**
total time	.46**	.84***	-.34
mean time	-.55**	-.04	-.33
	Group D40/E10, part B		
total num obs	.82***	.80***	.03
unopened win	-.75***	-.71***	-.04
16 window obs	.58***	.80***	-.18
total time	.74***	.83***	-.06
mean time	-.42*	-.09	-.29

Note: *** $p < .001$ ** $p < .01$ * $p < .05$

It is interesting to note, that subjects who used more dimensional than alternative processing were, on average, faster in information processing on the micro level.

Global measures.

(a) Whole problem analyses - The total time and number of observations made on each trial were analyzed. The total number of observations showed a significant effect for Group [F(1,58)=6.11, p<.05], with means of 23.35 and 18.53 for groups E10/D30 and D40/E10, respectively.

Total time showed significant effects for Group [F(1,58)=5.04, p<.05], part [F(1,58)=13.93, p<.001], and a marginal interaction [F(1,58)=2.90, p<.10]. Subjects in group E10/D30 showed means of 57.80 and 48.50 for parts A and B, respectively, while subjects in group D40/E10 showed means of 45.88 and 41.79, respectively.

(b) Order: Strategic and pattern variance measures - In order to assess strategic effects, the data were first defined according to various types of dimensional or alternative moves: For each trial, whole sequences that included within dimensional and alternative move sequences were computed. Sequences of processing according to dimensions and alternatives were marked separately. There were many sequences of various types (see the following section) and therefore the data were analyzed according to several main types of strategies:

Full-dimensional and full-alternative strategies. A full-dimensional strategy was defined by a sequential inspection of the four dimensions, each dimension fully observed before turning to another. The proportion of trials in which subjects used this strategy, including the within-alternative moves necessary to transfer from one dimension to another, and also counting cases in which subjects inspected a whole alternative just before making a choice, but deleting repetitions and sequences in which repetitions appeared, was analyzed in a two-way, Group x Part ANOVA. The effect of group was marginal [F(1,58)=3.01, p=.09), with no main effect or interaction with part. Group E10/D30 tended to make more such dimensional processing (M=0.14) than group D40/E10 (M=0.07). The results were identical when we deleted the trials which included the within-alternative moves (leaving those in which the transfer from one dimension to another was done in a diagonal fashion; this is a purer definition of dimensional strategy since the moves among alternatives between dimensions can be done also in order to inspect the alternatives themselves), and no additional effects were found when we compared blocks of 5 trials in each part.

The full-alternative strategy was defined by a sequential inspection of the four alternatives, each alternative fully observed before turning to another. The proportion of trials in which subjects used this strategy, including the within-dimension moves necessary to transfer from one dimension to another, but deleting repetitions and sequences in which repetitions appeared, was analyzed in a two-way, Group x Part ANOVA. **Only the effect of part was significant in this analysis [F(1,58)=6.38, p<.05; M=0.032 and 0.003 for parts A and B,**

respectively). The results were identical when only the trials with diagonal moves were counted, and no additional effects were found when we compared blocks of 5 trials in each part, except for a main block effect [$F(1,58)=4.34$, $p<.05$; M= 0.027 and 0.008 for first and second block, respectively].

The above results suggest that subjects tend to use more dimensional type of strategy. To further test this idea, we also analyzed the strategy subjects used in the first four windows observed in each trial. The number of repetitions for these four observations was very low (30, which constitute about 2.5% of the trials) and trials with repetitions were therefore deleted. We then looked at the number of times a whole dimension or a whole alternative were observed at this initial processing. A two-way, Group x Part ANOVA, revealed a significant effect for part for either the dimensional measure [$F(1,58)=10.07$, $p<.01$], or the alternative measure [$F(1,58)=8.85$, $p<.01$], with no effects for group or its interactions with part (all F's<1). The means for the dimensional measure were 0.79 and 0.87 for parts A and B, respectively, while for the alternative measure they were 0.15 and 0.07, respectively. Thus, in most trials subjects were consistent, usually starting with a dimensional processing strategy, and this type of processing became more frequent in the second part of the experiment, while alternative processing became less frequent with trials.

<u>Pattern variance</u>. The raw data suggested that subjects employed numerous search patterns. Therefore, we tried various ways of measuring the number of versions subjects used in each part. Two main indexes were analyzed: (1) The number of different patterns, each pattern (or each trial) including differentiating indicators for each start of alternative or dimensional sequence, and discriminating between whole or partial alternative or dimensional observation, without taking into account repetitions. No effects were found for the Group x Part ANOVA applied to this measure.

A variation on this measure, that took repetitions into account but deleted one-move steps, between either alternatives or dimensions (in order to eliminate moves that transfer from one dimension to another, or from one alternative to another), and did not differentiate between whole and partial processing, showed **a significant effect for Group [$F(1,58)=4.68$, $p<.05$], with averages of 8.78 and 7.87 for group E10/D30 and D40/E10, respectively.**

(2) Another measure of variability was the number of times subjects changed from alternative to dimensional processing and vice versa within a trial. When the maximal number of such changes was counted, based on the patterns including differentiating indicators for each start of alternative or dimensional move, and discriminating between whole and partial observations of each alternative or dimensions, taking repetitions into account, **the effect of Group was significant [$F(1,58)=4.64$, $p<.05$]**, with no part effect ($F<1$), but a tendency towards a Group x Part interaction [$F(1,58)=3.32$, $p<.08$]. The

means were 8.69 and 7.98 for parts A and B in group E10/D30, while the respective means of group D40/E10 were 6.62 and 6.84. Thus, group E10/D30 patterns of observations were longer. This effect disappeared when the scores were divided by the number of windows opened. Other variations on this type of measure showed similar effects.

Decision making and confidence level.

Subjects choices were mainly assessed according to two types of choices: 1) Following the compensatory model, subjects should choose, in each problem, the alternative with the highest overall value. As already suggested, the typical compensatory strategy is exemplified by the "linear compensatory" or additive model: Each alternative acquires an overall value, arrived at by summing over its weighted values, i.e., Value of alternative = sum of (relative weight x scale value) of all dimensions.

In the present research, each dimension was assigned a unique weight by the subjects (1-4), and had a specific value for each alternative (1-5). Thus, the overall value of each alternative could be computed, and compared with subjects' choices. If, for example, an alternative was assigned the values 1, 5, 3, 1 (where 1 is very low and 5 - very high) on the 4 dimensions of the problem, rated 1-4 (from the least important to the most important, respectively), its overall value was 1x1 + 5x2 + 3x3 + 1x4 = 24.

2) In addition, subjects choices could be analyzed according to whether or not they represented unidimensional strategy. The "optimal" choice according to this kind of strategies is to choose the alternative with the highest value on the most important dimension.

Inspection of the data revealed that there were cases in which one alternative was highest on both overall value as well as on the value it possessed on the most important dimension as rated by the subject. Therefore, choices were initially analyzed according to four different criterions: (1) "best" choices - choosing the alternative which was highest on both the overall value as well as on the value it possessed on the most important dimension (2) "unidimensional" choices" - choosing the alternative that was highest on the most important dimension, but not highest on its overall value, (3) "compensatory" choices - choosing the alternative with the highest overall value but not the highest on the most important dimension, and (4) "error" choices - the choice was not compatible with either of the three above mentioned criteria.

The results were analyzed using two-way, Group x Part ANOVAs. The means indicated a relatively high level of compensatory choices (M = 0.56 and 0.53 for groups E10/D30 and D40/E10, respectively), as well as best choices (M = 0.27 for both groups), with very few unidimensional choices (M = 0.05 for each group) and a relatively low level of "errors" (M = 0.13 and

0.15, respectively). There were no significant effects for group, or group x part interactions, on either of the decision criterions, suggesting that **the information manipulation did not affect decision making**. The effect of part was significant for the best choices only [$F(1,58) = 4.49$, $p < .05$] with a weaker trend observed on part B when compared to part A ($M = 0.24$ and 0.29, respectively). This effect, however, could have been the result of the existence of a higher proportion of this kind of choice options in the second part.

Since no effects were found for the above criteria, we analyzed choices according to choosing the highest, medium high, medium low and lowest alternative according to the compensatory criterion, but no effects were found. In addition, defining choices according to the least important dimension did not show significant effects.

The correlations between choice measures were consistent across groups and parts: In all cases except one, the correlations between proportion of compensatory choices and either the best, unidimensional, or error choices were negative ($p < .05$), while the last three types of choices were not highly correlated among themselves (all ps' $> .05$).

Confidence level average was very high overall ($M=6.06$), and did not show any group or part effects.

Content measures.

The results so far suggest that the effect of the manipulation is evident in information processing measures that reflect quantity in processing, namely, subjects who expect few decision problems make more repetitions on observational items, and observe each different item for longer periods of time. Type of choices, in contrast, did not show significant effects. The following measures combine information processing measures and the content of the decision problem as well as final choice:

(a) Dimension importance and information processing. The first analysis was carried out in relation to the dimensions of each problem. We used subjects' ratings to determine which dimension was more important and which was less important (ratings of 1-4), and computed the correlation, in each trial, between these ratings and the total number of intra-dimensional moves made on each dimension. Mean correlation over trials was 0.26, but no differences were observed for groups, parts, or their interaction. The overall time spent on each dimension likewise did not reveal any significant effects.

