Contingent Negative Variation (CNV) and Speed Anticipation Reaction Test

CONTINGENT NEGATIVE VARIATION (CNV) AND SPEED ANTICIPATION REACTION TEST

By

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Relationships among CNV, the simple reaction time, and the performance of the speed anticipation reaction test, a test being utilized as one of the most sensitive tests for driver aptitude in Japan, were investigated. 32 bus, truck, taxi drivers served as *S*s.

There was no signifcant correlation between the CNV amplitude and the simple reaction time. However, some degree of negative correlation was found between the CNV amplitude and the speed anticipation reaction time ($r=-0.3294$, $p<0.05$ in one-tailed test). And there was a tendency that *S*s who showed the semi-hasty reaction in the speed anticipation reaction test yielded larger CNV than that of the standard reaction (nearly accurate estimation) *S*s, and that *S*s who showed the delayed reaction yielded smaller CNV amplitude ($p<0.01$). Thus larger CNV amplitude of *S*s does not always predict the accuracy of the performance of the *S*s.

INTRODUCTION

CNV (the contingent negative variation) is usually measured in the constant foreperiod reaction time situation, one of the situations where the simple reaction time (RT) is measured. Consequently the investigators of CNV found interest in the relation between CNV and RT when they tried to find the behavioral correspondent of CNV. Walter, the first reporter of CNV, himself noted that the development of CNV was accompanied by the shortening of RT as the trials were repeated (Walter *et al.*, 1964). However subsequent studies have not supported the direct relation between the CNV amplitude and RT. Rebert & Tecce (1973), reviewing the studies on the relation between CNV and RT, pointed out that in 19 of the studies correlation coefficients were found and the mean of them was -0.365, and that in 4 studies no coefficient was reported but it was indicated that no significant correlation was found. Negative correlations in the above studies suggest some relationship between CNV and RT. However, based on the small average magnitude of the cor-

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relation and the common occurence of CNV–RT dissociation, Rebert & Tecce made the inference that the relationship is not causal one. Thus the simple reaction time does not seem to be always predicted by the CNV amplitude. Then, to make clearer the behavioral correspondent of CNV, the relation between CNV and other types of the reaction time could be investigated.

In the present paper, the results from the investigation on the relation between CNV and the speed anticipation reaction are mentioned. Strictly speaking, the speed anticipation reaction time is not the reaction time but the estimation time. However the test is conceived to involve the similar situation to that of the constant foreperiod reaction time experiment in which CNV is usually measured. Moreover, the speed anticipation reaction test is widely utilized as one of the most sensitive tests for driver aptitude in Japan. Therefore the present investigation on the relation between CNV and the speed anticipation reaction time will bring some information about the relation between CNV and individual difference variables.

Method

32 male bus, truck, and taxi drivers served as *Ss*. The mean age of them was 25.8 yr (19–37 yr). *Ss* underwent the measurement of CNV in the constant foreperiod reaction time situation, and the measurement of the speed anticipation reaction separately.

MEASUREMENT OF CNV AND RT

CNV was recorded in the constant foreperiod reaction time situation. Both the warning stimulus (S_1) and the imperative stimulus (S_2) were flashes of a Xenon lamp, and the S_1–S_2 interval was 2.0 sec. *S* was instructed to press a button with the right thumb when he recognized the second flash (S_2). 10 trials were carried out for an *S*, and RTs were recorded by an electronic time counter.

CNV was recorded from the Vertex (Cz) referred to the coupled ears with time constant 4.0 sec. EEG for 10 trials were averaged by a medical data processing computer (ATAC-501, NIHON KOHDEN) and CNV was drawn by an X–Y recorder. As the contamination of CNV by the eye movement is well known, eye movements were inhibited by the fixation of the source of the flash (6 mm in diameter), and the vertical movement of the left eye was checked by the simultaneous recording of the EOG.

SPEED ANTICIPATION REACTION TEST

Details of the apparatus and the procedure are explained elsewhere (Maruyama & Kitamura, 1961). In this test, a small light spot moves horizontally in a constant

speed and goes behind the black wall of a certain width. The task of *S* is to estimate the time to take for the spot to pass through the wall. *S* is instructed to press a key at the moment he thinks the spot comes out from the wall. And the time between the disappearence of the spot and the key press is called the speed anticipation reaction time (SART). 5 trials were carried out for an *S*.

