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SENSITIVITY AND CRITERION IN AN ATTENTION TASK WITH BRAIN-  
DAMAGED PATIENTS

Subtitle :

Attention Task

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I T A L Y

SUMMARY. Sensitivity and criterion were studied in an attention task requiring detection of new stimuli, for a group (20) of patients with unilateral brain damage, restricted to the anterior or posterior areas. Patients were submitted to a simple attention task, in which the presence of a novel stimulus had to be detected against the repetition of the same repeated stimulus. It was found that only the site of the lesion (anterior vs posterior damage) had influence on the performance of the task. In fact frontal patients had both a lower capacity to discriminate between signals and nonsignals and a lower confidence of their responses.

Despite the great importance of attention in human behaviour, particularly for cognitive processes (Luria, 1973), very few studies considered how the two hemispheres work and how a local brain lesion affects this performance. Recently, it has been proposed that the two cerebral hemispheres hold two different attention systems: one, whose function is the sustained attention or vigilance, carried out by the right hemisphere, and the other, performed by the left hemisphere, whose task is a selective attention performance (Dimond, 1978; Jerison, 1977). Today we have very few data to say when one or the other mechanism is involved and so to specify the different hemispheric mechanisms at work.

The use of the Signal Detection Theory (S.D.T.) in sustained attention researches, has made possible the distinction of two possible factors implied in an attention task, that is, the sensitivity and criterion, or response bias. Whether these factors have different neurological bases it is not at present known, but many data are now available that show a difference between the behaviour of the two measures in sustained attention tasks (see reviews in Swets, 1973; 1977). Some recent experiments (Salmasso et al., 1976; Salmasso, 1980) have also proved that sensitivity and criterion may have a different hemispheric basis. So, it should be reasonable to expect that patients with unilateral damage will show different behaviour effects according to the side of the lesion. However, as suggested by Luria (1973) different zones of the brain may, in an attention task, hold different roles. In fact, although not directly implied in sensory processes, anterior areas seem to keep the main role every time a discrimination and a decision process are necessary to respond correctly (Luria,

1973).

Our aim was to see how the site and the side of the lesion might affect attention performance of brain damaged patients, and whether the same or a different pattern could be found between sensitivity and criterion.

## METHOD

### Subjects

Twenty patients of the Neurological and Neurosurgery Department of the University of Padua were tested. They were subdivided in four even groups. All subjects had unilateral cortical damage (left or right) restricted to the anterior (frontal areas) or posterior (temporal, parietal, and occipital areas) parts of the brain, as assessed by clinical, neuroradiological, electroencephalographic and Brain Scan data. Their average age was 54.4 and no significant differences were proved among the four groups. Twelve patients, of comparable age, admitted to the same Department for a lesion below the cervical spine, were also used as controls.

### Procedure

Two tachistoscopic tests were presented to the patients, one with pairs of letters and the other with pairs of lines, as previously used with normal people (Salmaso et al., 1976; Salmaso, 1980). To prevent or reduce possible scanning effects, the two elements of both letter and line pairs, were vertically arranged. One of these pairs was used as nonsignal stimulus, the habituating one, and all the others as signals. Every pair was rear-projected on the centre

of a grey translucent screen for 100 msec. Two sequences of 160 pairs were presented to every subject. In every sequence, divided in two equal periods, 32 stimuli were signals, for which an overt response was required, and the remainders were repeated presentations of the same pair. In order to make the test more sensitive to possible differences among the four groups, a very fast event rate (1 stimulus every 2 seconds) was used.

When projected, the size of every stimulus was about  $1 \times 0.5$  degrees. To habituate the subject every sequence began with the repeated presentation of the same pair (the nonsignal stimulus) and the task was to detect and report, by pressing a switch, the presence of a novel stimulus. In order to see whether the relative superiority of each hemisphere to handle particular type of stimuli could also affect attention performance, each patient was tested with a letter sequence and a line sequence. Half of the subjects began with the first one and the others with the second one. Before starting the patients received a brief training in which the maximum attention was given to the appropriate understanding of the instructions of the task.

The performance was scored according to non-parametric estimates of sensitivity [  $P(\bar{A})$  ] (McNichol, 1972) and criterion [FPR] (Richardson, 1972).

## RESULTS

The data of the controls and of the patients were analysed by means of two analyses of variance, one for  $P(\bar{A})$  and one for FPR. In both measures, no differences were proved in the control group for main factors or interactions.

For the patient group only one important result was found to

reach significance. Both measures show a significant effect for the site of the lesion (anterior, posterior). In the  $P(\bar{A})$  measure [ $F=6.73$ ,  $df=1/16$ ,  $P<.025$ ] the patients with a posterior damage have a greater sensitivity than that of anteriors (0.948,  $SD=.049$  vs 0.807,  $SD=.179$ ). On the contrary, the FPR measure shows that the criterion adopted by the anteriors is larger than that used by posteriors [ $F=5.833$ ,  $df=1/16$ ,  $P<.05$ ](0.127,  $SD=.194$  vs 0.054,  $SD=.055$ ). Both results, together with those of control patients, are summarized in Table 1. No effect of hemisphere damage and no interaction "hemisphere-

INSERT TABLE 1 ABOUT HERE

re by material" was found. Also, in the first and in the second period the performance of the patients was the same.

#### DISCUSSION

As suggested by previous works (Diamond, 1977; Salmasso et al. 1976; Salmasso, 1980) it was expected that the side of the lesion would have the major effect in this task. On the contrary, the damaged hemisphere seems not to have as much importance as the site of the lesion and the relative superiority of each hemisphere for a particular kind of process does not modify the performance on this attention task. The absence of any interaction between side and site eliminates the possibility to use hemispheric findings and theories to explain such differences.