(b) Alternative importance and information processing. The same type of measures as described above were used for alternatives. We first computed for each alternative its total value [see above - the overall sum of the multiplication of each dimension rating (i.e., weight), with the value it obtained on the specific alternative], and looked at the correlation, within each trial, between alternative values and number of intra-alternative moves. Although no effects were found in a Group X Part ANOVA, the average correlation over trials was 0.41, suggesting that **attractive alternatives were observed more frequently than non-attractive ones.**

The correlation of compensatory level with the time measure for alternative processing, shows a marginally significant effect for Group [$F(1,58)=3.42$, $p<.07$], with means of 0.44 and 0.39, for group E10/D30 and D40/E10, respectively. Thus, group E10/D30 showed a somewhat higher correlation than group D40/E10.

(c) Choice and information processing. To find more about the relationship between information processing and choice, the above viewing data for each trial were analyzed according to the difference between the chosen and unchosen alternatives on the number of moves and total time allocated to each. Number of moves showed no significant effects, but the time data showed a significant effect for part [$F(1,58)=4.31$, $p<.05$]. Thus, the chosen alternative was inspected for a longer time on the first rather than the second part of the study (M=18.79 and 16.13, respectively), as well as the unchosen ones (M=11.02 and 9.67, respectively). **In both parts subjects made more moves along the chosen rather than the unchosen alternatives ($t=16.04$, $p<.0001$), and observed longer the chosen alternative ($t= 19.22$, $p<.0001$).**

(d) Correlations between depth, content and choice measures over trials, for each group and part. Table 13 presents the correlations between depth micro measures and choice types: Compensatory (comp), unidimensional (unidim), error, and best choice.

Table 13: Correlations between micro measures and choice types.

	unopened windows	16 window observation	mean time	time variance	total num observ	conf level
Group E10/D30, part A						
comp choice	-.10	.07	.22	.53**	.09	-.24
unidim choice	.46**	-.31	-.11	-.34	-.32	.25
error choice	-.22	.17	-.01	-.23	.24	-.14
best choice	.07	-.07	-.22	-.31	-.14	.29
conf level	.18	-.31	-.04	-.16	-.09	

Group E10/D30, part B

comp choice	-.19	-.03	.08	-.22	.17	.10
unidim choice	.35	.05	-.02	.02	-.12	-.33
error choice	.23	-.13	.25	.25	-.31	-.16
best choice	-.21	.14	-.34	.02	.18	.24
conf level	.12	-.20	-.27	-.22	-.04	

Group D40/E10, part A

comp choice	-.22	.26	-.41*	-.29	.34	-.08
unidim choice	.07	-.10	.06	.02	-.14	-.31
error choice	.10	-.07	.27	.37*	-.21	.10
best choice	.13	-.19	.23	.04	-.16	.16
conf level	.01	.07	.31	.03	.08	

Group D40/E10, part B

comp choice	-.16	.13	-.11	-.26	.22	.37*
unidim choice	-.00	-.05	-.10	-.14	-.12	-.04
error choice	.15	-.06	.02	.25	-.19	-.55*
best choice	.08	-.09	.21	.22	-.06	.06
conf level	-.08	.02	.09	-.07	.03	

Note: ***p< .001 ** p<.01 * p<.05

As can be seen from Table 13, the correlations are usually low and no consistent pattern emerges. We next computed the correlations between choices and the main macro measures, which did not reveal any consistent results. However, the correlations between micro measures and the assessments of associations between contents and information processing, as well as choice types, suggested that **subjects who observed less information (on most measures), differentiated between important and unimportant dimensions, as indicated by the moves they made along these dimensions.**

Demographic variables and experimental measures.

The main demographic data analyzed were sex of subject, age (subjects divided into younger and older students according to the median -- 23), and prior experience with the mouse. These three variables were used each as the third factor in three-way ANOVAs for unequal ns', including group and part. The E10/D30 and D40/E10 groups did not differ significantly on the proportions of men/women, younger/older, or experienced/inexperienced subjects (Chi-square tests, $p>.10$). Mean age did not differ among men and women, nor was it related to experience with the mouse, but women reported on less experience with the mouse than men (Chi-square=13.07, $p=.0001$).

Experience with the mouse showed a significant main effect for mean time [$F(1,56)=18.28$, $p=.0001$; $M=2.62$ and 2.13, for those without and with experience, respectively], and the same was found for mean time of repetitions [$F(1,56)=8.57$, $p=.005$; $M=2.66$ and 2.22, respectively]. Mean time alone showed an Experience x Part interaction [$F(1,56)=4.28$, $p<.05$]. Thus, those with mouse experience performed faster, overall, but the effect was stronger in the first ($M=2.21$ and 2.79, respectively) rather than the second part of the experiment ($M=2.04$ and 2.44, respectively).

Since none of the variables interacted with Groups, this precludes confounding of group effects with demographic effects on the above micro measures.

Personality measures and experimental measures.

Psychometric data. The means, medians, standard deviations, ranges, and Alpha reliabilities for the six personality inventories used in the present experiment are presented in Table 14, and the inter-correlations in Table 15. Four of the measures -- Locus of Control (LOC), Maudsley Obsessional-Compulsive Inventory (MOC), Barratt Impulsiveness Scale (BIS), and Social Desirability (SD) are based on the whole item set; the Type A Behavior Pattern (TABP) is based on the 21 items used to assess Type A behavior, and the Intolerance Of Ambiguity (IOA) is based only on 12 items, after deleting the four from the original set that caused its reliability to be too low.

Table 14: Psychometric data for the personality measures.

	Mean	Standard Deviation	Median	Range	Alpha
LOC	36.28	4.32	36.5	27-46	.77
MOC	53.00	4.73	54	38-60	.81
IOA*	37.82	7.52	38	22-58	.51
BIS	112.97	12.21	114.5	84-135	.77
TABP	6.95	3.23	7	1-14	.67
SD	15.92	4.65	15	9-27	.71

* Based on 12 items, see text. The correlation with the 16-item score was .90.

Table 15: Intercorrelations between personality variables.

	LOC	MOC	IOA	BIS	TABP
MOC	.11				
IOA	-.03	-.11			
BIS	.08	-.08	-.38**		
TABP	.18	-.00	-.18	.38**	
SD	.24	.01	.18	-.31*	.05

*$p < .05$ **$p < .01$

As can be seen in Table 14, the Alpha reliabilities are satisfactory and in addition, most of the measures show an acceptable range of scores, with means and medians that are similar.

Personality inventories and micro measures.

The two experimental groups were compared on all six personality measures, with no significant differences observed on any of them in t-tests ($p > .10$), or Chi-square tests after dividing each personality measure according to the median. ($p > .10$) The relationship between personality measures and the experimental output was analyzed using three-way ANOVAs for unequal ns', after dividing each personality measure at the median. In light of the numerous analyzes applied to the data, marginal results ($p > .05 - < .10$) are not reported.

TABP main effect was significant for the proportion of trials in which all windows were opened [$F(1,56)=5.26$, $p < .05$], and for the total time allocated to the viewing of pre-decisional information, [$F(1,56)=6.39$, $p = .01$]. Thus, **Type A subjects observed less information than Type Bs (M=.29 and .46, respectively), and allocated less time for the observation of information (M=40.88 and 53.57, respectively).** In addition, the TABP x Group x Part was also significant for the time variance [$F(1,56)=6.22$, $p < .02$]. The means were, for Type As, in group E10/D30, 3.33 and 1.76 for parts A and B, respectively, and in group D40/E10, 3.87 and 4.00, respectively. The respective means for Type Bs were 3.82, 3.83, 4.17 and 5.36. Thus, **Type As time variance changed with the information manipulation mainly in group E10/D30 while Type Bs time variance changed more in group D40/E10.** This may suggest that Type A subjects are more sensitive to discouraging change, whereas Type Bs respond more to encouragement. No effects were observed for the choice measures.

The IOA interaction with Group and Part was significant for the proportion of trials on which all 16 windows were opened, total observation time, time variance, number of repetitions, and total number of observations [F(1,56)= 5.50, 8.15, 4.24, 4.58, and 5.59, respectively, p<.05]. In addition, the triple interaction was also significant for the compensatory choices [F(1,56)=4.72, p<.05]. Table 16 shows the means for these interactions.

Table 16: Mean data according to IOA.

	Group	Part	16 win	tot time	time var	num rep	tot obs	comp choice
	E10/D30	A	.53	52.80	2.63	10.2	24.4	.50
Low	E10/D30	B	.41	40.01	1.89	7.3	20.7	.61
intolerance	D40/E10	A	.26	41.59	4.24	5.6	17.4	.53
	D40/E10	B	.30	41.80	5.73	6.2	18.2	.52
	E10/D30	A	.54	61.62	4.36	10.4	24.3	.56
High	E10/D30	B	.46	54.99	3.74	10.5	23.7	.55
intolerance	D40/E10	A	.40	52.32	3.78	7.0	20.4	.47
	D40/E10	B	.26	41.77	3.56	6.2	18.9	.60

All the significant interactions are due to the fact that whereas subjects who tolerate ambiguity (Low IOA) respond to both initial information and to its subsequent alteration, subjects high on IOA seem to be unaffected by information change! The reason may well reside in the very nature of the characteristic studied, namely, **High IOA makes it difficult to respond to change**. This lends major support to our central hypotheses, and vindicates the inclusion of IOA as a major personality factor in information management research.

The LOC main effect or its interactions with group and part did not prove significant for any of the depth measures, but the LOC x Group and LOC x Group x Part were significant for the best choices measure [F(1,56)=7.06 p=.01, and F(1,56)=5.00, p<.05, respectively]. For Internals, in group E10/D30, parts A and B, the means were 0.21 and 0.24, respectively, while the respective means for group D40/E10 were 0.31 and 0.35. The parallel means for Externals were 0.37, 0.23, 0.26 and 0.25, respectively, indicating that the information on start has greater effect on subjects with External Locus of Control. It could be argued, that any motivational manipulation based on external information should, in principle, be more effective with these subjects.