The objective time for the spot to pass through the black wall is 2080 msec, and the estimation times of *S*s are classified as follows; (a) hasty reaction (0~1000 msec), (b) semi-hasty reaction (1001~1500 sec), (c) standard reaction (1500~3500 msec), (d) delayed reaction (3500 msec~). The intimate relationship between these classes and the accident proneness was verified by Maruyama & Kitamura (1965).

Results

The amplitude of CNV was defined as the maximum negative deflection from the baseline between S_1 and S_2 excepting for 500 msec immediately after S_1 as the evoked potentials by S_1 (the maximum amplitude). The mean amplitude of 32 *S*s was 14.4μv (SD=7.4). The mean reaction time (RT) to S_2 was 259.6 msec (*SD*=46.6). And the mean of the speed anticipation reaction time (SART) was 2304 msec (*SD*=917). Five of 32 *S*s are classified as the semi-hasty, 3 as the delayed, and the rest as the standard reaction. The estimation of the former two groups is inaccurate in the sense that the estimation time differs from the objective passing time.

Table 1. Correlations (r) among the CNV amplitude (CNV), the simple reaction time (RT), and the speed anticipation reaction time (SART).

	RT	SART
CNV	0.0328	−0.3294*
RT		0.2525

*$p<0.05$ (one-tailed test)

The between-subjects correlations were calculated among above 3 measures (Table 1). Among the correlations, only the negative correlation between the CNV amplitude and SART was significant ($r=-0.3294$, $p<0.05$ in one-tailed test). Except for an *S* whose RT is extremly long (420.7 msec), the positive correlation between RT and SART is significant ($r=0.4679$, $p<0.01$). However, the exception of the subject did not influence the significance of the CNV-RT correlation ($r=-0.1370$, n.s.), and of the CNV-SART correlation ($r=-0.3055$, $p<0.05$ in one-tailed test). The result of the more detail analysis on the relationship between CNV and the speed anticipation reaction is shown in Table 2.

Table 2. The relationship between the CNV amplitude and the speed anticipation reaction time (SART).

CNV / SART	0~20μv	20.1~40μv	*Mean*
Semi-hasty	2 Ss	3 Ss	20.2μv
Standard	22	2	14.3
Delayed	3	0	5.7

If the CNV amplitude are divided, tentatively, on the point of 20 μv, the distribution of the CNV amplitude differs according to the class of SART ($F(2, 29)=4.141$, $p<0.05$).

Discussion

No significant between-subjects correlation was found between the amplitude of CNV and the simple reaction time (RT) in the present experiment. As Rebert & Tecce (1973) pointed out, there may not always be an direct causal relationship between the two, but the correlation may occur when something, which independently influences CNV and RT, changes.

However it is more interesting that some degree of correlation was found between CNV and SART that were measured separately. The situation of RT measurement and that of SART are similar in the sense that there is some kind of anticipation of stimulus occurrence and that there is the motor response, but differ in the point whether the response is elicited by the occurrence of the stimulus or is emitted based on the estimation of the subject. The correlation between CNV and SART may suggest that CNV is not specific to the constant foreperiod reaction time situation, but may reflect some non-specific process common to other situations. In fact, the authors themselves observed that CNV occurred in the speed anticipation reaction situation (unpublished data).

The mean CNV amplitude of the *S*s who showed much shorter estimation time than the objective one (the semi-hasty reaction *S*s) tends to be lager than that of the standard reaction (nearly accurate estimation) *S*s, while the mean amplitude of the delayed reaction *S*s (who showed much longer estimation time than the objective time) was smaller than that of the standard reaction *S*s. Thus, in the present results, a larger amplitude of CNV did not always predict the accuracy of the performance of the *S*s.

And it might be noted that the complete inhibition of the eye movement was unattainable in the present experiment as in the other studies, despite the eye

movement was inhibited by the fixation and was checked by the simultaneous recording of EOG.

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