the repeat seriation to the right. All the lines of the repeat seriation to the right differ from the corresponding lines of the initial seriation by being somewhat less intense, more broken, more diffuse and more confused in their synapsis relations.

In a forked non-Bar stock recently derived from the above forked Bar stock by breeding from the rare Bar-reversions, the banding was found to be precisely identical with that of unrelated normals as far as could be observed in excellent permanent preparations of well-stretched chromosomes.

In a forked Bar-double stock, similarly derived from the same f B stock by breeding from the very rare "Ultra-Bar" type of eye, it was found that the extra section observed in Bar was present still again, giving a thrice-repeated seriation in direct sequence. The changes differentiating Bar from normal were carried further in Bar-double, as follows: The size and puffiness of the bulbous regions was still greater, as well as the blockiness of the banding and irregularity and obliqueness of the synapses. These disturbances were greatest in the middle one of the three seriations.

These findings enable the Bar "gene" to be reinterpreted as a section of inserted genes—a duplication. The production of Bar-double and of Bar-reverted is seen to be the insertion of this extra section twice, or conversely, its total loss—both presumably by a process of unequal crossing-over. That the section of bands should behave as a unit in this process is perhaps accounted for by the observation of oblique synapsis, especially frequent in Bar-double, where presumably one entire sequence synapses with another of a different position in the series of three. The oblique synapses were even more frequent in BB/B$^+$, where one series in B$^+$ has a choice of three series in BB, apparently usually synapsing with one or the other end series.

According to this interpretation the source of the duplication is the material directly adjacent to the repeat. But whether the point of insertion preceded the heavy doublet of 16A1 or the very faint final singlet of 16A5, can not be determined. If Bar is itself a repeat, a reason is thereby provided for its unique behavior of giving rise to Bar-double and Bar-reverted by oblique synapsis. Perhaps half of the Bar-reversions carry the original series and the other half the subsequent repeat restored to its original position.

On this interpretation, the "position effect"—the reinforcement of the action of one Bar gene by another in direct sequence next to it—has a visible cytological accompaniment in the increased size and puffiness, and the change in the character of the banding of both series in Bar as compared with normal and of all three series in Bar-double as compared to Bar itself. Part of this is presumably due to the "rounding-up" tendency of the synaptic attraction *along* the chromosome in addition to the oblique attractions and the straight-across attractions.

The Bar-eye reduction is thus seen to be interpretable as the effect of increasing the action of certain genes by doubling or triplicating their number—a genic balance effect. But "position effects" are never excluded when duplications or other rearrangements are present, either in the wedging further apart of genes normally closer, or by the interaction with new neighbors. The respective shares attributable in the total effect to the genic-balance change and to the position-effect change seems to be at present a matter of taste.

Study of the Baroid translocation apparently shows that the break in X comes between the two halves of the heavy doublet of 16A1. The break in 2R follows directly after the heavy capsular doublet of 48C1. Thus a demonstrable basis is laid for Dobzhansky's interpretation of the Baroid eye-reduction as a position effect.[7]

The previously reported finding[8] of the presence of "repeats" as a normal part of the chromosomes of *D. melanogaster,* and the suggestion that unequal crossing-over is probably the mechanism of production of some short repeats, thus have received ample verification by these direct observations on these processes in the case of Bar and its derivatives.

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A NEW METHOD FOR TESTING THE SENSE OF SMELL AND FOR THE ESTABLISHMENT OF OLFACTORY VALUES OF ODOROUS SUBSTANCES

IN a series of experiments we have found that if odors are injected into the nasal passages in sufficient volume and with sufficient force, they can be recognized even when the breath is being held, and in papers recently published[1] two procedures for the examination of the sense of smell were described, which are based upon this new principle.

The apparatus used consists of a wide-mouthed bottle, which is closed by a rubber stopper through which pass glass inlet and outlet tubes. The end of the outlet tube has a rubber connection for the attachment of a nosepiece, and the rubber connecting tube is closed by an ordinary pinchcock. The nosepieces are Y shaped, so that the nosetips at the ends of the branches of the Y can be inserted into the nostrils. In

[1] *Bulletin* of the Neurological Institute of New York, Vol. IV, Nos. 1 and 2, 1935.

one nosepiece the lumen of one branch of the Y is obliterated, while in the other both lumina are patent. By the use of the appropriate nosepiece, odor can be injected from the bottle into one or into both nasal passages.

