THE RELATION OF STUTTERING AND ALCOHOL TO CERTAIN TREMOR RATES[1]

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The occurrence of tremors in healthy persons was recognized as early as 1880 by Debove and Baudet (1). In 1896 Eschner (2) well established the truth of this observation. The most commonly recorded rate is 8 to 12 tremors per second. Neurophysiologists (3), (4), (5), (6), and (7), assign this tremor to the motor cortex. Athough we do not now agree with his statement in its entirety Peterson (8) has said "it is probable that all tremors are a modification of the rhythmic discharges from the cortex, which as is well known takes place at the rate of ten in a second." In a recent paper Travis (9) showed an absence of this tremor rate in the affected side in complete hemiplegia. This indicated that the source of this tremor rate has been correctly attributed to the cerebral cortex.

The purpose of the present study was to determine the effects of stuttering upon the rate and the extent of this tremor.

Apparatus and Method

The apparatus was that used by Travis (9). Briefly it consisted of three phonelescopes focused in the same vertical plane on Eastman standard size superspeed motion picture film. One phonelescope was used to record the tremors. To record these the fore-finger was placed directly on the membrane of the phonelescope. Into the backs of the other two phonelescopes were screwed telephonic electromagnetic receivers. One of these phonelescopes was placed in a circuit with a single dry cell battery and a make key to furnish a record of periods of overt stuttering. The other one was connected through a step down transformer (110/24) and a 2

[1] This study was done under the direction of Professor Lee Edward Travis.

m.f. condenser to a sixty cycle alternating current to record time in sixtieths of a second. The film was pulled through a film guide from a film box by a large wheel turned by hand. The various units of the apparatus were mounted separately on a thirteen inch concrete wall which extended several feet into the ground.

In order to obtain tremors from only the muscles responsible for the sustained extension of the fore-finger the hand was firmly supported at the level of the phonelescope. All tremors recorded were from the right hand. Each subject was instructed to extend his fore-finger and place it on the center of the phonelescope membrane. At an agreed command the subject was to talk of anything he wished. None recited memorized material.

Subjects

Thirteen male stutterers between the ages of 20 and 25 presenting both clonic and tonic types of stuttering served as subjects.

Results

There are three aspects of the tremor that might be observed, namely amplitude, rate and wave shape. Of these only the first two, amplitude and rate, were studied. In addition to these two aspects, consideration was given to the number of tremors appearing in equal intervals of time for the three conditions of the experiment, silence, free speech, and stuttering. Amplitude was determined by measuring the heights of tremors on a scale of equidistantly spaced horizontal lines. The units of the scale were arbitrarily chosen and represent a distance a little greater than 1 mm. These reported heights are not the absolute heights as any amplitude less than one was considered zero, and less than two was considered one, etc. In other words, no effort was made to estimate to fractions of a division of the scale. Furthermore, as will be seen in the third column of Table II tremors often failed entirely to appear during stuttering. On the basis of the rate of the tremors present during the stuttering period, the number of tremors, which would have appeared ordinarily

in the interval for which there were no tremors, was calculated. Each tremor derived by this means was given an amplitude value of zero and averaged in with those tremors which could be read. The number of tremors for each subject was determined as the average number occurring in an interval of time which was of the same length for silence, free speech, and stuttering. All figures in Tables I and II are averages derived from between 25 to 149 readings per subject. The ratio of observed difference to probable error of difference is expressed for each comparison that is made.[2]

Table I shows the differences in amplitude and rate of tremors during silence and during free speech in the first five

TABLE I

THE EFFECT OF NORMAL SPEECH ON AMPLITUDE, RATE, AND NUMBER OF TREMORS OF A RATE OF 8–12 PER SECOND

Subject	Amplitude			Rate per Second			Number of Tremors	
	Silence	Free Speech	O.D. / P.E.diff.	Silence	Free Speech	O.D. / P.E.diff.	Silence	Free Speech
E. S.	2.3	2.5	1.4	11.8	9.8	2.5	9.0	8.0
M. S.	1.0	1.3	2.1	7.3	6.2	4.4	8.5	6.0
W. S.	2.7	2.3	2.2	7.6	6.6	2.6	7.0	6.5
R. W.	2.1	2.6	1.9	6.0	6.9	.4	9.0	9.5
S. C.	.77	.87	1.6	9.5	9.0	3.1	9.0	8.0

stutterers studied. It will be observed that the act of speaking normally has no significant effect upon the amplitude of the tremor under consideration. There is a general tendency for the tremor rate to decrease during speech, but inasmuch as this trend is significant in only two of the five subjects, not much confidence can be attached to the finding. The greatest variation in the number of tremors per unit of time in the two situations is one and one-half tremors. This variation is quite insignificant since a rate difference of one tremor per second is found to be unreliable in the same subject. Table II gives the differences in amplitude, rate per second, and number of tremors found between free speech and

[2] This ratio should be three or more to be significant.

