charged with breeding economic plants for resistance that they must first be informed regarding the stability or limits of variability of the parasites they seek to circumvent. We know now that new races of fungi are arising through natural hybridization. Hybrid structures have been obtained showing dominance and Mendelian segregations with crossing-over at reduction which is such an important feature in furthering evolution. We also find in the fungi: mutants, lethal factors, deficient chromosomes, sex-chromosomes, sex-linked characters and other genetic features. To repeat what I have said elsewhere: "The fungi in their reproduction and inheritance follow exactly the same laws that govern these activities in higher plants and animals."

I have tried to show that the fungi are not degenerate organisms which are on their way out in a scheme of evolution and so of little economic importance and scientific interest. The fungi, on the contrary, are progressive, ever changing and evolving rapidly in their own way, so that they are capable of becoming readily adapted to every condition of life. We may rest assured that as green plants and animals disappear one by one from the face of the globe, some of the fungi will always be present to dispose of the last remains.

CHEWING AS A TECHNIQUE OF RELAXATION

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MOTOR automatisms in great variety have often been explained as "tension outlets." Tics and other accessory movements have been said to be the expression of "inner tensions" or perhaps to be the "symbolic release" of such tensions. Fidgeting, wriggling, pipe smoking, gum chewing, automobiling and various active sports have received a like extenuation. There has been, however, little precise definition of the character of these alleged "tensions," and experimental evidence of their relief by the collateral activities cited is not abundant. We present here a brief summary of a protracted series of experiments on this topic, conducted during the period of a year and involving the measurement of a considerable number of processes in 20 subjects during 20 experimental days.[1]

The experimental approach requires first of all specific measures of various forms of "tension," since this word has many meanings. It requires also a technique of producing collateral motor automatisms and maintaining them, under controlled conditions. Perhaps the most popular of the automatisms referred to is chewing. Our subjects have been studied under three conditions: (*a*) Normal—not chewing and having nothing in the mouth; (*b*) Chewing—the masticatory being ordinary confectioned chicle, sweetened and flavored; (*c*) Control—allowing a flavored candy wafer to melt in the mouth, as a control over such things as suggestion, sensory stimulation and like influences. The studies of the Carnegie Nutrition Laboratory have shown that the metabolism costs of chewing are the same, whether a gum or a rubber stopper be used.

The experimental schedules were so arranged as to equalize such factors as practise, fatigue and individual differences. In all cases a preliminary base was secured, and the experimental variations gave measures which could always be expressed in terms of the base for the particular working period. The subjects were throughout engaged in various types of standardized work, proficiency in which was always measured. Concurrently the various measures of tension were secured.

Tension as Nervous Restlessness. Without the knowledge of the subjects, special observers watched them throughout the working day and periodically rated each on a scale of motor restlessness. A restless movement was described as any motor activity irrelevant to the work being done at the moment. The units of comparison are steps on the rating scale, and since these may not be quantitatively equal the measures are relative only; but their direction is clear and consistent.

In one experiment (6 subjects, 6 full days of work and observation) a decrease of 9 per cent. in restless movement was found in the chewing periods. In another experiment (4 subjects, 4 days) a decrease of 10 per cent. was found. On the whole, therefore, there is a decrease of some 10 per cent. in restlessness while the masticatory is in use.

Tension as Feeling of Strain. After each round of work (about 45 minutes) the subjects rated on a linear rating scale their subjective feelings during the period. The linear scale was marked off into 20 equal steps, ranging from extreme strain at one end to extreme relaxation at the other. The rating was made by crossing this line with a pencil at some point between these two extremes. The units of comparison are again steps on the rating scale.

The workers unanimously report themselves as feeling more relaxed while chewing than during either of the other two conditions (normal and control). In

[1] The data are reported in full in the writer's recent monograph, "Psycho-Dynamics of Chewing," *Archives of Psychology*, No. 239, July, 1939, pp. 90.

one experiment (8 subjects, 6 days) subjectively felt relaxation increased 14 per cent. over control and 19 per cent. over normal, while chewing. In another experiment (4 subjects, 2 days) the decrease in felt strain amounted to 10 per cent.; in a third experiment (4 subjects, 4 days) the 10 per cent. strain reduction was again the average.

