temporal retina that lie outside of the fovea. One must conclude that the complex function describing the differential sensitivity of the eye to intermittent white light is somehow peculiar to foveal stimulation. The precise nature of this peculiarity is yet to be revealed (*4*).

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5 May 1960

Observing Behavior in a Vigilance Task

Abstract. It has been suggested that level of performance in a vigilance task is accurately reflected by frequency of observing responses. By means of photography it has been demonstrated that under conditions where a decrement in vigilance performance does not occur, the frequency of nonobserving behavior and general activity increases in time.

Studies of vigilance, that is, monitoring performance as a function of time, have recently raised questions of theoretical as well as practical importance. Holland (*1*) studied frequencies of observing responses—pressing a key to illuminate the display—during a vigilance task. Using the Mackworth (*2*) schedule of signals occurring at intervals of ¾, ¾, 1½, 2, 2, 1, 5, 1, 1, 2, 3, and 10 minutes, in that order, and repeated for three further half-hour periods, he reported a decrement in performance and a parallel decrement in observing rate and concluded that "the detection data of vigilance studies may reflect the observing response rates generated by the particular schedules employed."

Holland defined a key depression as an observing response. On the other hand, Blair (*3*) stated that "observing responses refer to the relation, through time, between sense-organ orientation and displays . . . the depression of a key may or may not be the same as actual head and eye movements involved in monitoring tasks." He arranged a vigilance situation in which the presence or absence of a signal could be detected only when the head was oriented toward the display. Only two of his five subjects exhibited behavior such as Holland described. Blair did not present data on detection performance, nor did Carpenter (*4*), who found that frequency of blinking increased during a vigilance task.

During six vigilance experiments, I registered general activity or "restlessness" by means of counters activated by microswitches placed under the subjects' pivotally mounted chair (Baker, *5*). I found that whereas general motor activity increased markedly in time "there is little possibility of predicting the level of vigilance from motor activity during the task."

Since key pressing is a form of motor activity, the Blair, Carpenter, and Baker studies raise a question about the generality of Holland's tentative conclusion. To examine this question, a Mackworth-type clock test was devised having a single hand jumping forward to a new position once a second, 100 jumps per revolution. Double jumps, designated as signals, occurred as per the Mackworth schedule. The clock face was a Lucite panel behind which a 16 mm camera was mounted. Photographs (1/32 sec exposure) were taken of subjects' heads and shoulders once per second for an hour. A ring-shaped fluorescent tube mounted around the clock permitted satisfactory photography and rendered the camera invisible. Subjects were not informed that they were being photographed, and possible auditory cues were deleted by a steady masking noise plus ear defenders. Viewing distance was 20 inches. [Fraser (*6*) has reported that when the clock test is used at such viewing distances a decrement in performance is not demonstrable, presumably because of the large signal magnitude (*7*); a decrement was not required for our purpose.] In addition, microswitches under the subjects' pivotally mounted chair gave a measure of general activity or "restlessness."

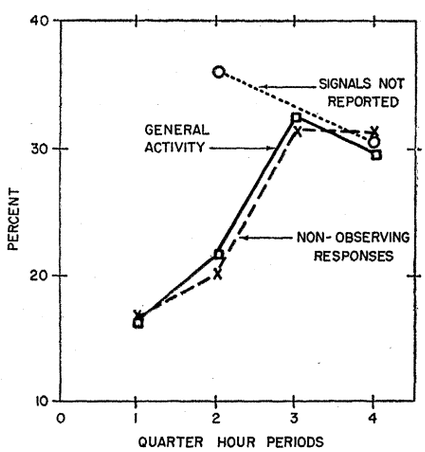

Fig. 1. Mean percentages of general activity, nonobserving responses, and signals not reported, as functions of time. Data for signals not reported are plotted for half-hour periods.

The task was to press a button when a signal was detected. Subjects were 19 paid housewives.