TABLE II

THE EFFECT OF STUTTERING SPEECH ON THE AMPLITUDE, RATE AND NUMBER OF TREMORS OF A RATE OF 8–12 PER SECOND

Subject	Amplitude			Rate per Second			Number of Tremors	
	Free Speech	Stuttering	O.D. / P.E.diff.	Free Speech	Stuttering	O.D. / P.E.diff.	Free Speech	Stuttering
E. S.	2.5	1.6	6.4	9.8	10.0	2.2	8.0	7.5
M. S.	1.3	.50	13.0	6.2	6.8	2.0	6.0	7.0
W. S.	2.3	1.7	4.0	6.6	7.2	1.5	6.0	4.3
R. W.	2.6	1.9	2.4	6.9	6.4	1.2	9.5	5.0
S. C.	.87	.31	8.0	9.0	9.2	1.2	8.0	4.5
S. B.	1.1	.48	6.2	8.6	8.5	.38	15.0	14.6
F. R.	3.2	1.3	5.4	6.9	8.3	6.6	7.8	7.4
P. G.	1.7	1.2	3.8	8.0	8.8	3.7	23.0	23.0
J. P.	2.9	2.0	3.4	10.5	10.3	1.1	28.0	15.0
C. C.	2.4	1.1	5.2	7.7	9.8	5.8	12.0	7.0
L. B.	3.8	1.3	5.0	8.4	8.8	1.4	9.0	9.0
P. H.	2.4	1.0	8.2	10.7	11.1	2.2	11.5	9.6
M. B.	2.1	.93	6.1	9.9	8.9	3.8	14.3	7.6

stuttering. In all cases but one, R. W., the amplitude of the tremor is significantly decreased during stuttering (Fig. 1.) The rate of tremors is significantly affected by stuttering in only four cases. Three of these show a decrease and one an increase in rate during stuttering.

The effect of stuttering upon the number of readable tremors is marked. In some subjects stuttering inhibits the appearance of tremors for over half the duration of the period studied.

EFFECT OF ALCOHOL ON TREMORS

At this point the research was extended to include the effect of alcohol upon the tremors. Dodge and Benedict (10) and Travis and Dorsey (11) have clearly shown that alcohol is a depressant to the nervous system having its first action on the higher centers. Being a depressant we wished to see what effect it would have on the tremors.

The same apparatus as previously described was used here. The alcohol used was double distilled 95 percent C. P. Alcohol.

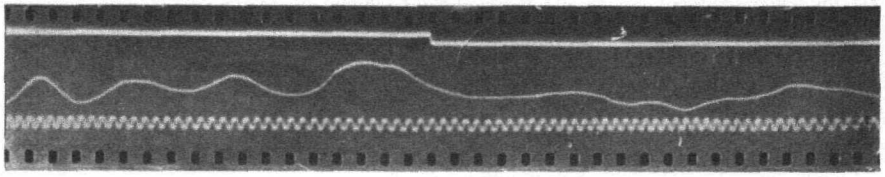

FIG. 1. A decrease in the amplitude of the tremors (8 to 12 per second) during stuttering. The break in the signal line (top) indicates the beginning of overt stuttering. In this and all subsequent figures time is in sixtieths of a second.

Subjects and Results

Six normal speaking males between the ages of 23 and 27 with varying appetites for alcohol served as subjects.

