Arh. hig. rada, 22 (1971) 323.

DETECTING RARE SIGNALS AND MONITOR'S CONFIDENCE THAT HIS RESPONSE IS A DETECTION

A. Krković, M. Gredelj and Zdenka Živković

Institute of Psychology, University of Zagreb, Zagreb

(Received for publication December 16, 1971)

While detecting rare visual signals subjects were asked to state their confidence that the signal to respond at was actually present whenever they emitted the reaction. Generally this subjective confidence proved to be higher for responses which were correct detections than for those which turned out to be false alarms. However, a substantial number of detections was made with low confidence and a substantial number of false alarms was made with complete certainty that the critical signal was actually present.

If not adopting the extreme strategy to emit affirmative response (detection) at every signal that comes along on a display, subject-monitor presumably selects some higher level of confidence (LC) that the critical signal was actually present before he responds at it.

Whenever this high or higher LC is attained a response occurs. Some responses turn out to be correct detections while others are false alarms (errors of commission).

It seems reasonable to assume that the judgement about the presence of a critical signal will be made with more confidence when the signal is actually present than when it is not. Consequently it could be expected that the average LC associated with detections will be higher than that associated with false alarms. Apparently the latter supposition is indirectly supported by the observation reported by *Davies* and *Tune* (1) that the response latencies associated with false alarms are considerably longer than those associated with correct detections.

In any case monitor's LC that the critical signal was present when he responded seems interesting enough to obtain, for it may not only shed some more light on the responding strategy employed, but, if consistent and valid, it could also increase the informative value of responses in a vigilance situation.

METHOD

A visual version of an auditory vigilance task developed by *Krković* and *Šverko* (2) was used in this investigation. Seated in a dimmed box the subject watched a signal light flashing at the rate of two per second. Flashes were grouped in sequences of 2 to 7 in a group, with a lag of 1.5 seconds between groups.

The signal to respond at by pressing a key was defined as any two subsequent groups having the same number of flashes. In the course of 1.5 hour long vigil there were 36 such critical signals presented.

Two sessions were run with each of 18 subjects (psychology students). In the LC-session the subject was required to declare (to jot down) the level of confidence that the critical signal was actually present whenever he responded. The level of confidence had to be expressed as a value on an eleven point scale: 0, 10, . . . , 100. In a control session, which was always run first, there was no such requirement, neither did the subject knew that it will happen in the following LC- session.

Subjects were rather familiar with the experimental conditions for previously they participated several times in experiments with this and other versions of the same vigilance task, and all important factors were therefore stabilized.

RESULTS AND DISCUSSION

In Table 1 are presented total numbers of detections and false alarms emitted by all subjects in the two sessions. In parentheses are given percentages of corresponding overall sums.

Table 1

	Detections	False alarms	Sum
Control session:	289 (53)	255 (47)	544
LC – session:	354 (69)	158 (31)	512

The overall number of responses (last column) is not significantly smaller in the LC-session than that in the control session. However, the number of detections in the LC-session is significantly greater (P cca. .02) and the number of false alarms is significantly smaller (P smaller than .01) than the corresponding numbers from the control session. It therefore seems that the requirement to state the level of subjective confidence that the critical signal was actually present with each response influences the strategy and performance of monitoring in a favorable way.

In Figure 1 are depicted distributions of frequencies of LC statements for detections as well as for false alarms.

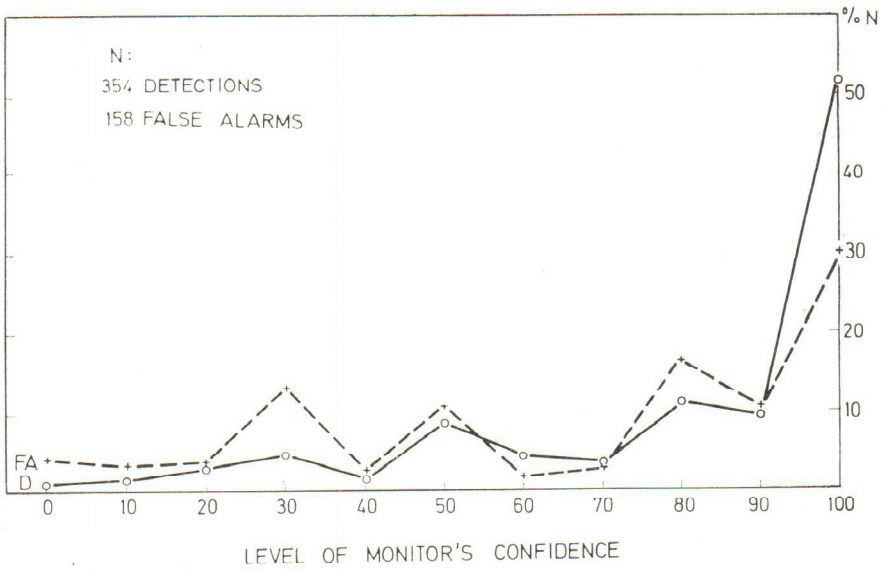

Fig. 1. *The distribution of relative frequencies (percentages) of responses given with different levels of confidence that the critical signal was acutally present. Solid line: detections; broken line: false alarms*

Surprisingly enough, only about 50 percent of responses which were correct detections was made with full (100) certainty that the signal was actually present, and many a detection was made with relatively very low LC.

On the other hand almost 30 percent false alarms was made with complete confidence that the response was a correct detection. However, this figure is significantly smaller than the corresponding percentage for detections (P smaller than .01). Mostly owing to this difference the overall average LC for detections (79) is greater than the overall average LC (64) for false alarms, though the total LC ranges for both kinds of responses are the same.