It seems to us that the only way to discuss the data comes along with the work of Luria and Homskaya (1970) on the role of the frontal lobes in the control of the orienting reactions. The part played by these structures in an attention task is an active one, with

a fine control of the arousal level, perhaps tonic and phasic, making possible the discrimination and selection of the incoming stimuli, that is, an appropriate level of sensitivity. Due to the lesion, that may increase the neurological noise (Gregory, 1959) and perhaps, to the experimental situation, that would cause an habituation to nonsignal events (Mackworth, 1969), the ability of the subject to detect the signals from noise is diminished. However, this effect seems to depend only on the anterior structures, because the sensitivity of the posterior brain damaged patients is quite similar to that of the control group (0.948 vs 0.989).

This hypothesis seems also confirmed by the FPR results. The anterior patients use a more liberal criterion to decide if a novel stimulus has been presented, that is, their responses have a lower confidence than those of the posteriors. This is the similar pattern reported by Luria (1973) with frontal patients, where a greater number of responses to irrelevant stimuli than any other type of patient was recorded. In this experiment, the false positive responses are responses given to the habituating stimulus, or nonsignal event, which did not require a response, or better, they are misclassifications of the same repeated stimulus. We can therefore conclude that anterior parts of the brain are directly implicated in the information processing analyses requested by an apparently simple task like a novelty detection. A similar pattern of results has recently been found by Shallice and Evans (1978) in a Cognitive Estimation Task and by Capitani et al. (1978) in a colour discrimination, despite that in the latter one a difference between left and right frontal patients was also proved. However, in both cases posterior patients perform better than anterior

ones. Unfortunately, no other experimental data are today available showing a difference between the site of the lesion, irrespective of the side, and, of course, the relationship among areas of the same hemisphere cannot be studied that in brain damaged patients. So, nothing else may be said about the specific role of the frontal areas as compared to that of the others and, in particular, about the mechanisms by which human beings respond to new stimuli and do not respond to the old ones.

#### REFERENCES

- Capitani, E., Scotti, G., Spinnler, H. Colour imperception in patients with focal excisions of the cerebral hemispheres. Neuropsychologia, 1978, 16, 491-496.
- Dimond, S. J. Vigilance and split-brain research. In R. R. Mackie (Ed), Vigilance. Nato Conference Series, Plenum Press, 1977, Pp 341-359
- Dimond, S. J. Disconnection and psychopathology. In J. H. Gruzelier and P. Flor-Henry (Eds), Hemisphere asymmetries of function and psychopathology. Charing Cross Hospital Medical school, 1978.
- Gregory, R. L. Increase in neurological noise as a factor in ageing. Proceedings of the Fourth International Congress on Gerontology, 1959. Cited in D. G. Stein and J. J. Rosen (Eds), Learning and memory New York : Macmillan, 1974, P 49.
- Jerison, H. J. Vigilance: biology, psychology, theory and practice. In R. R. Mackie (Ed), Vigilance. Nato Conference Series, Plenum Press, 1977.



- Luria, A.R. The working brain. Harmondsworth: Penguin Books, 1973.
- Luria, A.R., Homskaya, E.D. Frontal lobes and the regulation of arousal processes. In D.I. Mostofsky (Ed), Attention: contemporary theory and analysis. New York: Appleton Century Crofts, 1970.
- Mackworth, J.F. Vigilance and habituation. Harmondsworth: Penguin Books, 1969.
- McNichol, D. A primer of signal detection theory. London: George Allen and Unwin, 1972.
- Richardson, J.T.G. Nonparametric indexes of sensitivity and response bias. Psychological Bulletin, 1972, 78, 429-432.
- Salmaso, D. Hemispheric differences in a novel task requiring attention. Perceptual and Motor Skills, 1980, 51, 383-391.
- Salmaso, D., Denes, G., De Stavola, G. Interhemispheric differences in attention to novelty. Italian Journal of Psychology, 1976, 3, 273-283.
- Shallice, T., Evans, M.E. The involvement of the frontal lobes in cognitive estimation. Cortex, 1978, 14, 294-303.
- Swets, J.A. The relative operating characteristic in psychology. Science, 1973, 182, 990-1000.
- Swets, J.A. Signal Detection Theory applied to vigilance. In R.R. Mackie (Ed), Vigilance. Nato Conference Series, Plenum Press, 1977.

TABLE 1 :  $\bar{P}(A)$  and FPR means for control, posterior and anterior patients.

Measures and groups	Controls N=12	Posteriors N=10	Anteriors N=10
$\bar{P}(A)$	0.989	0.948	0.807
SD	0.041	0.049	0.179
FPR	0.007	0.055	0.127
SD	0.005	0.09	0.194

Zusammenfassung :

In einer Gruppe von Patienten mit einseitiger Hirnschädigung, in anterioren oder posterrioren Bereich, wurden Sensitivität und Kriterium in einer Aufmerksamkeitsaufgabe untersucht. Dabei wurde herausgefunden, dass nur die Lage der Lesion auf die Ausführung der Aufgabe einen Einfluss hat. Patienten mit frontalen Läsionen zeigten eine geschwächte Fähigkeit zwischen Signalen und nicht-Signalen zu unterscheiden und sie zeigten eine verringerte Sicherheit in ihren Antworten.

Resume' :

Ce travail a été consacré à l'étude de la "sensitivity" et des "criteria" par lesquels un groupe de malades avec de lésions unilatérales cérébrales, limitées à la partie antérieure ou postérieure, ont réagi pendant la tâche qui leur fut donnée de prêter attention à la nouveauté. Les résultats démontrent que seulement la position de la lésion a une influence sur la performance de la tâche: les malades avec une lésion frontale se révélèrent soit moins capables de discerner entre signaux et non-signaux, soit ayant moins de confiance dans leurs réponses.