H. H., age 27, had been a constant drinker for the past five years. He drinks to intoxication two or three times a week with occasional drinks between sprees. He had had nothing to eat for nine hours prior to the experiment and had drunk to mild intoxication twenty-four hours before. 150 cc of 'near-beer' containing alternately 50 and 30 cc of alcohol was given H. H. every half hour for three hours. Thus he was given a total of 240 cc of alcohol. Tremor records were taken before every drink. After 80 cc of alcohol the tremors began to be depressed until after the entire amount of alcohol had been consumed, five hours after the experiment began, the tremors disappeared completely (Figs. 2 and 3). At this time

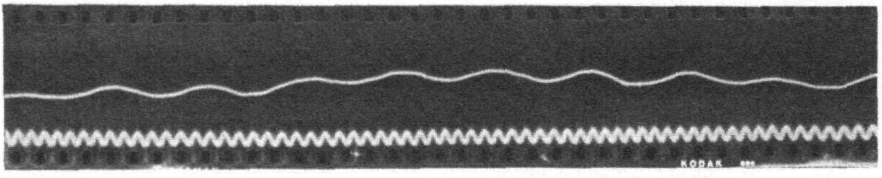

FIG. 2. Tremor record of H. H. prior to ingestion of alcohol.

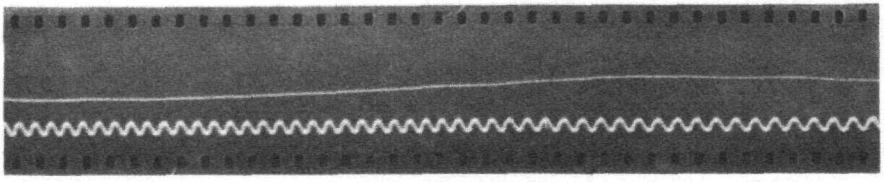

FIG. 3. Tremor record of H. H. after ingestion of 240 cc of alcohol.

the subject had all but lost voluntary control of general body movements.

R. I., age 23, had been a moderately heavy drinker for the past three years. He drank to intoxication two or three times a month with occasional drinks between times. He had eaten a light lunch four hours prior to the start of the experiment. R. I. was also given 150 cc of 'near-beer' every half hour containing alternate doses of 50 and 30 cc of alcohol. Records were taken every half hour. After 80 cc of alcohol the tremor frequency of 8 to 12 tremors per second disappeared but the tremor line became very irregular and rough and tremors of a rate of 15 to 20 per second appeared (Fig. 4).

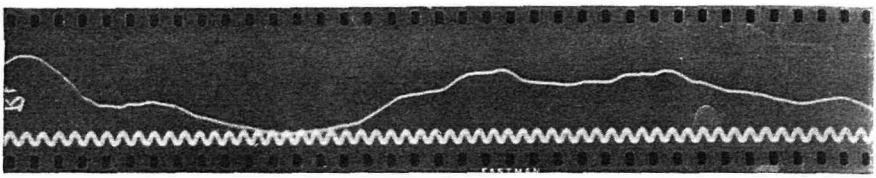

FIG. 4. Tremor record of R. I. showing tremors of a rate of 15 to 20 tremors per second.

After ingesting 130 cc of alcohol R. I. became sick and a half hour later vomited. One hour after vomiting the fast tremors (15 to 20 per second) had disappeared but the slower tremors (8 to 12 per second) had not regained their normal amplitude.

H. B., age 23, was a mild drinker. He had been intoxicated about once a month for the last two years. He had eaten a normal meal two hours and a half before the experiment began. 30 cc of alcohol were administered every half hour in 170 cc of orange flavored carbonated water. Records were taken after the ingestion of 90 and 150 cc of alcohol. The amplitude of the tremors was noticeably decreased after 90 cc of alcohol and was completely depressed after 150 cc of alcohol.

T. H., age 24, was also a mild drinker. He has been intoxicated about once a month for the past five years. He had eaten a normal meal two and a half hours before the experiment began. Every half hour 30 cc of alcohol were given in 170 cc of orange flavored carbonated water. Records were taken after the ingestion of 90 and 150 cc of alcohol. After 90 cc of alcohol, the tremors were gone. After 150 cc of alcohol

the tremors of the usual rate were still absent but a faster tremor frequency of 40 to 75 tremors per second appeared. In the third record, taken after vomiting the slower tremor was reappearing but was obscured by the faster one (Fig. 5).

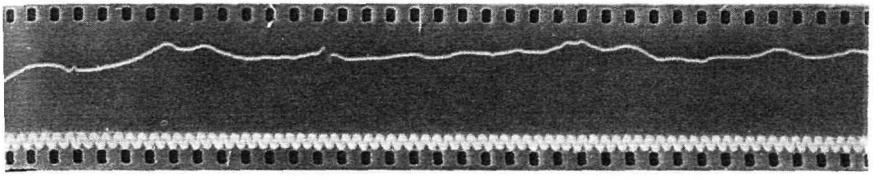

FIG. 5. Tremor record of T. H. showing tremors of a rate of 40 to 75 tremors per second.

