ON THE INTERRELATIONS BETWEEN SIMULTANEOUSLY OCCURRING CONDITIONED MOTOR AND SPEECH-MOTOR (VOCAL) REACTIONS

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The present investigation was carried out in order to solve problems connected with the analysis of some motor reactions of man.

A special apparatus built by L. A. Kazaryan permitted the determination of the latent period and magnitude of the conditioned motor reaction to stimuli (light, auditory cutaneous-mechanical), the latent periods of the vocal reaction and of the conditioned motor reaction to verbal stimuli.

The latent period of the vocal-motor (vocal) reaction was determined by the interval of time between the application of the stimulus and the initiation of sound formation (movement of the subject's larynx) when pronouncing the first sound of this or that word. Through the medium of laryngophones the movements of the larynx were changed into electrical waves; these, when amplified, cut off the relay system, which caused the electric timer (started the moment the stimulus was applied) to stop.

The motor response consisted of the subject's pressing a button or a handle with a spring.

Stimuli, addressed to the first signal system (light, auditory, cutaneous-mechanical), with a duration of 0.2 seconds were applied automatically every 3-5 seconds. The experimenter applied verbal stimuli also every 3-5 seconds. In the latter case, the latent period of the motor reaction was determined by the segment of time from the beginning of the movement of the experimenter's larynx when he was pronouncing the first letter of this or that word until the beginning of the motor response.

The observations were carried out on 16 healthy persons ranging in age from 20 to 35 years. In all, 74 experiments were carried out.

EXPERIMENTAL RESULTS

The results of the experiments are presented in the same order in which they were obtained in the process of conducting each experiment. In each experiment, 125 different stimuli, not counting the controls, were applied to the subject.

At the beginning of each experiment the latent period of the motor reaction to 15 light stimuli was determined for each subject. The extent of the latent period varied considerably - from 150 to 250 σ.

Then the extent of the latent period of the vocal reaction, consisting of the pronunciation of the word "light" in response to a light stimulus, was determined (15 reactions). In all 74 observations, the latent period of the vocal reaction was greater than the latent period of the motor reaction.

The lengths of the latent periods of the vocal reaction varied between 215-390 σ. The average length of the reaction equalled 305σ, i.e., it was 100σ longer than the latent period of the motor reaction.

As in the motor reaction, the latent periods of the vocal reaction (pronunciation of the word "sound") to an auditory stimulus were shorter than to light stimuli (by an average of 55σ).

In the next experiment, the subject was requested to press a button and simultaneously pronounce the word "light" in response to 15 light stimuli. Under these conditions the effect of the simultaneously occurring reactions on each other was insignificant. The latent period of the motor reaction increased by an average of only 5σ (2%), the vocal by 34σ (11%) in comparison with the data obtained during the isolated determination of these periods.

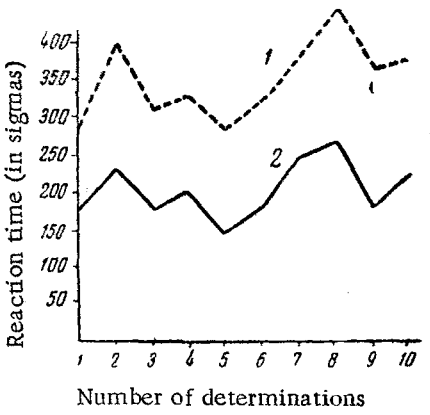

Fig. 1. Length of the latent periods of concurrent motor and vocal reactions. 1) time of the vocal reaction; 2) time of the motor reaction

In the majority of cases the variations in the lengths of the latent periods of the motor reactions coincided in their direction with the variations in the lengths of the latent periods of the vocal reaction (Fig. 1).

This, apparently, indicates that the variation in the lengths of the latent periods of both reactions is determined to a great extent by a change in the functions of the afferent pathways common to both of these reactions.

In the next experiment, the subject pressed a button and, in addition, named the stimulus (light by the word "light", auditory by the word "sound", cutaneous-mechanical by the word "blow") in response to 20 light, auditory and cutaneous-mechanical stimuli applied at random.

In this, a considerable increase in the latent periods of the motor, as well as vocal, reactions was observed.

The latent period of the verbal response was equal on the average to 540σ, while that of the motor response was 301σ, i.e., the time for the motor reaction increased by 97σ (47%) on the average and of the verbal one by 200σ (60%) in comparison with the data obtained in the preceding experiment.

The accomplishment of the motor reaction practically did not affect the length of the latent periods of the vocal reaction. Thus, the latent period of a vocal reaction occurring alone decreased only 37σ, or 7% on the average (according to the data of control experiments), in comparison with investigations in which the subject pressed a button and also gave a vocal response.

At the same time, control experiments showed that the lengths of the latent periods of the isolated motor reaction almost do not change if, instead of the stereotyped application of the same stimulus (for example, light), all of the above stimuli are applied at random. Consequently, the considerable increase in the latent periods of the motor reaction is connected not with a disruption of the stereotyped stimulus application, but is determined by the inhibitory effect of the vocal reaction – negative induction.

Thus, on the basis of the data obtained, the almost unilateral inhibitory effect of the vocal reaction on the motor reaction can be discussed. In individual cases it was possible to register the shortening of the lengths of the motor response in comparison with the lengths obtained in the preceding investigation, which also indicates a certain increase in the inhibition of the motor reaction.

Other relationships were observed when more complex motor reactions were studied.

