Proc. 2nd Internat.congress C.I.A.N.S., Praag 1975

S2 probability and CNV

R. Näätänen, A. Gaillard and S. Mäntysalo

Institute for Perception TNO, Soesterberg, The Netherlands, and Department of Psychology, University of Helsinki, Helsinki, Finland.

1. INTRODUCTION

The problem of behavioral correlates of the contingent negative variation (CNV) is still unresolved (for reviews, see Tecce, 1972; Hillyard, 1973; Näätänen, 1973). In early research, CNV was generally regarded as a correlate of expectancy, Therefore the name "Expectancy Wave" was used to denote the subjective probability of the immediate delivery of the imperative stimulus (S2). Later CNV has been suggested as being related to many other psychological mechanisms.

Despite the early interest in the relationship between CNV and expectancy little specific research attention has been directed at the possible relationship between expectancy and CNV. Moreover, much of this research has provided only mixed results. Many investigators (Walter et al, 1964; Hillyard and Galambos, 1967; Karrer et al, 1973; Järvilehto and Mäntysalo, 1973) have used reaction-time (RT) settings, in which S2 probability was varied. In such paradigms the effects of expectancy and motor preparation (for separation of these concepts, see Näätänen, 1971) are confounded because both increase as S2 probability increases (Sanders, 1966; Näätänen, 1972). These studies have generally found largest CNV amplitudes at submaximal S2 probabilities varying somewhere between 0.50 and 0.90. In the present study it is attempted to separate these two effects by varying the S2 probability under two experimental conditions: 1) in a signal-detection task in which no motor response was required; 2) in a physically identical RT-task in which the subject had to react to S2 as fast as possible.

2. METHODS

The EEG of 6 experienced subjects was monopolarly recorded from frontal (Fz), vertex (Cz), parietal (Pz) and occipital (Oz) positions. A weak visual warning signal (S1) was followed by an auditory S2 (1000 Hz, 50 msec) with an interval of one sec. The intertrial interval was randomly varied between 8 and 11 sec. S2 was embedded into noise (1000 Hz, 30 dB) so that it was detectable in 80-90 percent of the trials. S2 was presented at a within-block probability of .10, .30, .50, .70, .90 and 1.0, and the subject was told this probability before each block. Under the signal-detection condition, the subject had to press the "Yes" - or "No" - button to S2 after a delay of 1-2 sec to indicate whether S2 was present or not. After each block he was told his percentage of missed signals. Under the RT-condition, he was instructed to press the response button as fast as possible to S2. After each block he was told his median RT.

EEG and EOG signals were averaged and for each derivation two CNV measures were taken: the mean amplitude of early CNV (within the period of 500-666 msec after S1) and late CNV (834-1000 msec after S1) referred to the baseline (the mean amplitude within the period of 333-0 msec before S1).

3. RESULTS

An analysis of variance of the CNV data demonstrated that S2 probability had a significant effect on the late vertex CNV amplitude under the RT-condition ($p<0.01$), but not on the other CNV measures under either condition. Late CNV amplitude had an inverted U-curve relationship with S2 probability (Fig. 1). As shown in Fig. 1 both early and late CNVs at Cz were larger under the RT-condition than under the signal-detection condition (early: $p<.01$; late: $p<.02$). RTs became faster, when S2 probability increased ($p<0.01$).

4. DISCUSSION

As to the RT-condition, the vertex data (late CNV) corroborate the idea that highest CNV amplitudes are associated with high uncertainty conditions. The corresponding frontal data appear consistent. As to the detection task, the picture remains unclear, perhaps, because generally low amplitudes were recorded. Hence, it is not possible to see what kind of relationship would prevail between S2 probability and CNV without the possibly contaminating effect of the motor response. On the other hand, it appears that the motor response in this kind of experimental situation is important in order to secure a reasonable size of CNV.(*)

New experimental paradigms without motor response should be developed to attempt to settle the question regarding the relationship between S2 probability and CNV. Serious problems, however, might emerge in the interpreting even such good data. For example, of highest CNV amplitudes which still are observed as associated with high degrees of uncertainty, we might be tempted to regard CNV as a correlate of uncertainty. Such a result, however, might simply reflect a higher degree of interest or motivation of subjects under conditions involving high uncertainty as compared to those involving less uncertainty.