The test bottle has a capacity of 530 cc and contains 30 cc of the odorous substance with a 500 cc space above it. Air is injected into the bottle through the inlet tube by means of a calibrated glass syringe and released into one or both sides of the nose by pressure on the pinchcock which surrounds the outlet tube. By the injection of air into the bottle, and release of the blast into the nasal passages while the subject who is being examined holds his breath, the air is carried to the olfactory membrane and the force of the injection takes the place of the inspiratory movement of ordinary breathing. At regular intervals an amount of air and odor is injected into the nasal passages until the number of cubic centimeters is ascertained by which the odor can be identified by the subject. This procedure was called the Blast Injection Test. The smallest number of cubic centimeters of an odor that can be identified by this procedure with a test bottle of the size used was called the M.I.O. (minimum identifiable odor), and the M.I.O. upon bisynchronorhinal injection was called the olfactory coefficient of the odorous substance. As each odorous substance has its own olfactory coefficient, it was possible to classify odors on this new principle, and it was found that the olfactory coefficients varied directly with the boiling points of the odorous substances, and therefore inversely with the vapor pressures.

In the procedure of blast injection of odors the volume of the injected odor and its pressure are known. It was therefore possible to investigate the relative importance of volume and pressure of the olfactory stimulus and to conclude that for the perception and identification of an odor, the force with which the odor impinges upon the olfactory cells in the superior meatus of the nose is of more importance than the volume that is injected.

The olfactory acuity of each side of the nose was studied separately by means of the nosepiece which permitted the injected odor to reach only one side, and the acuity of birhinal smell was studied by means of the nosepiece through which odor was injected into both nasal passages.

In a second procedure which was called Stream Injection, the odor was injected into one or both nasal passages in a continuous stream for various periods of time, and at varying volume-rates, while the subject was breathing through the mouth. This is accomplished by means of a tank of compressed air, the outflow from which is controlled by a gage. The outlet from the tank is connected to the test bottle which contains the odorous substance (after the pinchcock has been removed) and during the test air and odor flow from the test bottle into the nasal passages.

The procedure of stream injection was found to be of value both for the study of olfactory fatigue and for investigations of the trigeminal effects of odorous substances. The odorous substances whose effects were purely olfactory could be distinguished from those that affected also the trigeminal nerve, and it was found that many substances hitherto believed to be pure olfactory stimulants have an effect upon both the olfactory and the trigeminal nerves.

By means of the stream injection of odors it was possible to produce olfactory fatigue of different duration, and then by means of blast injection tests to determine the relation between the duration and volume-rate of the stream injection and the depth and duration of the resulting fatigue, and to gain some insight into the nature of olfactory fatigue and the parts of the brain responsible for this alteration of function. The fatigue produced by the stream injection of an odor was mainly specific for the odor used, but fatigue for one odor also caused some diminution of the acuity of smell for other odors.

By the use of blast and stream injections, we were able to study the effect of unilateral olfactory stimulation upon birhinal acuity of smell, and the effect of bilateral stimulation upon monorhinal acuity of smell.

These olfactory tests were applied in patients with tumors of the brain. The small series of tests thus far made showed that when the M.I.O. of one or both sides of the nose was high, while the fatigue produced on both sides was not prolonged beyond what is normal, the growth was small and so situated on the under surface of one or both frontal lobes as to make pressure upon one or both olfactory bulbs and tracts. When the M.I.O. was within normal limits or lower than normal, and the fatigue was prolonged on one side, the tumor was within the substance of the cerebral hemisphere and on the same side as that on which there was increased fatigability. By these procedures, therefore, it was possible to gain information regarding the situation of the growth.

The tests made upon normal individuals and upon patients with tumors of the brain demonstrated that olfactory fatigue was not due to a refractory state of the olfactory receptors or of the olfactory bulbs and tracts, but was the result of an abeyance of function in the receptive and memory centers for smell in the brain itself.

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