Social Desirability was found to interact with group and part for the mean number of unopened windows [F(1,56)=8.05, p<.01], proportion of trials in which all information was inspected [F(1,56)=5.67, p<.05], total observation time [F(1,56)=5.77, p<.05], and total number of observations [F(1,56)=4.56 p<.05]. For unidimensional choices, the SD x Part interaction was significant [F(1,56)=5.97, p<.05]. Table 17 presents the means for these interactions.

Table 17: Means of information and choice according to SD.

	Group	Part	16 win	unop win	tot time	unidim obs	choice
	E10/D30	A	.58	1.94	59.14	25.5	.06
Low	E10/D30	B	.45	2.93	47.09	22.6	.06
Social	D40/E10	A	.31	3.87	45.17	18.1	.08
Desirab.	D40/E10	B	.37	3.35	45.80	19.6	.03
	E10/D30	A	.49	2.05	56.46	23.1	.02
High	E10/D30	B	.43	2.47	49.92	22.3	.05
Social	D40/E10	A	.32	3.29	46.43	18.9	.04
Desirab.	D40/E10	B	.22	3.99	38.73	17.6	.07

The significant interactions indicate that the information manipulations (both initial and subsequent change) were more effective with subjects low on SD. **High SD subjects were particularly resistant to informational change.**

Impulsivity (BIS) interacted with group and part for the time variance measure [F(1,56)=5.50, p<.05]. The means were for the high impulsive subjects, 3.22 and 1.99 in group E10/D30, parts A and B, respectively, 4.45 and 5.83 in group D40/E10, parts A and B, respectively, while the low impulsive subjects showed means of 3.95, 3.76, 3.61, and 3.75, respectively. **Thus, this interaction stems from the highly impulsive subjects being more influenced by the information management manipulations than low-impulsive ones.**

Obsessivity-Compulsivity (MOC) interacted with group for the proportion of trials in which all 16 windows were opened [F(1,56)=3.90, p=.05], while the number of repetitions showed an MOC x Part interaction effect [F(1,56)=4.34, p<.05]. In addition, the triple interaction was significant for the proportion of compensatory choices [F(1,56)=5.17, p<.05], as well as number of errors in decision [F(1,56)=7.17, p<.05], which also showed a significant MOC x Part interaction [F(1,56)=7.03, p=.01].

MOC was also the only variable that showed significant effects for confidence level: There was a Group x MOC interaction [F(1,56)=4.93, p<.05], and a Group x MOC x Part interaction [F(1,56)=3.87, p=.05]. The means for the MOC results are presented in Table 11.

Table 18: Means of Decision Making data according to MOC.

	Group	Part	16 win	rep num	comp choice	error choice	conf level
	E10/D30	A	.50	10.88	0.59	0.11	5.86
High	E10/D30	B	.36	8.45	0.55	0.17	5.73
Obsession-	D40/E10	A	.39	8.50	0.51	0.15	6.14
Compulsion	D40/E10	B	.36	8.02	0.59	0.10	6.30
	E10/D30	A	.58	9.49	0.46	0.14	6.14
Low	E10/D30	B	.54	9.99	0.61	0.08	6.22
Obsession-	D40/E10	A	.22	3.05	0.50	0.15	6.06
Compulsion	D40/E10	B	.18	3.78	0.49	0.22	6.06

In Group D40/E20 high MOC subjects tend to view all 16 windows and make more repetitions than low MOC subjects. Thus, **Obsessive-Compulsive tendencies to some extent protect the decision maker from undue influence of the discouraging information!**

Covariance analyses between groups using the six personality indices as covariates produced essentially the same results as the simple ANOVAs.

Personality and macro and content measures.

TABP interacted with part on the dimensional minus alternative moves difference [$F(1,56)=4.72$, $p<.05$], with Type B means of 1.39 and 4.24 for parts A and B and type A means of 5.12 for both parts. Thus, **only Type B subjects changed from one type of processing to another between parts.**

IOA had a main effect on the intra-dimensional minus intra-alternative moves difference [$F(1,56)=5.69$, $p<.05$], and the IOA x Part interaction was also significant [$F(1,56)=4.80$, $p<.05$]. The means were for parts A and B, for the low IOA, 5.05 and 5.43, and the high IOA, 0.57 and 3.70, indicating that **information change effectively reduced high IOA subjects' performance!**

BIS showed an BIS x Group x Part interaction on the intra-dimensional minus intra-alternative moves difference [$F(1,56)=7.13$, $p<.01$]. The means for the low impulsive subjects were 2.45 and 6.51 for group E10/D30, parts A and B, 3.67 and 4.63 for group D40/E10, parts A and B, and the respective means for the high impulsive subjects were 3.78, 2.71, 1.84 and 4.29. Also, BIS had a main effect on the correlation between intra alternative moves and compensatory level [$F(1,56)=3.98$, $p=.05$, with means of 0.44 and 0.39 for low and high impulsive subjects.

MOC had one main effect for the difference between chosen and non-chosen alternative [$F(1,56)=9.05$, $p<.01$], with high MOCs observing more the chosen rather than the non-chosen alternatives than the low MOCs ($M=2.19$ and 1.52).

Summary.

As hypothesized, encouraging information led to a more complete information processing than discouraging information, in terms of the amount of the information that was processed, and the amount of time that was invested in each informational item. These effects were stronger at the beginning of the task, suggesting, as in our previous research, that initially encouraging information is the most effective.

The results we have presented indicate that expected load may lead to changes in the amount of information the person is going to use or process before making a choice. They are in line with both our earlier studies using this paradigm, as well as research about effects of time pressure on decision making.

Since expected load did not have a major effect on the type of choices subjects made, this suggests that the information processing phase and the decision phase are related in a highly complex fashion, and in fact could be partially independent of each other.

Several highly promising associations were found between the information processing measures themselves, and in relation to personality measures. Their theoretical and practical value will be discussed in the general discussion section of this report.

IV. Choice Between Gambles.

Aims

This study aimed at investigating the effects of information about task length on processing decision relevant information, as well as the type of decision finally made, using problems simulating gambles. Each gamble was characterized by four dimensions: Amounts to win or lose, and the probabilities of winning or losing these amounts. Subjects had to chose between two gambles one of which was always a high-variance gamble, representing risky choice (greater amounts to win and lose) while the other was a low-variance gamble (smaller amounts to win and lose).

Like in the previous experiment, the relevant information for each of the gambles that constituted a decision problem was presented on a computer monitor in a 2 X 4 matrix, and using a self presentation method, the subjects could view any piece of information that appeared in one of 8 information "windows" for as long as they wished and as many times as they wished before making a choice.

The major aim of the study was to find out how initially encouraging or discouraging information on the number of gambles (few or many, respectively) would affect subjects' risk taking as well as information processing measures. In addition, like in the COMPLEX DECISIONS study, the effect of information change was also assessed.

Although both this and the previous study utilized decision making situations, they differ in several important ways: First, the present study used decision problems that allow direct assessment of risk taking. Second, there were two alternatives in each problem, with the same dimensions used in all problems, and a larger number of gambles to process. Thus, the task was longer in terms of the actual (and expected) number of decisions. The same personality inventories were used, and their association with information processing and risk taking under the various information conditions was investigated.

Method.

Sample. Sixty Israeli born students were tested, 30 men and 30 women with an average age of 23.65 years (SD = 2.23; range 10-29). All students were paid IS40 (approximately $13.00) for participation. An additional small sum of money (up to $2.50) was given after playing one of gambles.

Materials. Forty pairs of gambles were used in the study, based on the 36 items from the Ben-Zur and Breznitz study (1981) with additional 4 items, constructed in a similar manner. A batch of 6 additional pairs, similarly constructed, was used for training purposes. Each decision problem included two gambles, which differed from each other on four dimensions: Probabilities of winning (PW) and losing (PL), and amounts to win (WIN) and lose (LOSE).

The gambles were constructed according to two characteristics of the probability distribution: mean and variance. The mean is the Expected Value (EV) of the gamble, computed in the following way: EV = (PWxWIN) + (PLxLOSE). Two values of EV were used in the gambles of this study: +25 and -25.

These values were always identical within each decision problem, so that they could not affect the choices.

However, the two gambles in each pair differed on variance so that one had a high variance and the other low. The values of variance differed from one item to another, but in general, the high variance was about 10 to 20 times higher than the low variance.

To construct the gambles, we first determined PL and PW in each gamble. Since a situation in which PL+PW=1.00 makes perfect prediction of one probability when the value of the other is known, we minimized such prediction by using in each gamble values of probabilities whose sum ranged between 0.60 and 1.00, the sums being equal in the two gambles in each pair. The remaining probability referred to the chances that there would be no outcome at all. Seven sums of probabilities were used, with 19 different combinations of PL and PW. Amounts of winning and losing were determined according to the requirements regarding EV and Variance as reported above, with an additional requirement that half of the gambles with high variance will include the high PL within a pair of gambles.