On the whole, then, tension in the sense of the subjective feeling of strain is reduced from 10 per cent. to 15 per cent., while the worker indulges in the collateral chewing movements.

Tension as Fatigue. If these two are not identical they are at least often closely related, the strain of fatigue being contrasted with the freshness of earlier hours of work. The problems involved in the measurement of fatigue are notorious. We have used an indicator which has been reported to have some general value—the rate of change of designs seen in equivocal perspective.

McDougall reports that fatigue decreases the rate of fluctuation of reversible figures (staircase, blocks, windmill) and that refreshing substances such as tea and coffee increase it. In one experiment (6 subjects, 6 days) we found no change in the rate of fluctuation (Scripture's blocks) when chewing or when using the control wafer. In a second experiment (4 subjects, 4 days, staircase figure) there was a definite increase of 11 per cent. in one-minute periods. In a third experiment (6 subjects, 6 days, staircase) the increase was over 7 per cent.; a fourth experiment with 2 observers also showed definite increase—the increased rate of fluctuation in all these cases being in the chewing periods.

The net evidence from these four experiments is that if there is any change in the rate of fluctuation of reversible figures while chewing it is by way of increase, this being the opposite of the effect said to be produced by fatigue. In so far then as fatigue means tension the indication is reduced tension when the masticatory is in use.

Tension as Effort. Tension as effort might be expected to show itself in the consumption of more energy and to be reflected in measures of metabolism and of pulse rate. We have carried through for one week metabolism measures on two workers, but the data are too complicated to summarize in this short review. They show, however, that such collateral activity as chewing may be carried with no actual cost to the organism, apparently because of the surplus due to reduced motor restlessness.

In the case of 4 subjects (2-day experiment) at sedentary work, pulse rate was found to increase 5 per cent. while chewing, this being only half that reported when a resting state is taken as the base. In another experiment (4 subjects, 4 days) when the main occupation was moderately active but far from strenuous, no change in pulse rate was found. It is clear that determination of energy costs of chewing, with a resting state as a base, can by no means be generalized to cover the situation when this motor automatism is added to a livelier initial activity level.

Direct Muscular Tension. Perhaps the best meaning of *tension* is the direct muscular strain existing in parts of the body not immediately occupied with the main occupation. Using a specially devised work chair we measured tension at the left elbow joint in the case of two subjects meanwhile occupied with the use of the right arm. Measures were taken 33 times during each hour of two working days, the subjects being occupied with such tasks as cancellation, addition and recording the changes in figures seen in equivocal perspective.

The apparatus releases, at the experimenter's wish, a weight which pulls against the unoccupied arm which lies on a hinged arm-rest. The rate at which the arm moves when the weight is thus applied is measured (in sixtieths of a second) by means of a kymograph and time line. The greater the tension existing in the arm at the moment, the slower is the movement produced in it by the fixed weight.

In this experiment conditions were varied each hour (chewing, not chewing, control wafer). Without exception, with both workers and during all three kinds of work, muscular tension is decreased during the chewing periods, the decrease amounting to an average of 5 per cent. in time units. While chewing, parts of the organism not occupied with the main task are appreciably relaxed. The relaxation thus found was greater in the case of the more "tense" of the two workers.

Tension as Interference. Any agent interfering with the proficient course of work might be said to result in strain or tension. In nine different varieties of work we have measured the output, for quantity and quality, during the three main experimental conditions. With the possible exception of work in which a wholly new performance is being learned chewing while working does not interfere with output. In some kinds of work, especially number checking and typing, the work is positively facilitated.

The suggested effect on new learning (not yet adequately demonstrated) is especially interesting. Some investigators have found that muscular contraction (tension) is an aid in learning tasks. But all our results show that sustained chewing results in a *lowering* of tension, however measured. We might therefore expect to find an indication of interference with new learning and such results would be an obverse confirmation of those showing more effective learning under conditions of greater tension.

