

## INTERRUPTION OF A MONOTONOUS ACTIVITY WITH COMPLEX TASKS : EFFECTS OF INDIVIDUAL DIFFERENCES

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The fluctuations of vigilance and performance for operators working in monotonous conditions were studied in laboratory. Three experimental designs were achieved on 20 subjects :

- one reference condition with a vigilance task of 3 hours 30 during day time,
- one experimental condition with interruptions of monotony during the vigilance task by a sustained task, during the same day time period,
- the same experimental condition during night time.

The purpose was to analyse the effect of breakdown in monotony on arousal and human performance and to look for individual differences in human performance. Physiological data were collected in order to study the variation of arousal. Response times and omissions were used as performance index. Individual differences can be observed for performance and vigilance. Two kinds of behavior are defined : stable subjects and subjects characterized by fluctuations both for arousal and performance during the task. During day time period, breakdown of monotony has a positive effect on performance especially for subjects with fluctuations of arousal. Night time condition creates a sleep deprivation and the consequence is that the efficiency of the reactivation due to breakdown by sustained task is not demonstrated. Results are discussed in regard of the theory of Fisk and Schneider on automated and controlled mental processing during monotonous activities.

### INTRODUCTION

The growing automation of the work often creates monotonous situations that can increase the difficulty of the task for the operator, especially when he has to take a decision or to achieve a manual action after a long and monotonous period of monitoring, i.e. in transport operations (Coblentz et al., 1989 ; Coblentz et al., 1990) as well as in supervisory control activities (Saito, 1972 ; Murell, 1977). The aim of this research is to study in laboratory the effects of the interruption of a monotonous vigilance task (VT) by some small modifications (Sustained Attention Task : SAT) that involve a different processing.

### METHOD

The task consists in the monitoring on a computer screen of a vertical bar which laterally moves in a frame. On each side of this frame, there are two limits. Subjects are instructed to detect each passage of the vertical bar through the limits. With a randomly duration (within 15 seconds and 1 minute) before this event, a visual stimulus (a square) appears above one of the limits. This stimulus has two different meanings according to the level of the task :

- the first level called Vigilance Task (VT) is considered as a monotonous task of passive monitoring ; at this level this signal indicates the side where the bar will go. When the signal passes through one of the limits, subjects have to press a button. Then, the bar comes back

automatically to the center of the frame. Since the task does not require effort nor memory the used processing is an automatic one. At this level, the event rate is of 3 per period of 10 minutes, the second level called Sustained Attention Task (SAT) can be seen as a dysfunction of the automatic system. Subjects are told that sometimes the square appears at the opposite side of the one where the bar will pass. In these cases, subjects are informed that no response is required. On the contrary, when the bar passes through the marks, subjects are told to bring the bar in the center of the rectangle with a joy-stick. At this level, the task requires a controlled processing since subjects have to memorize the position of the square before responding. The event rate is of 6 per period of 10 minutes.

Subjects can detect that the level is changing only by the increase of the velocity of the bar displacement. In order to maintain the motivation of the subjects, a knowledge of the results is given after each response or omission. Furthermore, subjects are required to read a text which explains the task on a scenario form.

Three conditions are compared (figure 1) :

- control condition :  
VT is presented during 2 hours 50.  
SAT is only presented on baseline (SATBAS) and at the end to evaluate the final performance (FINSAT)