Apparatus and tasks. A PC AT computer with a colored display and a mouse was used for instructions and stimulus presentation for all tasks. For the main task - the gambles task, a 2 X 4 array of rectangles ("windows") represented the problem space. The two columns represented the two gambles while the four lines indicated the four dimensions. Each dimension was named (e.g., probability of winning), and each gamble was numbered. Upon presentation of the problem the 2 X 4 windows appeared empty, but each move (using the mouse) revealed the value of the certain dimension for the specific gamble. Subjects chose their preferred gamble by moving the mouse towards its number. There were eight different forms of presentation of the four dimensions, so that each appeared the same number of times as the first, second, third or forth on the display. These eight forms were arranged in five different (randomly determined) orders so that each form appeared approximately the same number of times, and its appearances were dispersed throughout the 40-problem sequence.

Following each choice another display appeared, depicting a 7-point confidence scale, the level of confidence was also indicated by the use of the mouse. A mouse training task was given before the main task, and it included the same display but with no verbal information on it. Subjects had to use the mouse in order to move from one rectangle to another in a random order predetermined by the program.

A dimensions importance ratings task was also performed, using the computer display. Since the four dimensions were the same in all decision problems, they were presented to subjects three times, with ranks 1-4. Subjects had to indicate for each dimension the importance they assigned to it in the experiment, and then separately in the first and second part.

The data recorded included subject demographics and experimental conditions. The mouse training data included the time needed for each of the moves. The decision problem data for each problem consisted of: the gamble chosen, the level of confidence, as well as the number of each observed window and the time needed for viewing the information presented in this window. In addition, subjects ratings of the dimensions were also recorded by the computer, as well as the time taken to read each type of instructions. Viewing times were measured in milliseconds.

Design. Two information conditions were tested:
(a) Initial Encouragement with a Discouraging change (E20/D60): This condition consisted of information that the task consisted of 20 pairs of gambles, but after 20 gambles it was followed by information about 60 additional ones. The number of decision problems actually presented in the second part was identical to the first, i.e. 20.
(b) Initial Discouragement with an Encouraging change (D80/E20): This condition consisted of information about 80 pairs of gambles to process, but after making 20 choices, subjects were told that

the task consisted of only 20 more.

Procedure. Subjects were run individually, and were randomly allocated to groups run in parallel, with the following constraints: Each group included men and women in identical proportions, and each included similar proportions of male students studying in mathematical, technical and engineering faculties. (This was done to control for potentially task relevant experience).

After taking some personal data and experience with mouse subjects received their respective instructions and performed all tasks using the computer monitor and mouse. The mouse exercise was practiced until subjects performed on eight trials (not necessarily consecutive) in less than 3 seconds each. Then followed the instructions that explained the nature of the decision task, the structure of the gambles and the characteristics of the dimensions. Following two examples, the task began, with different instructions for the E20/D60 and the D80/E20 groups.

In order to maximize motivation, subjects were told that following the experiment, one of the gambles would actually be played out, and that they will have extra money with which to gamble.

Each subject in each group was presented with a different order of the 40 pairs of gambles. The order of the pairs of gambles was determined so that each batch of 6-7 gambles contained one gamble from each sum of probabilities. Half of the gambles with high variance were used on the right side of the display, and half on its left, their order determined randomly, but with no more than three consecutive pairs with the high (or low) variance on the same side. In addition, there were no more than four consecutive pairs in which high variance and high (or low) probability of losing were combined in one gamble. There were 40 different sequences that changed between subjects by moving one item from top to bottom so that each subject started with a different item.

Following the performance on the first 20 pairs, each group was given the informational change instructions, and subjects were presented with 20 more problems. After the last decision they were asked to rank the importance of the 4 dimensions. This was done 3 times: once for the overall importance, and once separately for each part of the experiment (before and after informational change). In order to facilitate the ranking task, the 4 dimensions were once more presented on the screen.

After the ranking subjects were told that the computer will pick randomly one of the gambles they have chosen and play it. Next they were seated in another room and filled the 6 personality inventories. After receiving remuneration they signed a promise not to discuss the details of the experiment.

RESULTS.

Description of output data
The computer output for each subject was highly similar to that obtained in the previous study. It included demographic information (i.e., age, sex, previous experience with the mouse), registration of the time taken by each move during the mouse training period, and registration of the time the subject spent on each segment of the instructions. There were 40 decision problems, and the main search measures for each included the type of each window viewed out of possible eight, and the duration of viewing. For each pair of gambles, final choice and confidence level were of course recorded.

Control measures: The two groups had identical number of men and women, and they did not differ significantly on mouse experience report (yes/no answers, Chi-square<1.20). There was no association between gender and reported experience with the mouse Chi-square<1), subjects' ages in the two groups were similar (M=23.6 and 23.7 for the E20/D60 and D80/E20 groups, respectively, t<1). The two groups did not differ on mouse training measures.

Descriptive statistics: Subjects made between 2 and 70 window observations per trial before making a choice. These numbers are comparable to those reported in the previous study, although the number of possible windows in the present study is 8 rather than 16. The mean of windows opened was 13.42, indicating that subjects repeated some of the observations at least once. The maximal number of repetitions over trials was 10, with a mean of 1.24. The range of viewing times was between 0.31 and 53.30 sec, with mean viewing time of 2.49.
The various indices used in this research parallel those described in the COMPLEX DECISIONS study.

Depth measures.
Frequency variables: (a) Number of 8-window observations - for each subject and each trial, the overall number of the different windows that were observed was counted. Then each trial was given a score of 1 if all 8 different windows were opened at least once, and 0 otherwise. This measure indicates whether or not all information was observed on the specific trial.
A two-way, Group X Part Analysis of Variance (ANOVA), revealed a significant Group x Part interaction [$F(1,58)=4.98$, $p<.05$]. The means were 0.915 and 0.898 for parts A and B in group E20/D60, while group D80/E20 showed respective means of 0.877 and 0.912. **Thus, the proportion of trials in which all information was observed changed precisely as predicted: expectation of a large number of items lowered the number of such trials, while expecting a small number of items elevated them, in both groups.**
(b) Number of unopened windows - this number reflects the amount of missing information on each trial. Since considering the

nature of the gambling task little information was overlooked, the mean of this measure was less than 1 (0.27), and no effects were observed for either group, part, or their interaction.
(c) Repetitions - The first measure analyzed was the average number of repetitions made in each trial. The Group x Part interaction effect was marginally significant [$F(1,58)=3.70$, $p<.06$]. For group E20/D60 the means for parts A and B were 6.80 and 6.46, respectively, while the respective means for group D80/E20 were 4.22 and 5.31. Thus, there was a tendency for the number of repetitions to become higher when the expected number of choices became lower, in both groups.
When analyzing the number of first repetitions, i.e., how many windows were opened for the second time, a two-way ANOVA revealed a significant interaction effect [$F(1,58)=4.48$, $p<.05$]. The means were 3.88 and 3.60 for parts A and B, respectively, in group E20/D60, and 3.00 and 3.29, respectively, for group D80/E20. **Thus, viewing the same information the second time was affected significantly in both groups in a reversed manner, in accordance with the information manipulation.**
The same interaction effect was significant for the analysis of second repetitions [third viewing of windows, $F(1,58)=4.81$, $p<.05$], with similar trends: The means were 1.63 and 1.50 for parts A and B, respectively, in group E20/D60, and 0.94 and 1.29, respectively, for group D80/E20. This trend weakened for the third and fourth repetitions.
We looked at the number of windows opened prior to the first repetition. The effect of group was significant [$F(1,58)=5.81$, $p<.05$], and the Group x Part interaction was marginal [$F(1,58)=3.79$, $p<.06$]. The means were 5.27 and 5.47 for parts A and B, respectively, in group E20/D60, and 6.11 and 5.91, respectively, for group D80/E20. **When the expected load is high, subjects tend to make fewer repetitions before viewing most of the information for the first time.**

<u>Time variables</u>: In light of the fact that the time data contained several very long observations, the time scores for each window were log-transformed. All the following analyses were carried out on the log-transformed scores, while group averages are given in their original scale (i.e., seconds).
(a) Mean viewing time per window. A two-way, Group X Part ANOVA applied to the average time per window showed no group or interaction effects ($F<1$), but a highly significant effect was obtained for part [($F(1,58)=59.61$, $p<.0001$]. **As in the previous study, the average time spent on each window decreased from the first to the second part in both groups.** Similar results were obtained when looking at the time spent on each window when it was first viewed, the average time spent on first, second or third repetitions, as well as the average time spent over all repetitions.
(b) When we analyzed the mean time of observing each different window out of the possible eight (the time intervals were added

and averaged by the number of different windows observed), a significant interaction effect [$F(1,58)=4.88$, $p<.05$] emerged. **Subjects in the E20/D60 group started with allocating a relatively overall longer time to each specific informational item on part A problems (M=5.04), which decreased in part B (M=4.32), whereas in group D80/E20 the difference was much smaller (M=3.97 and 3.82, respectively).**
(c) Viewing time variance decreased significantly from Part A to Part B [$F(1,58)=6.78$, $p=.01$], [M=5.48 and 4.20]. This finding also matches the one reported in the previous study, providing further evidence that the effects are robust and reliable.

Table 19 presents the correlations between the various measures according to Group and Part.