The Energy of Work. In two ways we have measured the energy of the movements made in prescribed

activities, while the workers were intent only on the accuracy and tempo of their work. In a variety of tasks the point pressure of writing was measured. In a specially devised set-up measure was secured of the energy of thrust in a "pin target" activity.

In all these cases more energy was put into the activities of the main occupation while chewing. The motor automatism not only reduces restlessness (nervousness), but some at least of the surplus energy thus resulting goes unwittingly into the main work. Whether or not this results in increased output obviously depends on the nature of the work.

Conclusions. All these results tell a consistent story. The collateral motor automatism involved in the sustained use of the conventional masticatory does result in a lowering of tension, and the tension thus reduced is muscular. In a sense this is only a confirmation of the testimony of the chronic pipe smoker, whistler, gum chewer and watch chain twiddler. His statement is likely to be that he does these things when he is "under strain" and that he gets from these collateral activities a "relief from tension." The results also give some support to the clinical inference that the motor automatism grows directly out of some tension, for which it serves as an outlet.

Perhaps these results also throw some light on the striking fact that during the past ten or more "tense" years the chicle processors have enjoyed their greatest prosperity. The results also suggest techniques which might be put to good use in "relaxation therapy."

These results can be fitted readily enough into almost any conception or explanatory scheme of neuro-muscular dynamics. Advocates of a "drainage" hypothesis could show how a collateral automatic activity such as chewing serves as an outlet for discharges that would otherwise take more devious, uncoordinated, and perhaps obstructive or interfering channels. At any rate it is apparent that such an activity may serve a neat regulative purpose and organize available energy more effectively. The subjectively felt gain in relaxation may be an introspective indicator of this organization. Effectual gains in some kinds of work output may be an objective sign of it as may also the increase in the energy of the working movements. Reduction of random restlessness may be the machinery through which it operates.

In the case of chewing particularly certain other considerations of a somewhat more subtle psychological type may be relevant. These are quite in line with certain systematic principles that have usefully guided our experimental program during the past dozen years. The primary function of chewing is of course the mastication of food. Eating is ordinarily a more or less "quiet" occupation. When we eat we sit; random restlessness is at a low point; we rest; we relax; and the general feeling tone is likely to be one of agreeableness and satisfaction.

An important item of the eating situation is chewing. It may well enough be that chewing, as a "conditioned stimulus," brings with it, whenever it is sustained, a posture of relaxation. Chewing, in other words, may serve as a reduced cue and some degree redintegrate the relaxation of meal-time.

SCIENTIFIC EVENTS

THE BRITISH ASSOCIATION IN WAR TIME[1]

SINCE the Dundee meeting of the British Association was brought to an untimely end, the office at Burlington House, London, has been reopened for the routine work which always follows upon the annual meeting, and a certain amount of official business is also being carried on at Down House, where the rooms normally open to the public are closed and dismantled, and Charles Darwin's former dining-room serves the valuable if regrettable purpose of an office-refuge. The first number of the new quarterly report, *The Advancement of Science,* will be produced, all being well, probably rather later than the announced date at the end of October, and in smaller bulk than was contemplated. As to its future, and, for that matter, the future of the association's work generally, obviously nothing definite can be stated. Preparations for the intended meeting next year in Newcastle-upon-Tyne have been suspended, by agreement with the authorities there. It is an unhappy coincidence that the last meeting in that city was the last to be held during the last war, in 1916. Conditions are so far different now that it is impossible to estimate whether any sort of meeting could or should be held next year, whether in Newcastle or anywhere else. Yet it is permissible to dream of the possibility of adapting the association's very flexible constitution to a meeting of four days or so, with science in war time as the leading theme, with sessions in three or four telescoped sections—physical, biological, anthropological and economic, for example—and of course the Division for the Social and Economic Relations of Science. No doubt before anything of this sort could be undertaken there would be need of careful and wide inquiry as to the amount of support which might be forthcoming for such an effort. But if this were favorable, such a meeting could be arranged at relatively short notice. "The minor humors of war" may be offered in advance as one subject on the anthropological side.

[1] From *Nature.*