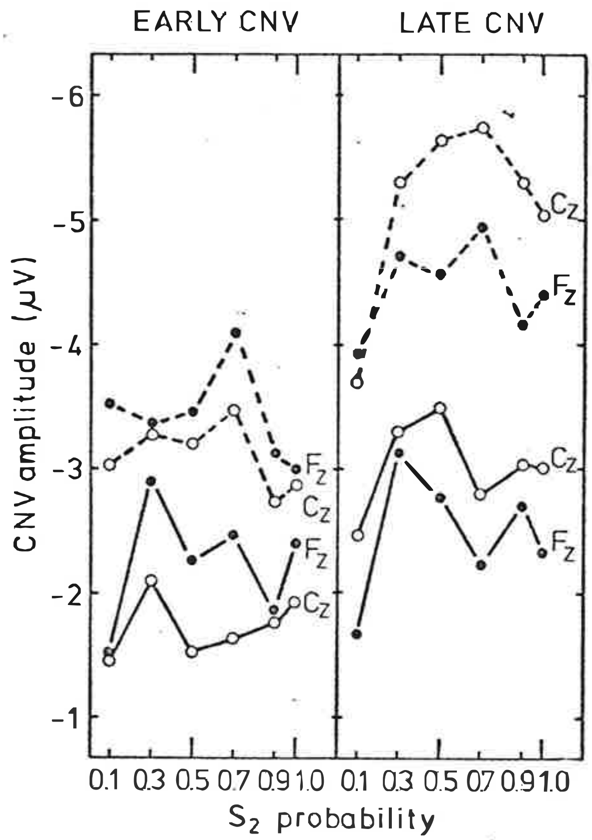

Fig. 1. Early and late CNV at frontal (Fz) and vertex (Cz) derivations as a function of S2 probability under the signal-detection (solid line) and RT-condition (dotted line).

FOOTNOTE

(*) However, it appears to be a serious error of interpretation to ascribe the large amplitude difference between the tasks to the mere activation of the pertinent motor systems in the RT-task. This difference might also reflect a higher degree of interest or motivation of the subjects in the latter kind of task.

REFERENCES

Hillyard, S.A. The CNV and human behavior: A review. Electroenceph. clin. Neurophysiol., 1973, suppl. 33: 162-172.

Hillyard, S.A. and Galambos, R. Effects of stimulus and response contingencies on a surface negative slow potential shift in man. Electroenceph. clin Neurophysiol., 1967, 21: 538-543.

Järvilehto, T. and Mäntysalo, S. Dependence of the CNV upon the probability of occurrence of S2. Paper presented at the 3th International Congress on Event Related Slow Potentials of the Brain, 1973, Bristol, (in press).

Karrer, R., Kohn, H. and Ivins, J. Effects of varying the stimulus and response contingencies of the CNV. Electroenceph. clin. Neurophysiol., 1973, suppl. 33: 39-43.

Näätänen, R. Non-aging fore period and simple reaction-time. Acta Psychologica, 1971, 35: 316-327.

Näätänen, R. Time uncertainty and occurence uncertainty at the stimulus in a simple reaction time task. Acta Psychologica, 1972, 36: 492-503.

Näätänen, R. On what is the contingent negative variation (CNV) contingent in reaction-time experiments? In A. Fessard and G. Lelord (Eds.) Proceedings of I.N.S.E.R.M. 1er colloque de Neurophysiologie Appliquée à la Psychologie & à la Psychiatrie: Activités Evoquées et leur conditionnement chez L'homme normal et en Pathologie mentale. 1973, INSERM: Paris, 121-152.

Sanders, A. Expectancy: Application and measurement. Acta Psychologica, 1966, 25: 293-313.

Tecce, J. Contingent negative variation (CNV) and psychological processes in man. 1972, Psychol. Bull., 77: 73-108.

Walter, W.G., Cooper, R., Aldridge, V.J. MacCallum, W.C. and Winter, A.L. Contingent negative variation: An electric sign of sensorimotor association and expectancy in the human brain. Nature (London), 1964, 203: 380-384.