	8 window observation	mean time	time variance	total number observation
	Group E20/D60, part A			
unopened win	-.99***	-.04	-.10	-.44*
8 window obs		-.05	.11	.46**
mean time			.79***	.00
time variance				.24
	Group E20/D60, part B			
unopened win	-.98***	.08	-.17	-.37*
8 window obs		-.04	-.11	.40*
mean time			.73***	-.18
time variance				.00
	Group D80/E20, part A			
unopened win	-.92***	.01	-.09	-.52**
8 window obs		-.01	-.16	.53**
mean time			.78***	-.29
time variance				-.21
	Group D80/E20, part B			
unopened win	-.88***	.15	-.01	-.36*
8 window obs		-.12	-.02	.40*
mean time			.76***	-.22
time variance				-.07

Note: *** $p < .001$ ** $p < .01$ * $p < .05$

The associations between frequency measures, i.e., total number of observations, number of unopened windows, and 8-window observations are consistent for groups and parts. The time measures, although positively related within themselves, show no associations with any of the frequency measures

<u>Macro measures.</u>
(a) Sequential viewing of whole dimensions or alternatives - The frequency analyses, carried out for both total and average numbers, did not reveal any systematic differences between the groups. The time measure for the dimensional scans showed a part effect [F(1 16.05 and 13.27 for the first and second part respectively. The corresponding measure for alternatives showed a marginal interaction effect [$F(1,58)=3.67$, $p<.07$], with means of 29.67, 26.14, 22.79 and 23.00 for group E20/D60, parts A and B, and group D80/E20, parts A and B, respectively. This interaction disappeared when the time measure was divided by the number of windows. This later measure showed a marginal part effect for the dimensional measure [$F(1,58)=3.02$, $p<.09$, means of 1.83 and 1.65, for parts A and B, respectively], and a part effect for the alternative measure [$F(1,58)=18.44$, $p<.0001$, means of 2.46 and 2.21, for parts A and B, respectively]. Thus, both measures showed longer observation times for the first vs. the second part of the experiment.
(b) Intra-dimensional and intra-alternative measures - The numbers of intra-dimensional or intra-alternative moves are the total numbers of moves subjects made within dimensions or alternatives. No significant effects were found, and the number of intra-alternative moves showed a marginally significant effect for part [$F(1,58)=3.46$, $p<.07$; $M=6.49$ and 7.03 for parts A and B, respectively], and for the Group x Part interaction [$F(1,58)=3.76$, $p<.06$; $M=7.33$ and 7.30 for parts A and B in group E20/D60, $M=5.65$ and 6.75 for parts A and B, group D80/E20]. Thus, the effect of part stems mainly from **group D80/E20 making more intra-alternative moves during the second part of the experiment.**
Similar effects were observed when we divided the number of intra-dimensional moves by the number of dimensions in which at least one move was made, and the same was true for the number of intra-alternative measure.

<u>Correlations with depth measures</u>.
The main macro measures, were intercorrelated with the main micro measures. The results are presented in Table 20.

With the exception of mean viewing time, the micro measures correlated better with intra-alternative moves than with the intra-dimension moves. Furthermore, as in the previous study, **subjects who used more dimensional processing were, on average, faster.**

Table 20: Correlations between micro and macro measures.

	intra-dim moves	intra-alt moves
	Group E10/D30, part A	
total num obs	.51**	.87***
unopened win	-.22	-.39*
8 window obs	.24	.40*
total time	.40*	.88***
mean time	-.27	.17
	Group E10/D30, part B	
total num obs	.55**	.88***
unopened win	-.12	-.35
8 window obs	.14	.37*
total time	.37*	.92***
mean time	-.40*	.04
	Group D40/E10, part A	
total num obs	.47**	.57**
unopened win	-.23	-.32
8 window obs	.17	.38*
total time	.20	.66***
mean time	-.43*	.16
	Group D40/E10, part B	
total num obs	.39*	.79***
unopened win	-.27	-.22
8 window obs	.26	.24
total time	.20	.82***
mean time	-.45*	.10

Note: *** $p < .001$ ** $p < .01$ * $p < .05$

Global measures.
(a) Whole problem analyses - The total time and number of observations made on each trial showed a significant effect for Group X Part [$F(1,58)=4.15$, $p<.05$], with means of 14.51 and 14.17 for group E20/D60, while group D80/E20 means were 11.91 and 13.11, respectively.
Total time showed also a significant effect for the double interaction only [$F(1,58)=5.61$, $p<.05$]. Subjects in group E20/D60 had means of 39.51 and 33.71 for parts A and B, respectively, while subjects in group D80/E20 showed means of 30.84 and 29.89.
(b) Strategies - Since in more than 40% of the cases subjects in the present study inspected all 8 windows without repetitions, we used these data to evaluate dimensional and alternative processing. The full-dimensional strategy was defined by a sequential inspection of the four dimensions, each dimension

fully observed before turning to another. The proportion of trials on which subjects used this strategy, out of the trials in which they inspected all 8 windows without repetitions, was analyzed in a two-way, Group x Part ANOVA. No effects were found in this analysis (all Fs'<1), but when we analyzed the full-alternative strategy, the effect of part was significant [F(1,54)=8.49, p<.01] and the interaction as well [F(1,57)=4.60, p<.05]. The means were 0.23 and 0.35 for parts A and B in group E20/D60, while group D80/E20 showed similar means of 0.29 and 0.30, respectively. **Thus, the change in information indicating a higher expected load, subjects used more alternative processing.**

We also analyzed the level of dimensional strategy subjects used in the first two windows observed. The effects were significant for part [F(1,58)=4.46, p<.05] and Group x Part interaction [F(1,58)=4.17, p<.05], with means of 0.59 and 0.49 for parts A and B in group E20/D60, and 0.54 and 0.53, respectively, for the second group. **Thus, the first group lowered dimensional processing in the second part.**

(c) Choice and risk - The specific design used in this study allowed us to analyze choices according to their level of risk. Each choice could be characterized as being one of the following four types: High Variance/High Probability of Losing (HV/HPL), High Variance/Low Probability of Losing (LV/LPL), Low Variance/High Probability of Losing (LV/HPL), Low Variance/Low Probability of Losing (LV/HPL).

Two-way, Group x Part ANOVAs, applied to the four types of choices, showed no significant effects for either group, part, or their interactions (and similar results were obtained when the data were analyzed by a three-way Group x Part x Block ANOVA). The group means were, for group E20/D60, 0.18, 0.19, 0.31, and 0.32 for HV/HPL, LV/HPL, HV/LPL, LV/LPL, respectively, and for group D80/E20, 0.17, 0.19, 0.31, and 0.33. Thus, in both groups subjects tended to choose more the gambles with lower probability of losing.

(d) Confidence in choice - A two-way, Group x Part ANOVA, showed significant effects for part [F(1,58)=6.35, p=.01], and for Group x Part interaction [F(1,58)=4.40, p<.05]. The means for group E20/D60 were 5.04 and 5.01 for parts A and B, respectively, and 5.16 and 4.90 for group D80/E20. Thus, the later group level of confidence was lower when the number of problems was lowered.

<u>Content measures</u>.

Which of the dimensions are viewed first? <u>Table 21</u> presents the data.

There is a very interesting significant Group effect due to a tendency of the initially encouraged group to start the task with opening the window indicating Amount to Win [F(1,58)=6.35, p<.05]!

Table 21: First window opened according to Dimension, Group and Part.

Group	Part	WIN	PW	LOSE	PL
E20/D60	A	0.50	0.21	0.14	0.15
	B	0.50	0.22	0.13	0.15
D80/E20	A	0.31	0.32	0.14	0.22
	B	0.26	0.37	0.15	0.23

Personality measures.

Psychometric data: The means, medians, standard deviations, ranges, and Alpha reliabilities for the six personality inventories used in the present experiment are presented in Table 22 and the inter-correlations between them in Table 23.

Table 22: Psychometric data for personality measures.

	Mean	Standard Deviation	Median	Range	Alpha
LOC	36.14	3.54	37.0	29-43	.65
MOC	52.60	4.56	54	41-60	.79
IOA*	39.47	7.84	39	24-57	.55
BIS	108.29	12.45	108.5	83-143	.79
TABP	6.33	2.67	6	2-12	.49
SD	15.62	5.05	15	2-26	.76

Note: LOC - Locus of Control; MOC - Maudsley Obsession Compulsion scale; IOA - Intolerance of Ambiguity; BIS - Barrat Impulsivity Scale; TABP - Type A Behavior Pattern; SD - Social Desirability.
* Based on 12 items, see text.

Table 23: Intercorrelations between personality variables.

	LOC	MOC	IOA	BIS	TABP
MOC	.46***				
IOA	.06	-.09			
BIS	-.13	.09	-.37**		
TABP	.04	-.09	.04	.09	
SD	.29*	.22	.14	-.42***	-.11

*p <.05 **p<.01 ***p<.001

Table 22 indicates that the Alpha reliabilities are quite satisfactory, and most of the measures show an acceptable range of scores, with means and medians that are similar. The data are similar to those of the previous study, except for the BIS and

TABP means and medians that are somewhat lower in the present study. The data of Table 23 show similar trends as those in the previous study, with few significant associations, suggesting that the various inventories measure different characteristics.

Personality inventories and micro measures.
The two experimental groups were compared on all six personality measures, with no significant differences observed on any of them using t-tests ($p>.10$). The relationships between personality measures and the decision making indices were analyzed using three-way ANOVAs for unequal ns', after dividing each personality measure at the median. In light of the numerous analyses carried out, marginal results ($p>.05-<.10$) are not reported.