The changes in the average LC as a function of the time on watch are presented in Figure 2.

Throughout the watch the average LC for detections is consistently higher and more stable than that for false alarms. For the latter there is a significant decrease in the average LC from the first 15-minute work period toward the last 15-minute period (P smaller than .01). For several reasons this decrement cannot be ascribed but to subject's becoming more critical in judging the LC with the given response as the time on vigil goes on. The main supporting reason for this is the fact that the frequency of false alarms does not significantly decrease in the course of

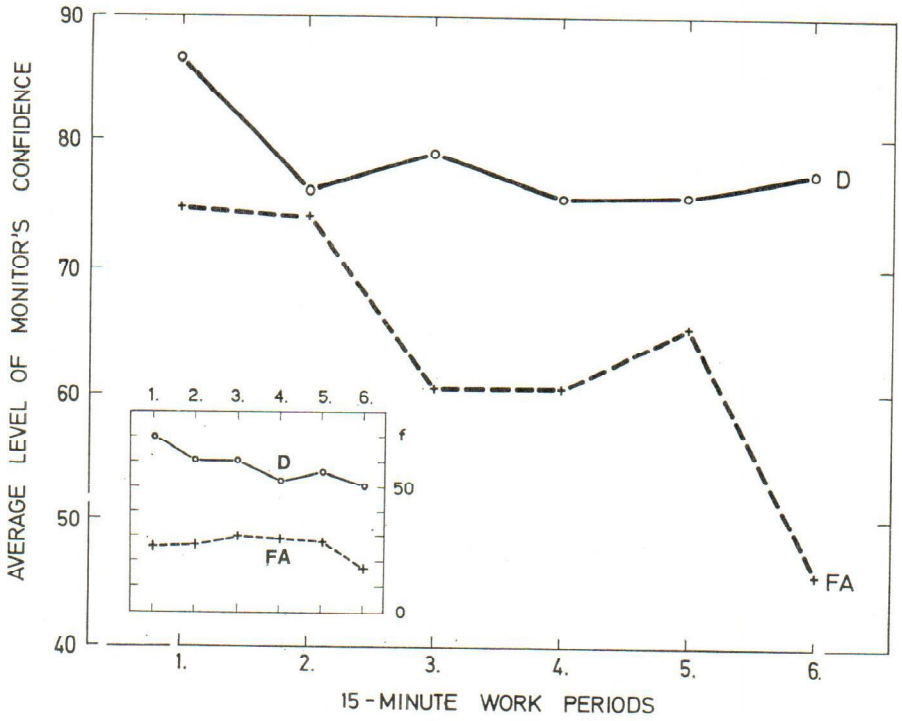

Fig. 2. *Main figure: Average confidence level associated with detection (solid line) and with false alarms (broken line) as a function of the time at work. Small inserted figure: Frequency of detections (solid line) and false alarms (broken line) as a function of the time at work*

vigil (see small diagram inserted in Fig. 2). It remains to be explored whether the low average LC for false alarms attained in one session will persist in the next.

However, great individual differences were observed in the total number of emitted responses in the course of LC-session ranging from only 8 up to 57 responses.

Average individual LC was also found to vary considerably, i. e. from from 41 up to 100 (one subject used no other LC value but 100).

Correlations of individual average LCs with different measures of vigilance performance and strategy did not prove very high. Computed as *Spearman's* coefficients of rank correlation obtained values are as follows.

1. With the total number of emitted responses . . . . . –.02
2. With the number of detections expressed as percentage of the total number of critical signals presented 56

3. With the number of detections expressed as percentage of the total number of emitted responses 44
4. With the number of false alarms expressed as percentage of the total number of stimuli presented . . . . . –.42
5. With d' measures from the signal detection theory 53
6. With β measures from the signal detection theory 30

All values are significant at the .05 level except the first and the last one, but because of a small sample a cross validation may seem advisable. Yet it seems that there is a tendency of LC to have more common variance with measures of the efficiency of performance (e. g. with variable 2.) than with any measure of responding strategy used.

References

1. *Davies, D. R., Tune, G. S.:* Human Vigilance Performance, Staples Press, London, 1970, p. 17.
2. *Krković, A., Sverko, B.:* Acta Inst. Psychol. Zagreb, *54* (1967) 49.

Sažetak

SUBJEKTIVNA SIGURNOST U ISPRAVNOST REAKCIJE PRI DETEKTIRANJU RIJETKIH SIGNALA

Za sat i pol detektiranja rijetkih vidnih signala od opažača se tražilo da nakon svake reakcije deklarira stupanj sigurnosti da su reagirali na signal na koji treba reagirati. Rezultati pokazuju da taj dodatni zahtjev općenito poboljšava radni učinak; u usporedbi s kontrolnim pokusom, broj ispravnih detekcija značajno je veći, a broj tzv. lažnih uzbuna značajno manji. Nadalje, prosječni stupanj sigurnosti u ispravnost reakcije veći je od one reakcije koje su zaista detekcije, nego uz one koje su lažne uzbune. Ali samo 50% detekcija dano je uz potpunu (100) sigurnost da se reagiralo na signal koji treba reagirati, a čak 30% lažnih uzbuna učinjeno je s punim uvjerenjem da se reagiralo na takav kritični signal.

Institut za psihologiju,
Filozofski fakultet, Zagreb

Primljeno 16. XII 1971.