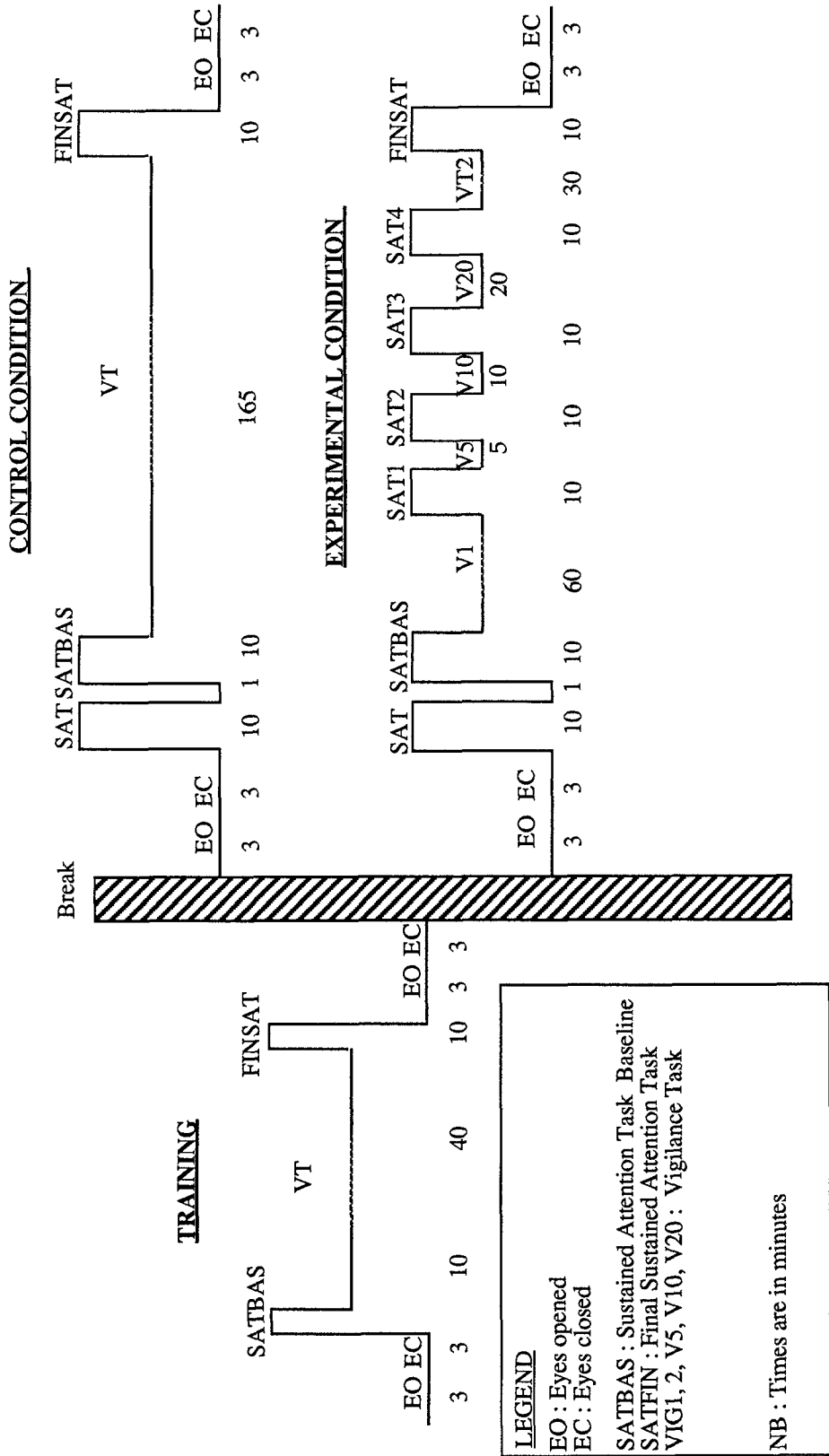


Figure 1. Design

- experimental condition :  
 VT is presented during a 90 minutes period (VT1) and then during a 45 minutes period (VT2).  
 SAT is presented during 10 minutes periods :  
 . at the beginning (SATNAS),  
 . after VT1 to interrupt monotony : SAT1, SAT2, SAT3, SAT4,  
 - at the end of the experimentation (FINSAT)
- night condition :  
 the experiment takes place according to the same protocol that the experimental condition. Subjects can be considered as sleep deprived since they had a normal work the day before the experiment.

Because of the individual differences that can mask the effect of the conditions, a within-subjects design was conceived. Subjects performed the task into three conditions.

In order to control a possible learning effect, a training is given to subjects. This training is identical to the control protocol but lasts only 2 hours. Between this training and the beginning of the experiment, a break of 1 hour is given to the subjects for a small lunch or a collation.

The data collected are of two sorts :

- performance parameters : response times and omissions,
- physiological data : electro-encephalography (EEG) and electro-oculography (EOG). For the recording of EEG, 16 standard 10/20 derivations were used. For EOG, two electrodes were fixed, one at one centimeter above the eye, the other on a neutral zone, the mastoid. These two parameters are recorded on a magnetic tape and then digitized. EEG was automatically analyzed with specific programs developed in order to provide one mean spectrum par 10 seconds period. Subsequent analysis was performed, in particularly the alpha-theta and (alpha+beta)-(theta+delta) ratios. EOG was processed with the aim in view to extract the eyes blinks frequency per minute.

Each one of the twenty subjects performed the task in the three conditions, in each of the six possible orders, for a total of sixty experiments. On these sixty experiments, forty eight are available. Twelve were rejected because of technical problems.

## RESULTS

Two main results were shown. First, a great individual variability was noted : some subjects present a stable level of arousal and performance during all the experiment whereas other show fluctuations of vigilance and performance.