The IOA interaction with part was significant for mean time [$F(1,56)=6.43$, $p=.01$], and number of windows opened until first repetition [$F(1,56)=4.26$, $p<.05$]. Low IOA subjects time means were 2.79 and 2.39 for parts A and B, while high IOAs' means were 2.63 and 2.43. The respective means for low and high IOA subjects on parts A and B for the number of windows opened were 5.81, 6.05, 5.58 and 5.37.
LOC had no significant interactions with either Group or Part in this study.
SD was found to interact with group and part for the total time spent on repetitions [$F(1,56)=4.37$, $p<.05$]. This replicates our earlier finding indicating that Low SD subjects are more influenced by the information manipulation. The significant interaction with BIS [$F(1,56)=4.58$, $p<.05$] is yet another replication of our finding that the information manipulation is particularly effective for highly impulsive subjects. The means are presented in Table 24.
Table 24: Means of repetition time according to SD and BIS.

	Group	Part	SD	BIS
Low	E20/D60	A	20.87	16.75
	E20/D60	B	15.16	13.39
	D80/E20	A	12.55	12.62
	D80/E20	B	15.67	10.79
High	E20/D60	A	19.61	26.27
	E20/D60	B	18.08	22.21
	D80/E20	A	13.76	14.10
	D80/E20	B	12.81	22.38

MOC was found to interact with part for the number of repetitions [$F(1,56)=3.89$, $p=.05$], the number of total observations [$F(1,56)=4.29$, $p=.05$], and the total time spent on repetitions [$F(1,56)=3.88$, $p=.05$]. The simple main effect of MOC was also significant for mean time spent on repetitions [$F(1,56)=4.80$, $p<.05$]. The means are given in Table 25.

Table 25: Means of information measures according to MOC.

	Group	Part	rep num	total num obs	tot time rep	mean time rep
	E20/D60	A	7.64	15.28	22.83	2.93
High	E20/D60	B	6.86	14.47	17.45	2.73
Obsession-	D80/E20	A	3.28	11.14	12.74	3.15
Compulsion	D80/E20	B	3.54	11.47	12.64	2.57
	E20/D60	A	4.83	12.71	14.18	2.35
Low	E20/D60	B	5.51	13.48	14.68	1.98
Obsession-	D80/E20	A	5.04	12.59	13.44	2.02
Compulsion	D80/E20	B	6.85	14.54	16.02	1.77

Covariance analyses were also applied to the groups' means as well as differences between the two parts on the micro measures using the six personality measures as covariates. The result for the proportion of 8-window observation difference score was still significant, as well as the mean number of windows observed until first repetition was made. The effects for number of observations and time were weaker and non-significant in the covariance analyses.

Summary.

The Choice Between Gambles Study showed effects similar to those found in the Complex Decisions Study. The manipulations were effective in influencing information search and processing, with only marginal effects on choice. **Encouraging information indicating a lower expected load led to a more thorough search of relevant information prior to making a choice.**

GENERAL DISCUSSION.

Based on our earlier studies we hypothesized that expected cognitive effort plays a significant role in determining the decision making process. If successful, the demonstration and explication of such a role could pave the way to utilizing information management techniques to enhance the quality of decisions in a variety of contexts.

Needless to say, expected cognitive effort is probably affected by countless aspects of the decision making situation. At the same time, the variables in the focus of this study can reasonably be expected to be among the variables contributing to the expectations of cognitive load. Thus, when faced with a task comprising of numerous discrete items, **the size of the item pool may well determine the subjective evaluation of the cognitive load involved.**

The complexity of each of the items comprising the task is, of course, yet another important variable. A particular level of cognitive effort can be divided among few items of high complexity, or numerous items of low complexity. In a recent review of process tracing methods in decision making research Ford, Schmitt, Schechtman, Hults, & Doherty clearly state that: "Results indicate that increases in task complexity lead to (1) decreases in the proportion of information search, (2) increases in the variability of search patterns, and (3) decreases in mean search time." (1989, p. 99).

It was with these arguments in mind that our research program attempted to spread the net wide in terms of the actual task demands used, ranging from the very simple task of scaling, all the way through complex decisions, with dilemmas of risk and choice between gambles occupying an intermediate level of complexity. However, in view of the particular kind of information manipulation used, (i.e., information about number of items rather than about their complexity), our range of tasks is necessarily slanted towards the more simple ones.

The effectiveness of our manipulations depends on the degree to which the initial information about number of anticipated items translates into a distinct representation of the cognitive effort implied by that information. This in turn depends on subjects' experience with the difficulty of the initial items. Thus, if a person finds the decision task easy and engaging the anticipation of a long list of similar items is not, necessarily unduly discouraging. In the same vein, anticipating even a relatively short number of items that produce some difficulty may seem too long. All of these arguments reduce the initial chances of obtaining significant main effects between groups.

The role of Initial Information.

Considering the above constraints, *the systematic confirmation of our main hypothesis in all of the four studies* *carried out lends extra weight to its underlying rationale.* Specifically, in each of the studies, **the group that was given initial information implying a fewer number of items performed the decision making task more effectively**! The particular indices of performance depended, of course, on the specific nature of each task:

(a) In the comparative scaling of anger evoking situations we were able to demonstrate that initially discouraging information (200 versus 40 items) led to **diminished sensitivity of judgments**, as indicated by a smaller number of categories that were used. Furthermore, it led to more **simple minded decisions**, as witnessed by frequent usage of the most extreme categories. In addition, subjects in this condition **spent less time** deliberating their judgments. Although fast processing does not necessarily indicate reduced performance, in our case it typically does, a point that will be further elaborated at a later stage of the discussion.

(b) Results of the choice dilemmas study also indicate that initially discouraging information (85 versus 15 items) reduced the time spent on the task, as well as the variance of time allocated across items. It also **increased conservative choices**, in line with prior research on time pressure.

(c) Data from the study involving complex decisions indicate that initially discouraging information (40 versus 10 complex problems) **reduces the chances of utilizing the entire information available** as demonstrated by frequency of opening all information windows. Furthermore, **the amount of unutilized information** is also greater in this condition. Once again, subjects in this group spent less time on screening the information.

In addition, initially discouraging information produced a **more shallow deliberating process** as suggested by reducing the number of repetitions of previously viewed information. Since it is practically impossible to remember all 16 items of information, repetition indicates serious attempts to base the decision on as much currently available information as possible.

Furthermore, **the information manipulation had a significant impact on the systematicity of informational search preceding choice**. Specifically, initially encouraging information enhanced whole dimension and whole alternative processing, as opposed to a more haphazard viewing of information.

(d) The results of the last study which investigated choice between gambles are very similar to the one involving complex decisions. Thus, initially encouraging information (20 versus 80 choices) increased the chances of viewing all of the information, as well as viewing it again (repetitions), and viewing it for a longer time. In addition, subjects in this condition were more inclined to open the window indicating Amount of Win than those with initially discouraging information.

The fact that basically the same kinds of effects could be demonstrated across four different experiments suggests that the information manipulation is both highly reliable and robust!

<u>Information change</u>.

To the above mentioned list of a priori obstacles confronting our manipulations several more have to be added when moving from Initial Information to Information Change. First and foremost, our previous studies indicate that in most situations information is particularly effective at the onset of a task. With actual experience, there is a tendency to settle into a pattern that resists alteration.

Secondly, our specific manipulation attempts to actually reverse the conditions of the initial information. As such, it is in head-on collision with the more powerful effects of the earlier manipulation. Furthermore, each information change reduces by its very nature the credibility of the information source, as well as its actual content (Breznitz, 1984).

With this in mind, it might be necessary to reduce our expectations about the magnitude of the effects that can be produced by information change. Thus, it is conceivable that instead of a full reversal of conditions, the manipulation will be able to cancel the impact of the initial information, reducing the differences between the various groups involved.

The results suggest exactly that, with several instances of even a more powerful reversal effect. Specifically, in the choice dilemmas experiment the difference in mean time of processing the various items was faster for the initially discouraging group, but those differences were cancelled out by information change. The same was found concerning time variance. **Risky choices on the first 5 items were more frequent in the initially encouraging condition, with a full reversal after information change.**

In the complex decisions study the frequency of first repetitions indicated a significant Group X Part interaction, i.e., information change caused a full reversal, in the direction of our hypothesis. Significant interaction was also obtained when calculating the mean viewing time per each of the 16 windows. Thus, information change prolonged viewing time in Group D40/E10 and reduced it in Group E10/D30.

The results of the choice between gambles experiment were even stronger, and **a significant Group X Part interaction was found when analyzing the proportion of trials in which all of the information available was observed.** First repetition also indicated a full reversal due to information change. As in the previous study, mean viewing time per each of the 8 windows showed a significant interaction as well. Furthermore, **information change indicating a higher expected load led to increased processing along alternatives rather than dimensions.**

The above results demonstrate that although to a lesser degree than initial information, information change has a systematic impact on several indices of level of processing. In general, *increasing the expected task load reduces the per-item allocation of cognitive resources, and the opposite effect can be observed when the anticipated number of items is reduced.*

Role of experience: Enhancing or shallowing of processing?

Since the design of all of the four experiments called for information change to take place half-way through the task, its impact might be obscured by potential practice effects. It is therefore of paramount importance to analyze the influence of experience with the task on decision making performance.

This has direct relevance to the **speed of processing** issue that has already surfaced in the earlier part of our discussion. Even a brief glance at the results sections of all the experiments is sufficient to realize that on practically all the temporal measures **speed in Part B was faster than in Part A**. Such systematic findings raise the obvious question of practice.

Undoubtedly, having gone through a significant number of items, subjects benefit from experience and can carry out some of the aspects of the task faster than before. At the same time, *increased speed is not without its cost.* In fact, it could be indicative of precisely the same psychological processes that are affected by information leading to a high expected task load. In other words, a more casual and shallow processing of decision relevant information, as well as reduced deliberation of that information prior to making a choice, would necessarily increase speed.

