THE AUDITORY REACTIONS OF THE DOG STUDIED BY THE PAWLOW METHOD

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From the time the first review¹ of Pawlow's ingenious method in animal psychology was published in this country great progress has been made by the numerous students of Professor Pawlow which puts an entirely new aspect on the psychology of the dog. Unfortunately, we are not in a position at this moment to offer a further extensive summary of the results obtained by this method since 1909, but a brief review of the recent paper of Usiewitch,² concerning the auditory faculty of the dog may prove of interest to American investigators.

It will not be amiss to state succinctly for the benefit of those not familiar with the first article referred to, the principle of Pawlow's method, the minute analysis of the animal reactions performed with its aid and some of the broad generalizations regarding nervous activity deduced from those analyses.

It is a matter of common experience that the salivary reflex may be actuated by the mere thought or even remote suggestion of a delectable article, but it remained for Pawlow's unusual acumen to recognize in this trivial fact the means provided by nature for penetrating the hidden workings of the animal's psychology. The presence or absence of the salivary reflex informs the investigator of the organism's reaction to a given stimulus. The method, therefore, possesses all the advantages of being strictly objective, i.e., quite independent of the observer's interpretation or "persönliche Ueberzeugung," as the Germans name it.

Starting with the idea of the salivary reflex, it was a relatively simple matter to determine the flow of saliva both quantitatively

¹ Yerkes, R. M., and Morgulis, S. The Method of Pawlow in Animal Psychology. *Psychol. Bull.*, vol. 6, pp. 257-273, 1909.

² Usiewitch, M. A Physiological Investigation of the Auditory Capacity of the Dog. *Bull., St. Petersburg Military Medical Academy*, Vol. 24, pp. 484-502; Vol. 25, pp. 872-891, 1912 (Russian).

and qualitatively by a special adaptation of the Pawlow fistula method. The duct of the parotid gland is exposed by an incision of the cheek and a permanent fistula or outlet to the exterior is made. The saliva is collected in a tube where it can easily be measured.

Through persistent training the salivary reflex may become coupled with any desired stimulus which is frequently applied while the secretion of saliva is called forth by feeding the animal a powder consisting of meat and sugar. After long continued repetition the application of the particular stimulus alone is sufficient to cause a normal flow of saliva. This indirectly produced salivary reflex is what Pawlow terms a "conditioned reflex," and the success of the analysis of reactions is based upon the absolute specificity of the latter. The ability of the animal to differentiate between gradients of various stimuli is measured by the changes registered in the fundamental salivary reflex.

What the experimenter achieves by patiently adhering to a prearranged plan happens in nature continuously. The world of the individual is two-fold in its make-up. Some of its elements act on the animal's receptors causing sensations by directly stimulating them, others exert an influence, thanks to a more or less temporary association with one of the fundamental or unconditioned reflexes. In the function of the higher centers Pawlow distinguishes, therefore, two mechanisms; the mechanism of receptors ("analysers" in Pawlow's terminology) which is for sifting out and selecting from the mass of external stimuli and transforming them into nervous processes of purposeful reactions; the other mechanism is that of the transitory association or interlocking of the phenomena of the outside world with the organism's responses. The latter is the mechanism of the conditioned reflexes in all its complexity.

One of the most important discoveries in the investigation of the conditioned reflexes is the fact that every receptor at first enters into temporary association with the salivary reflex by its most generalized activity, its more refined and subtle faculty of differentiation being involved only gradually and by a very slow process. The intensity of an illuminated area becomes the cause of a conditioned reflex much sooner than the shape of that area. Likewise, when the central portion of the receptor mechanism—which may be either in the brain or in the spinal cord—

is destroyed or injured this particular receptor loses its ability to form conditioned reflexes except by its primitive and generalized function. Animals whose optic centres have been injured can still form associations between stimuli of various light intensities and the salivary reflex, but not with stimuli from special groupings of light and shadow.

As regards the auditory reactions of the dog it has been discovered by the conditioned reflex method (Selionyi, Elliasson, Tichomirov, Babkin, Burmakin) that its auditory faculty is much greater than that of man. The dog perceives $\frac{1}{8}$ of a tone and appreciates tones of a frequency of vibration which is entirely beyond human reach. It was also discovered that the dog has an absolute memory for sounds, which probably, but very few of the most gifted musicians possess.

Usiewitch's particular problem has been to study the dog's reaction to an intermittent auditory stimulation with a view to determining its ability to differentiate time intervals. It is hardly necessary to describe his technique, which is essentially the same as already described in the review alluded to. The intermittent stimulation was produced by means of a metronome. The subject of these experiments, a large healthy dog which never had been used for similar tests before, was found to be totally indifferent to the metronome so far as its salivary reflex was concerned.

By persistent training a conditioned reflex has been established to the stimulation with 100 oscillations per minute of the metronome. The stimulation of intermittent sounds of such frequency called forth 6-10 drops of saliva every time. The interval between successive oscillations was then modified, the moment of the disappearance of the conditioned salivary reflex indicating the lowest limit of differentiation. Without going into any details of this most interesting investigation or quoting actual data, I will say that the dog could sharply distinguish the shortening of the interval by less than $\frac{1}{10} - \frac{1}{15}$ of a second. Indeed with the well developed reflex to the stimulation of 100 beats per minute a change of the rate to either 96 or 104 beats was immediately reacted upon by a marked diminution or even complete cessation of the flow of saliva.

Furthermore, Usiewitch brought out some very significant points with regard to the intermission between tests with the

established, standard stimulation, and some unusual stimulation. Thus, the dog is able to differentiate distinctly between 104 and 100 beats (standard) if the new rate is tested 10, 15, 45, or 60 minutes later. The differentiation is less certain after 18 hours of intermission and vanishes completely after a lapse of 45 hours.

In responding to various intermittent stimuli of unaccustomed frequency a remarkable regularity and uniformity stamps the results. Applied immediately after stimulation with the standard rate of oscillation it produces a distinct depressing effect on the salivary secretion in the first trial. During the subsequent few trials the conditioned salivary reflex increases considerably, then again diminishes to complete disappearance in further tests. These facts are very important because they offer a clue to the analysis of the phenomenon of inhibition.

This review purports to bring once more before the attention of American investigators the enormous value of this purely objective analytical method in animal psychology and to stimulate an active interest in the subject which should soon lead to a systematic investigation of the reactions of various animals by this method.