over the flask until the mouth of the latter is somewhat below the rim of the tray. Exact alignment is easily obtained by placing a glass rod, with rubber stoppers attached to both ends, into the flask. The rod should protrude from the mouth of the flask just sufficiently to arrest the tin can at the desired level. As soon as the tin can is correctly aligned over the filled water bottle, the device is quickly inverted. Water will immediately stream into the glass tray and fill it up to the height which is determined by the mouth of the flask (Fig. 1). The drinking well is now ready for use. In order to facilitate immediate reading of the water level in the flask, a vertical slit (length, 8 cm; width, 1 cm) may be cut into the wall of the tin can just below its upper rim. As soon as drinking has caused the water level in the tray to fall sufficiently to bare the mouth of the flask, air will enter the flask and water will stream down into the tray until the rising fluid level again occludes the opening. This play will obviously continue as long as there is any water left in the flask.

The drinking well in the dimensions indicated in Fig. 1 will easily fit inside the standard cage used for larger groups of rats or guinea pigs in many laboratories. By changing the size of the flask, tin can, and tray, the experimenter can adjust the capacity of the drinking well to his individual needs within a wide range.

The self-leveling drinking well has many advantages, since it combines the good features of the drinking bottle and the open tray without retaining the drawbacks of either. First and foremost, it makes available large reserves of drinking water, which are released automatically and in small quantities from an airtight, sealed container into an open tray located near the bottom of the cage; thus, comfortable and natural drinking is assured continuously, while the inaccessibility of the greatest part of the tray to the animal practically eliminates the danger of pollution. The amount of water consumed can be readily estimated with the help of the graduations on the transfusion flask. The fact that the water is in contact with glass only may become of special importance in some nutritional studies and in experiments using drinking fluids of certain definite composition. The self-leveling mechanism is foolproof and can be adjusted to maintain any desired height of the water level. Refilling is easy and will obviously have to be done far less frequently than with most of the watering devices used at present. In experiments entailing accurate collection of urine, no mistakes or disturbances will be encountered from leaking drinking tubes or spilled water cans. The well is sturdy and stable enough to resist overturning without fixation. Finally, the device can be readily and quickly constructed with materials available in abundance from the discards of every biological research laboratory or hospital, without special tools and at almost no expense.

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Book Reviews

Reading and visual fatigue. Leonard Carmichael and Walter F. Dearborn. Boston: Houghton-Mifflin, 1947. Pp. xiv + 483. $5.00.

This is a thoroughgoing report on an extensive experimental program and the scientific literature pertinent to its development. The research was sponsored by the Committee on Scientific Aids to Learning. Approximately the first half of the book is devoted to a summary of the literature related to visual fatigue and reading. This review is one of the main contributions of the book and should be valuable to persons undertaking work in this field. In discussing the general nature of fatigue, the authors are critical of the frequent analogy with machines because of the way exercise sometimes strengthens certain human functions. There follows a review of the results with the conventional photographs of eye movements, first, when the subject is voluntarily fixating different points, and then when he is actually reading. Especial attention is given to ocular behavior with prolonged work. Note is made of the controversial material dealing with rate of blinking as indicative of fatigue or visual efficiency, and the authors do not come to definite conclusions on this point. Reading behavior is discussed as related to various aspects of format such as length of line, type face, or leading. Reading is likewise considered with reference to degree of illumination—a rather controversial topic. The authors are inclined to tone down the seemingly excessive claims of some investigators as to the light intensity necessary for various types of visual work. This toning down seems to be in line with recent publications on this subject. Then follows a more extensive review of the methods of recording eye movements, leading up to the present experiment. The review covers the whole range from watching the eyes through peekholes, observing afterimages, feeling the eyeball, or having a capsule operated mechanically by the eyeball, to the extensive work on corneal reflection and, finally, devices

whereby electrodes are attached to the skin, recording changes in potential between the retina and the cornea. The reader who has not done experimental work in this field will be impressed by the ingenuity and technical detail involved in such experiments.

The authors then turn to their own technique, which is a continuous record of eye movements by means of electrodes attached to the skin near the eyes. Lateral movements of the eyeball and, in the vertical direction, blinking are recorded. Records of heart rate (electrocardiogram) and brain waves (encephalogram) were taken simultaneously. The experimental design covered a number of interesting points. The subjects sometimes read an interesting historical novel and sometimes a dry economic treatise, both in book form and on microfilm. About every 25 pages in one series they were given a comprehension test which was designed primarily to maintain motivation. In other series, they did not have this motivation.

The results are analyzed in great detail—"miles of polygraph records." Especial attention was given to the number of fixations, the number of lines read, the number of blinks, and the number of regressions in the eye movements. A number of findings stand out as of particular interest. One is that the normal subject can read continuously for 6 hours without undue signs of fatigue. This applies also to microfilm and should answer the frequent qualms in that respect. High school and college students showed the same trend. The authors speculate as to the reason for this finding and hint that the intermittent operation of the ocular musculature may allow for adequate recuperation, just as the heart muscle recuperates between beats. There is a further hint that this may be partly due to training, much as an athlete gets in "condition." Particularly interesting is the contrast between the subjects who were well motivated and those who were not. In the main experiment, the periodic comprehension tests served very definitely a motivational purpose and apparently forestalled any pronounced decrement in performance. The authors conclude by attributing visual fatigue in reading primarily to this motivational factor. At least, the first index of fatigue is in these alterations of attitudes and general feelings and not in a breakdown of the sensory neuromuscular mechanism. From the educational standpoint, it would appear that, with adequate motivation, persons could read for prolonged periods without any appreciable decrement in efficiency. This has obvious bearing on academic schedules, study periods, and the like.

A great many of the original data are summarized in tables in the appendix, and there is a bibliography of over 400 titles. On the whole, the work is thorough, the historical material will be useful to persons who are contemplating undertaking any research in this field, and the conclusions regarding length of reading periods and particularly the motivational aspects should be of considerable interest to educators.

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Scientific Book·Register

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