Our data points out some meaningful patterns of relevance to this issue. Thus, slower times were more present in paid subjects than in subjects performing the task for credit. Paid subjects are typically more motivated in psychological experiments than unpaid ones.

Time variance is another important symptom. The higher that variance, the more responsive to the specifics of a particular item the decision making process is. Low temporal variance suggests that information processing is following a standard pattern insensitive to the specifics involved. In our studies, time variance was reduced in Part B, and significantly related to fast processing.

Of major importance is, of course, the finding that in Part B there were fewer instances of attending to all the information available. This is a direct implication of speed in this context. Stated differently, some of the time effects were due to simply **neglecting part of the available information.** The fact that the average viewing time of opened windows was reduced suggests that **even when information was sought, it was less seriously attended to.** The positive correlations between both mean time and time variance with compensatory choice is yet another indication that within the context of our research, effective decision making is characterized by slow rather than fast processing.

Perhaps the best way to summarize this issue it to state that the relationship between time and performance is probably curvilinear, namely, while practice obviously increases performance speed, beyond a certain point increased speed cannot be achieved without detracting from performance quality. **When fast speed is not forcibly produced by external constraints or**

demands, it could be symptomatic of shallow processing. Our study suggests that information indicating a high expected task load leads to reduced per-item allocation of resources with a concomitant fast and shallow processing.

Information management and choice.

In spite of hopes to the contrary, decision research is to some extent plagued by low correlations between process measures of the decision task itself and the final choice of alternative. The two appear to be partially independent, and this poses an upper limit on attempts to predict the one from the other. Although process tracing methods provide a wealth of information of theoretical and practical interest in its own right, their effectiveness in explaining a significant part of the variance in choices has so far been rather limited. It is in this context that our own attempts have to be considered.

The only studies providing data on this issue are those of complex decisions, and choice between gambles. In the complex decisions study initially encouraging information (Group E10/D30) increased the frequency of observing whole dimensions or whole alternatives in comparison with initially discouraging information (Group D40/E10). Furthermore, the former made more consecutive within dimensional moves. Both of these findings indicate a more systematic search typical of a linear compensatory strategy.

Research in this area indicates that any aspects of the decision making task that increases its complexity increases the likelihood that subjects use simplifying nonlinear strategies to make their decision task more manageable. This is a very robust effect (E.g.: Biggs, Bedard, Gaber, & Linsmeier, 1985; Billings & Marcus, 1983; Johnson & Meyer, 1984; Johnson, Meyer, & Ghore, 1986; Klayman, 1983; Olshavsky, 1979; Onken, Hastie, & Revelle, 1985). Our own research suggests that high expected task load produced by information about number of anticipated items produces effects similar to those caused by increased complexity.

This makes sense in the context of mobilization and allocation of cognitive resources. Any aspect of the decision task that may cause some discouragement signals would by necessity reduce those resources. Thus, task manipulating task importance produced effects in line of the above arguments (Billings and Scherer, 1988; Klayman, 1983). We argue that **if there are only a few problems to be deliberated, each one of them is more important than if there are many.** Under conditions of time pressure there is also more use of noncompensatory decision strategies (Payne, Bettman, & Johnson, 1986).

A number of researchers have highlighted the utility of examining decision making behavior from a cost/benefit perspective (Beach & Mitchell, 1978; Einhorn & Hogarth, 1981; Payne, 1982). "A cost/benefit analysis implies that a decision strategy is a compromise between a desire to make a correct decision and a desire to minimize cognitive effort." (Ford, et. al., 1989; p. 109). **Anticipated high number of decisional**

problems would obviously lead to minimize the cognitive resources allocated to each item.

We found that windows of the chosen alternatives were viewed more frequently than those of non-chosen alternatives. This data provides a direct link between process measures and choice, suggesting that the latter can to some degree be predicted from the former. It appears that in complex decisions that require a significant amount of information evaluation and put a major load on memory, the decision maker may develop an initial preference for one of the alternatives and from that point onwards proceeds to view it more than others. In such instances, while the preference is not yet above the JND for choosing an alternative, the data on information search may provide the clue to such future choice.

Finally, in the choice dilemmas study we found that in the initially encouraging information condition subjects were less conservative in their judgments. This is in line with our previous work on risky choices under time pressure (Ben-Zur & Breznitz, 1981), indicating that expected load operates in ways similar to actual time pressure.

<u>Personality factors in information management of decisions</u>.

The personality characteristics chosen in two of the studies reported here were found to be relevant to the main themes of our research. Not only were there systematic individual differences in the process measures tested, but personality factors interacted with the information manipulations themselves. Let us recapitulate the main findings:

(a) Type As viewed fewer information windows than Type Bs. This is in line with the claim that Type As operate under constant (though self-imposed) time pressure. In a recent experiment carried out in our laboratory Type As were shown to make fewer compensatory choices (Ben-Zur & Vardi, in press).

(b) Subjects low on Intolerance of Ambiguity were more affected by both initial information and information change than those high on IOA. It appears that intolerance of ambiguity makes it difficult to respond to unexpected changes in the situation. Information change effectively reduced the performance of high IOA subjects as indicated by reduced dimensional and increased alternative processing.

(c) Essentially the same was found concerning Social Desirability, with low SD subjects being more responsive to the information manipulations than high SD ones. The latter were more resistant to change.

(d) External locus of control enhanced the impact of initial information. This is clearly in line with the very notion of externality, implying greater influence of information coming from without rather than from within.

(e) Information management manipulations were found to be more effective with subjects high on impulsivity.

(f) Obsessive-Compulsive subjects were less affected by information change, particularly the discouraging change. This trait may well produce stable patterns of behavior resistant to subsequent change.

Practical implications.

Although the complexity of the issues involved warrants a great deal of additional research, with due caution, several initial practical recommendations can be formulated at this stage of our knowledge:

1. Since information concerning the number of decision tasks has direct impact on quality of processing, it should be handled with extreme care. Specifically, if quality of decisions is of significant importance, the initial information should never discourage the decision maker.

2. Initial information is more effective than information change. Consequently, even at the cost of having to change it at a later stage, the initial information should be encouraging, implying lower cognitive load.

3. Information implying low cognitive load tends to reduce conservatism and enhance more risky choices. In situations that are extremely risk aversive it might be possible to trade quality of decision making for increased preference for conservative decisions. On the other hand, when conservatism is a problem, initial information should be particularly encouraging.

4. The above recommendations are particularly effective for decision makers who tolerate ambiguity, are not high on social desirability, have external locus of control, and tend towards impulsivity.

5. It should be possible to select individuals with characteristics conducive to particular type of decision making. Thus, for instance, obsessive-compulsive tendencies may to some extent protect individuals from the deleterious effects of having to engage in repetitive routine decisions. After ensuring high quality decisions during the initial phase of the task, that quality could be maintained for longer durations than in less OC people.

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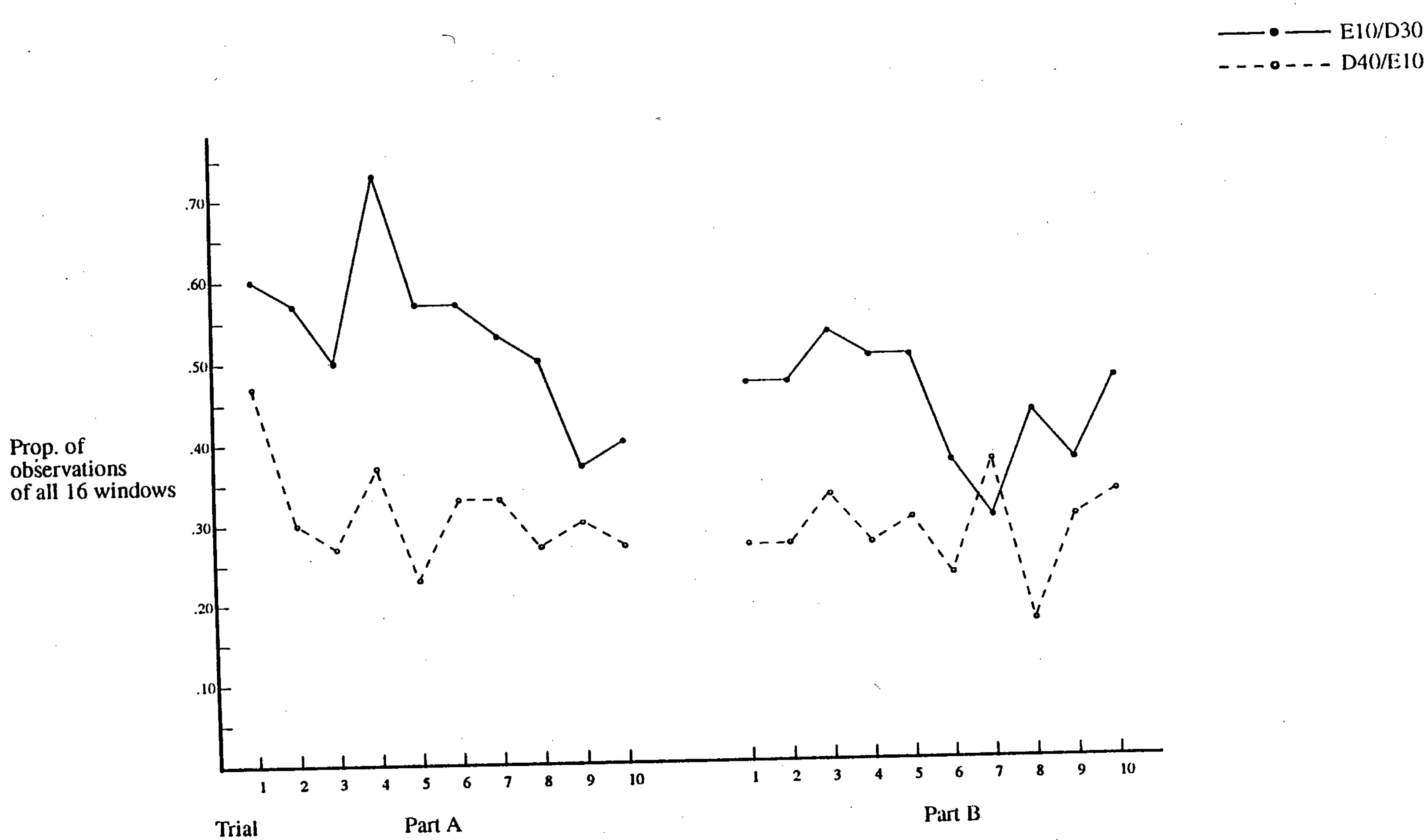
FIGURE 1