The second result concerns the effect of the interruption of the task. The comparisons of the means for response times do not show significant effect due to the important individual variability. That is the reason why this effect was studied on the variability of the whole sample of subjects. A coefficient correlation was computed between the mean response times collected at the beginning task (figure 2). In the day-experimental condition, the correlation coefficient is significant. This result indicated that the SATs have maintain the performance at a stable level between the beginning and the end of the experiment. On the contrary, in the control condition, in which the coefficient does not reach a significant level, the performances are varying. In the night experimental condition, breaking the monotony by alternating the processing has no significant effect because of the sleep deprivation.

## DISCUSSION

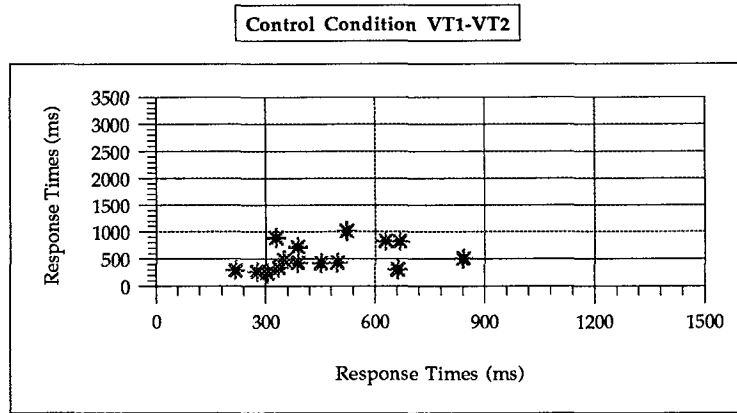
This result may be explained by the automatic controlled processing theory of Fisk and Schneider (1980, 1981, 1985). During the VT, an automatic processing was used whereas controlled processing was required during the SAT. The VT does not require an important effort by the subject. He only had to monitor the vertical bar and had nothing to memorize. On the contrary, the SATs required effort since subjects had to memorize the position of the square. Fisk and Schneider's theory suggests that vigilance decrement is due to the use of the same type of processing for extended periods of time. During the control condition, subjects performed the same task (VT) for 2 hours 30 without interruption, whereas during the experimental condition this task was presented for 1 hour 50 with four 10 minutes interruptions (SAT).

## ACKNOWLEDGEMENTS

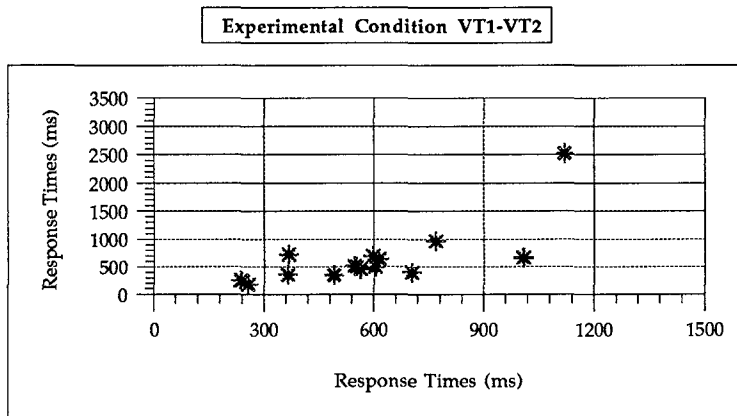
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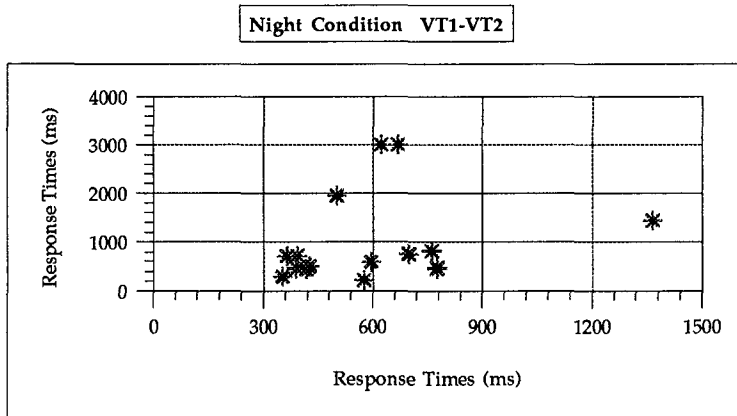
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$r=0.13$  NS



$r=0.53$   $p<0.02$



$r=0.30$  NS

Figure 2.  
Correlation diagrams between the beginning (VT1) and end (VT2) of the task under the three conditions.

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