The data consisted, then, of the number of signals reported, a record of general activity, and 64,698 photographs (*8*). An observing response was defined as eyes open and oriented toward the display. A decision as to whether subjects met the criteria of an observing response was made by two judges who together examined the photographs and reached agreement in each case. When not meeting the criteria, subjects were blinking, yawning with eyes closed, turning to look behind, reaching down toward the floor, looking overhead, and so forth.

Percentages of time the subjects observed the display ranged from 90.6 to 99.4 with a mean of 97.2 and a median of 98.2. The frequency distribution of nonobserving responses (which consumed an average of 2.8 percent of the hour) showed a marked change with time: 16.8 percent occurred in the first quarter-hour and 31.4 percent in the last. This difference is significant at the 0.01 level. General activity showed a parallel increase, 16.4 percent of the activity occurring in the first quarter-hour and 29.6 percent in the last, a difference also significant at the 0.01 level. These percentages are very similar to those previously reported (*5*).

There was no decrement in number of signals reported, 36 percent of the signals not being reported in the first half-hour and 30.7 percent in the second. The difference is not significant. (In only one case was the subject actually not observing the display when a signal occurred.)

Figure 1 shows how closely the increasing frequency of nonobserving responses paralleled increasing general activity, while neither paralleled the frequency of signal reports (*9*).

Three Spearman rank-difference coefficients were calculated between the total values of the three variables recorded for each subject, and none differed significantly from zero. To consider one case only, the subject who spent the lowest percentage of time observing the display (90.6) had the smallest record of total general activity over the hour and failed to report only three signals (all appearing in the first half-hour). It is recognized, of course, that in a situation where the range of nonobserving responses is much greater than that reported here a relation must exist with the number of signals reported.

However, in this experiment the fre-

quency of nonobserving responses and degree of general activity were independent of one another for each subject, and although both increased with time neither was related to performance on the vigilance task used (*10*).

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8. The possible total of 68,400 photographs was not achieved because of camera difficulties.
9. Signal detection data obtained under the Mackworth schedule are never plotted for quarter-hour periods because of different frequencies.
10. This report is DRML Report No. 234-5, Project No. 234, PCC No. D77-94-20-42, H.R. No. 185.

25 April 1960

Sex Chromatin in Mammalian Bone

Abstract. The presence of a sex chromatin body similar to that reported in other tissues has been demonstrated in the nuclei of osteoblasts, osteocytes, and periosteal cells from female dogs and cats.

Since 1949, when Barr and Bertram (*1*) first described a histologic sex difference in the neurons of the female cat, the presence of the nuclear sex chromatin body has been noted in a variety of cells from different species (*2–5*). In man, it has been studied extensively in the nervous system (*6*), polymorphonuclear leukocytes (*7*), epidermis (*8*), and mucous membrane (*9*). It has also been observed in the cells of the amniotic fluid, the placenta, and the fetal membranes (*10, 11*). In animals other than man an even greater number of cell types have been examined (*4*). Only a few species did not exhibit a visible nuclear sex difference (*2*). In any animals in which the sex chromatin body could be identified, it was demonstrable in all of the tissues that were investigated.

Table 1. Incidence of the sex chromatin body in the bone and periosteal cells of female animals (fewer than 10 percent of cells in male animals showed a similar structure).

No.	Cells with sex chromatin (%)		
	Periosteum	Osteoblasts	Osteocytes
		Adult cat	
4	76	53	48
		Adult dog	
4	72	52	50
		Puppy	
4	79	76	73

The presence of a sex chromatin body in bone has not been previously reported. We do not know whether this tissue has actually ever been studied, or if technical difficulties in fixation and decalcification have prevented the proper examination of nuclear detail. The purpose of this investigation was to disclose whether the sex chromatin body could be observed in the bone of animals known to exhibit a histologic sex difference in other tissues (*12*).