E10/D30
D40/E10
Prop. of observations of all 16 windows
.70
.60
.50
.40
.30
.20
.10
Trial
1 2 3 4 5 6 7 8 9 10
Part A
1 2 3 4 5 6 7 8 9 10
Part B

FIGURE 2

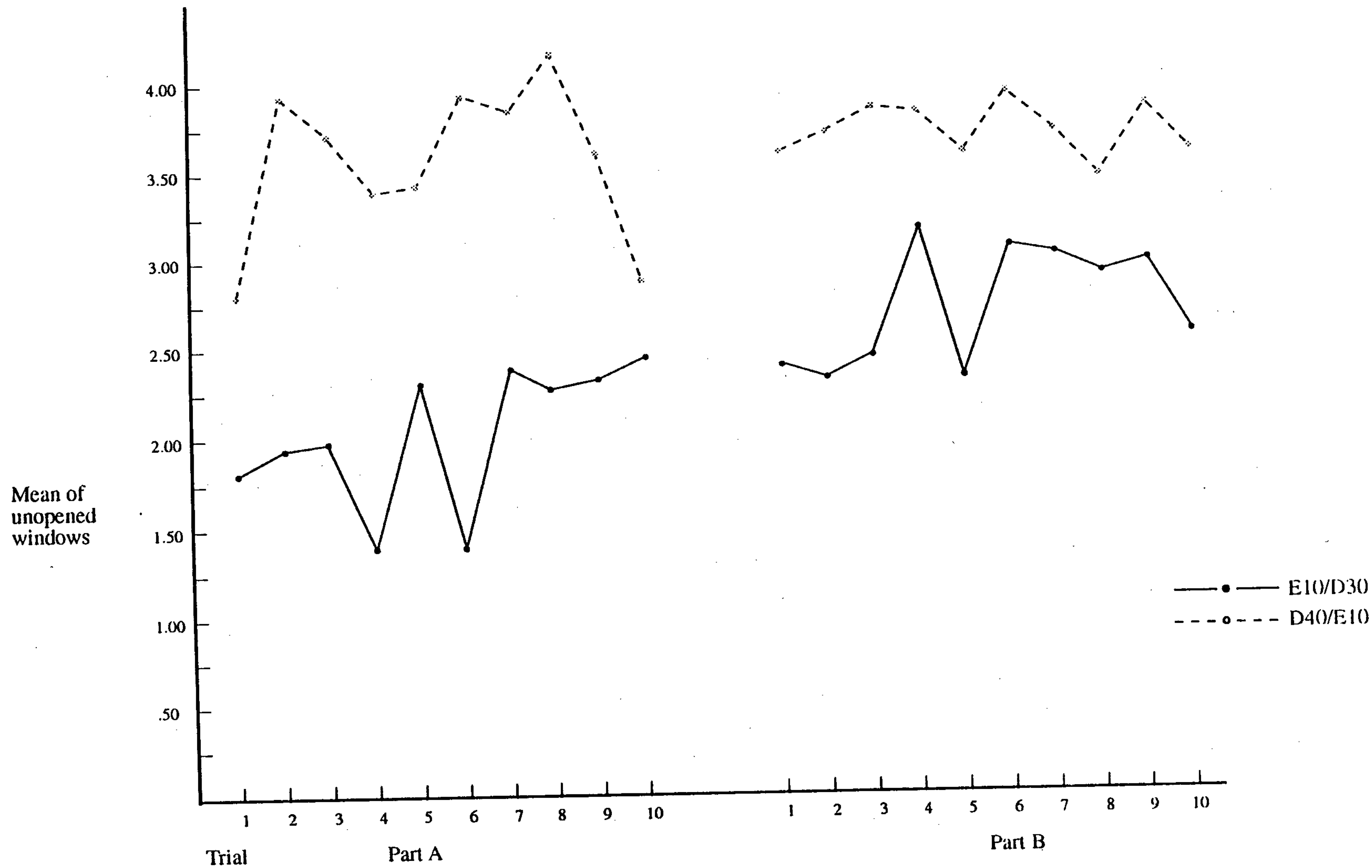
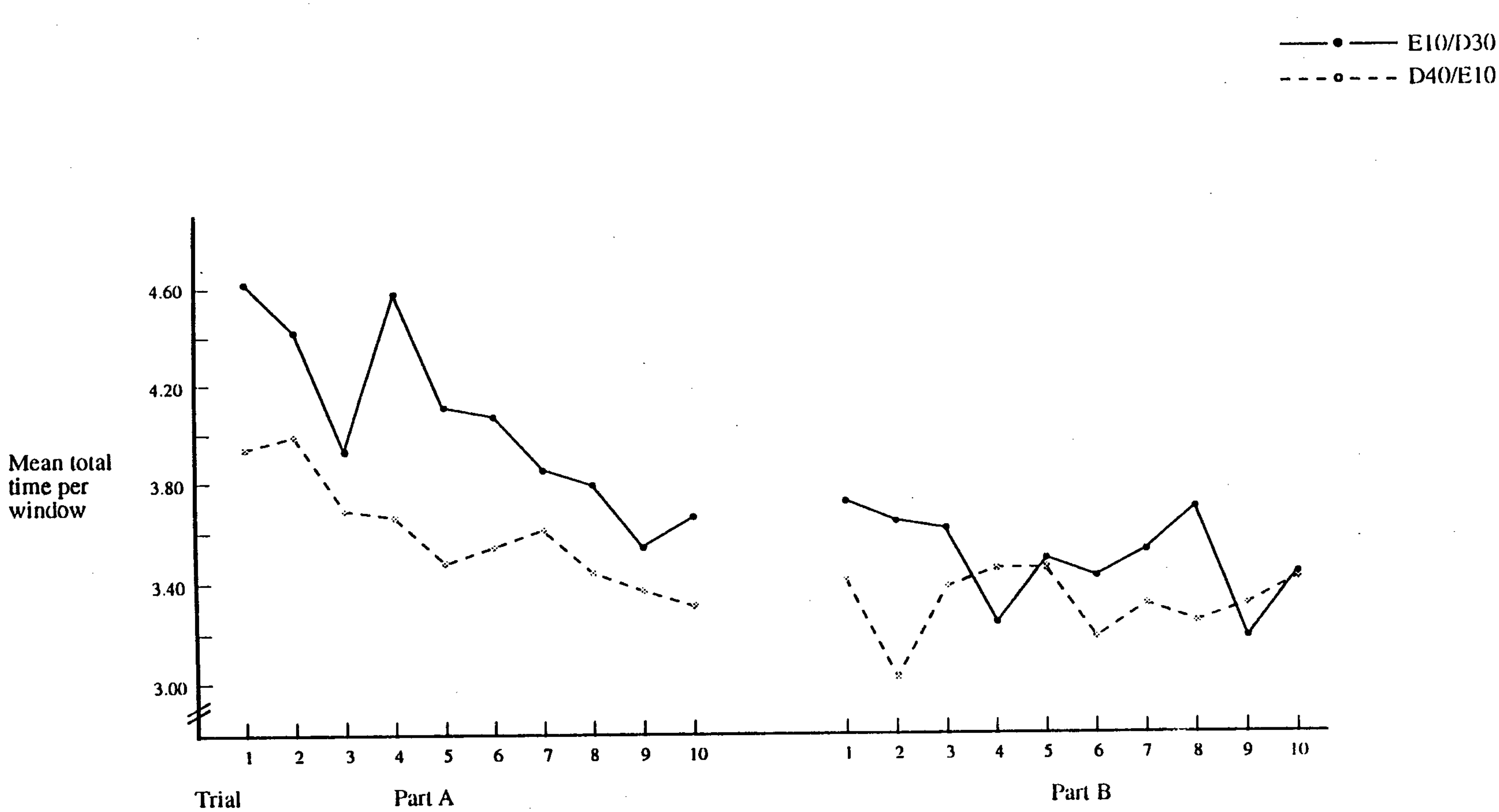

Mean of unopened windows
4.00
3.50
3.00
2.50
2.00
1.50
1.00
.50
Trial
1 2 3 4 5 6 7 8 9 10
Part A
1 2 3 4 5 6 7 8 9 10
Part B
E10/D30
D40/E10

FIGURE 3


E10/D30
D40/E10
Mean total time per window
4.60
4.20
3.80
3.40
3.00
Trial
1 2 3 4 5 6 7 8 9 10
Part A
1 2 3 4 5 6 7 8 9 10
Part B