In these investigations, the subject was first requested to press one of three buttons, which were placed close to each other, in response to three stimuli (light, auditory, cutaneous-mechanical) which were applied in various combinations. The average time for the motor reaction in these cases was equal to 526σ. Then the subject was requested to name the stimuli (vocal reaction) at the time the button was pressed. In 49 investigations, the average time for the motor reaction decreased in comparison with the data obtained in those investigations in which the subject responded to the applied stimuli with only a motor reaction; in 6 investigations this time was the same and only in 19 investigations (in 26% of the cases) did the average time for the motor reaction increase insignificantly. But the time for the vocal reaction when the motor problem was complicated increased considerably. On the average, it was equal to 653 σ, however, as indicated above, with a simpler motor response (pressing the same button when any stimulus was applied) it equalled 540σ.

In this case the practically unilateral inhibitory effect of the motor reaction on the verbal one can be discussed, while the occurrence of the vocal reaction even had a positive effect on the occurrence of the motor reaction.

In the control experiments after the basic investigations were carried out, we requested the subjects, as before, to name the stimulus as quickly as possible while pressing the button, i.e., we attempted to hasten the occurrence of the speech response only by artificial vocal reinforcement. In this case, some decrease in the time for the vocal reaction was always observed with a decrease in the time for the motor reaction also.

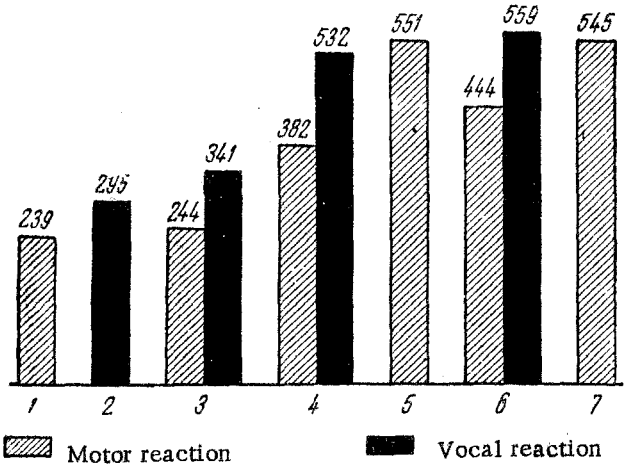

Fig. 2. Time (average) for motor and vocal responses with various experimental variants (in sigmas); the numerals 1, 2, 3, 4, 5, 6 and 7 indicate the experimental variants.

In the last experiments, the subject pressed the button corresponding to each stimulus in response to the words "light", "sound", "blow" spoken at random by the experimenter. The average time for the motor reaction was equal to 509σ, i.e., only 17σ less than in the case when the stimuli were applied which were addressed at the primary signal system.

The results of one observation on Subject S. are presented in Fig. 2.

The numeral 1 indicates the time for the isolated motor reaction to a light stimulus (average of 15 reactions). The numeral 2 designates the time for the isolated vocal response (average length of 15 reactions). As is evident, the time for the motor reaction was 56 σ less than that for the vocal one. The average duration of time for the concurrent motor and speech reactions (out of 15 reactions) to a light stimulus is designated by the numeral 3. In this case, the time for the motor reaction practically did not change, the time for the vocal reaction increased somewhat (by 46 σ).

The numeral 4 designates the average duration of time for 20 motor and vocal reactions occurring simultaneously in response to light, auditory and cutaneous-mechanical stimuli applied at random. Complication of the vocal reaction caused a considerable inhibition of the motor reaction, the average length of which became equal to 382 σ. Naturally, complication of the vocal reaction, in the present case, disruption of the steoreotype of applying the stimuli, caused an increase in the time for its occurrence to 532 σ.

The average time for 20 isolated motor responses (pressing one of three buttons) when three stimuli were applied at random (5) was equal to 551 σ.

The numeral 6 designates the average time for 20 simultaneous motor and vocal reactions when the three stimuli were applied at random. As is apparent in Fig. 2, in this investigation the time for the vocal response was greatest (559 σ), while the time for the motor response decreased considerably in comparison with the previous data which were obtained when this motor reaction occurred alone. Thus, in this case the occurrence of a vocal response brought about a noticeable decrease in the latent periods of the motor reaction.

In order to exclude the possibility that such a considerable decrease in the time for the occurrence of the motor reaction is connected with the effect of training, at the end of the investigation the subject again responded with only a motor reaction to 20 stimuli applied at random (7 in Fig. 2). In this case the length of the latent periods practically coincided with the data designated by the numeral 5 (differing from it by only 6 σ). Consequently, the above-described decrease in the time for the motor reaction when the vocal response occurs simultaneously is not determined by the effect of training.

The facts presented above indicate the complexity of the interaction between concurrent conditioned motor and vocal responses. If the occurrence of these responses is not connected with complicated analysis of stimuli but occurs stereotypically, their effect on each other is insignificant. In our experiments, this was observed with simultaneous motor and vocal responses to light stimuli which were applied stereotypically.

On the other hand, by complicating one of the reactions (for example the vocal one), thus complicating the central analysis, a distinct inhibition of its effect on the motor reaction could be observed. Even more complex relationships are observed when the accelerated analyses of the vocal, as well as of the motor reaction, are complicated simultaneously.

SUMMARY

The author studied the interrelations between simultaneously developing motor and vocal-motor reactions to such stimuli as light, sound, and skin-mechanical. When the stimuli were applied in a constant succession, the simultaneous development of motor and vocal-motor reactions did not exert any influence upon the length of latent periods. When the stimuli were applied nonstereotypically, inhibition of the motor reaction only was observed, if the motor reaction did not include the element of the central analysis of the vocal-motor reaction included it (verbal stimulus). If both the motor reaction and the vocal-motor reaction included certain central analysis, some decrease in the length of the latent periods of the motor reaction and a considerable increase in the length of the vocal motor reaction were observed in a majority of the experiments.