Eight adult dogs, eight cats and eight 6-week-old puppies, equally divided according to sex, were used for this study. The animals were killed with a lethal dose of sodium pentobarbital, and portions of rib and tibia, including the periosteum, were removed and immediately placed into modified Davidson's solution (alcohol-formalin-acetic acid). After fixation for 48 hours the specimens were transferred to an aqueous solution of ethylenediaminetetraacetic acid at *p*H 7.4. Periodic radiographic examination of the tissue samples was used to determine the degree of decalcification. After decalcification the specimens were washed, dehydrated in alcohol, and embedded in paraffin. Sections were cut at 7 to 10 μ with a rotary microtome. The tissues were stained with Stowell's modification of the Feulgen-Schiff technique (*13*) and counterstained with fast green dye.

The stained specimens were examined under oil emersion at magnifications of 900 and 1250. The criteria used for recognition of the sex chromatin body (size, shape, position, and Feulgen-positive staining properties) were based upon previous descriptions for other mammalian cells (*1, 5*). Identification of the sex chromatin was originally established in samples of bone tissue from four cats and four dogs of known sex. Subsequently, the sex determination of unidentified coded specimens was based upon the percentage of 100 well-preserved cells containing the sex chromatin body. Cell counts limited to one particular field could not be made in compact bone because of the difficulty in obtaining uniform cellular fixation.

The sex chromatin body could be identified in osteoblasts, osteocytes, and periosteal cells of the bone tissue from female dogs and cats (Table 1). In appearance, it was similar to that which has been seen in other mammalian tissues. Generally, it was the largest chromatin mass within the nucleus. It could be readily distinguished from the nucleolus by its differential staining properties. Due to the high deoxyribonucleic acid content, the sex chromatin body appeared red with the Feulgen stain whereas the nucleolus, containing mainly ribonucleic acid, was colorless. In counterstained specimens, the nucleolus was light green.

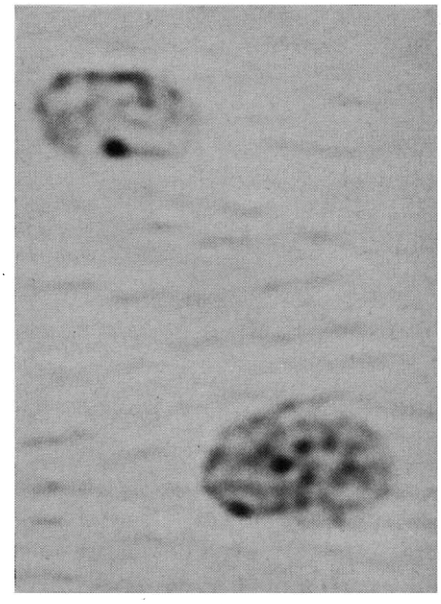

Fig. 1. Osteocytes in bone from female puppy. The sex chromatin appears as a planoconvex body at the nuclear-cytoplasmic junction. Feulgen stain (×1100).

In most instances, the sex chromatin body appeared as a centrally projecting, deeply stained, planoconvex-shaped mass approximating the nuclear-cytoplasmic junction (Fig. 1). Occasionally it assumed a triangular or flattened form. Although the sex chromatin body has sometimes been described as appearing in a more central position within the nucleus (*5*), contact with the nuclear-cytoplasmic junction was used as a criterion in this study.

The sex chromatin body was most readily observed in cells with well-

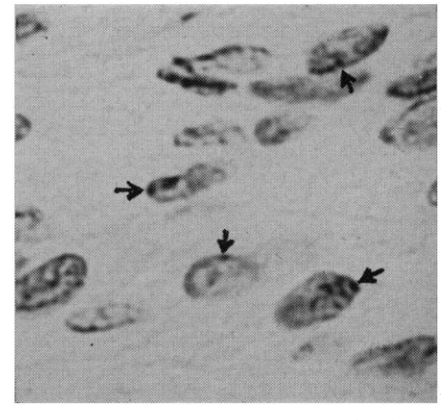

Fig. 2. Periosteum from female dog showing the high incidence of visible sex chromatin bodies. Feulgen stain (×1100).