W. T., age 26, was a very light drinker. He had drunk to intoxication only six times in his life. He had a normal meal two and one half hours before the experiment began. Thirty cc of alcohol were given every half hour in 170 cc of orange flavored carbonated water. Records were taken after 80 and 150 cc of alcohol were ingested. There was not much difference between the extent of the slower tremors in the normal records and the extent of those in the records taken after 90 cc of alcohol had been ingested. Tremors of a rate of 15 to 20 per second appeared however. The slower tremor was completely depressed after 150 cc of alcohol and a fast tremor rate, 40 to 75 tremors per second, was pronounced.

Thus in all cases it is seen that alcohol decreased the amplitude of the tremors of a rate of 8 to 12 tremors per second and in some cases introduced two new tremor rates. The first of these to appear had a rate of 15 to 20 and the other of 40 to 75 tremors per second.

EFFECT OF VOLUNTARY MOVEMENT ON TREMORS

In the course of the work thus far reported it was casually noted that gross voluntary movement brought out quite markedly the tremor rate of 40 to 75 tremors per second. The work was again enlarged to determine if any consistent difference in the occurrence of this rate could be demonstrated between stutterers and normal speakers.

Subjects and Method

The subjects, eight stutterers and nine normal speakers were all university students. Each was instructed to place his right fore finger on the center of the phonelescope diaphragm. At a command he was to slightly depress his finger and on elevating it to keep the recording beam of light as near the center of the film as possible. The hands of the subjects were not supported. All records were made during silence.

Results

Table III gives the percent of the time of occurrence of the fast tremor rate, 40 to 75 tremors per second. The percent was computed by reading the number of tremors occurring in a set interval of time. The time interval for all subjects was five seconds and the average number of gross movements in this interval for both groups was five.

TABLE III

THE PERCENTAGE OF TIME THAT THE TREMOR RATE OF 40 TO 75 TREMORS PER SECOND APPEARED IN STUTTERERS AND NORMAL SPEAKERS

Stutterers		Normal Speakers	
T	15.6	D	6.9
H	7.1	F	—
B	11.2	P	3.6
M	22.2	Pa	1.2
K	11.3	B	2.1
I	12.0	Fa	3.8
N	8.8	W	2.0
S	21.4	L	1.5
		H	1.8
Average	14.0		2.5

It will be seen in Table III that the fast tremor appeared much more frequently in the stutterer than in the normal speaker.

This greater proponderance of the fast tremor rate in the voluntary effort of the stutterer was well borne out in records taken for the first part of this report where we were not concerned with voluntary movement. When the hand was supported normal speakers rarely gave this fast rate of 40 to 75 tremors per second, but stutterers' records showed the fast

tremor very consistently whether during silence, free speech, or stuttering. Table IV shows the number of these tremors

TABLE IV

THE NUMBER OF TREMORS WITH A RATE OF 40 TO 75 PER SECOND APPEARING IN STUTTERERS' RECORDS IN HALF A SECOND

Subject	Silence	Normal Speech	Stuttering
R. W.	8	15	17
J. F.*	—	10	9
W. S.	8	7	7
C. A. C.*	—	6	11
L. B.*	—	8	16
E. R.*	—	4	7
S. C.	6	7	12
P. H.*	—	10	12
P. G.*	—	8	11
J. P.*	—	12	15
M. B.	5	7	12
Average	6.75	8.36	11.72

* No records taken during silence.

occuring in half a second in stutterers' records taken during the experimental work of the first part of this paper. It will be seen that these tremors are present under all considerations of the experiment and that their number is usually increased during stuttering.

GENERAL SUMMARY

1. Both stuttering and alcohol depress the tremors of a rate of 8 to 12 per second.

2. Alcoholic depression also causes the appearance of two other tremor rates, one 15 to 20 tremors per second and the other 40 to 75 tremors per second.

3. Voluntary movement produces a greater percentage of tremors of a rate of 40 to 75 per second in stutterers than in normal speakers. This tremor rate is more pronounced during stuttering than during silence or during free speech.

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