experimental tubes containing the enzyme solution. The vitamin C solution thus served as filter. The enzyme solutions were exposed to ultraviolet rays from a quartz mercury vapor lamp (Hanovia, 220 v, d-c) passed through vitamin C and water solutions, and the activity was determined at known intervals of time (Table 1).

The results show that vitamin C solution serves as a filter, absorbing the rays destructive to the enzyme, thereby protecting the enzyme from inactivation by ultraviolet light.

References

1. GIRI, K. V. *J. Indian Chem. Soc.*, **18**, 141 (1940).
2. DAS, R., and GIRI, K. V. *Ann. Biochem. and Exptl. Med. (India)*, **9**, 113 (1949).

Intermittent Loud Noise and Mental Performance[1]

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In 1946 Berrien reviewed the literature dealing with the effects of intense sound upon human performance (*1*). He noted a dearth of conclusive evidence. Further studies have been reported (*2–4*), but the data are to some extent still contradictory and incomplete.

The concern of the present investigation was the effect of intermittent loud noise upon mental performance. There appears to be some agreement that intermittent sound can be expected to be more deleterious than continuous sound; furthermore, the special case of intermittent noise is one often encountered in practice, and it seemed to merit specific consideration. Also, for practical reasons the experiment was designed to motivate participants (as do industrial and military situations) toward the rapid, accurate completion of each task assigned; attempts to achieve productivity in a hit-or-miss fashion were severely penalized.

Fifty-two male and 17 female subjects were secured from among adult registrants in summer classes by announcements that emphasized the financially rewarding character of the experiment. (It is of possible interest that almost all the subjects were members of the band or glee club.)

The subjects reported to a large lecture auditorium at 8:45 P. M. The men were seated together in one section of the auditorium, the women in another. Persons occupying odd-numbered seats in odd-numbered rows, and persons occupying even-numbered seats in even-numbered rows, were then abstracted from the group and escorted to a similar room in an adjoining building. The latter subjects (26 male, 8 female) constituted the control group; those remaining in the auditorium (26 male, 9 female) constituted the experimental group.

In the central portion of each room, appropriate numbers of alternate seats were provided with packets of test equipment, and the subjects were disposed in these seats. To each group was then read the same set of directions: The subjects addressed stamped envelopes in which their "winnings would be mailed." They also signed "routine release forms" to protect the college against "irresponsible lawsuits." They were then led through the standard instructions for the Minnesota Clerical Test and for the Revised Minnesota Paper Form Board Test (Series AA), the tests to be utilized in the experiment.[2] The subjects consulted their own test booklets for this purpose but did not open them to the tests proper. Time limits of 7 min for the number-checking section of the clerical test, 7 min for the name-checking section of the same test, and 14 min for the form board test were announced and emphasized. A scoring system placing a heavy premium on accuracy (number of items correct minus twice the number incorrect or passed over) was imposed. And, finally, a first prize of $15.00, two second prizes of $10.00, three third prizes of $5.00, four prizes of $2.50, and general consolation prizes of $1.00 were established.

Only after this identical indoctrination were the members of each group informed as to whether they were to work in silence or in sound. The control group was to "work in these ordinary surroundings, with no special noise being present." In the case of the experimental group it was announced that "The noise will come from the loudspeakers in this room. It will go off and on from time to time. It will be loud [brief sample of noise stimulus], but it is not dangerous. Try to do the best you can in spite of the noise."

The experiment then proceeded for both groups. The number-checking test was administered first, the name-checking test second, and the form board last. Between the end of one test and the beginning of the next only enough time was allowed to turn pages or to change booklets. The testing was thus completed in 30 min; the subjects then reassembled and returned their test packets. The tests were corrected, and the prizes awarded by mail, within a few days.

The two randomly selected groups were treated differentially in that the noise stimulus was administered to the experimental group only. The stimulus intensity was 100 ± 2 db for each subject. The spectrum was substantially constant for all, being essentially flat between 100 cps and 3,000 cps, except for a rise of approximately 7 db in the region of 150 cps–300 cps

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[2] The Minnesota Clerical Test consists of two subtests; one of these requires the subject to discriminate between pairs of identical numbers and pairs of slightly dissimilar numbers; the other requires a similar discrimination between pairs of names. The Minnesota Paper Form Board Test calls upon the subject to identify the result of assembling a given group of isolated plane figures. Both tests as used here were answered by marking directly upon the test booklets.

and a rise of approximately 4 db in the region of 2,500 cps; beginning at 3,000 cps, the sound level began a terminal drop of about 12 db per octave.[3] The noise: silence ratio for the experimental group was unity; that is, the total silent time was just equal to the total stimulus time. This ratio was maintained not only for the experimental period as a whole but for each successive minute during the period as well. Bursts of sound ranged in length between 10 sec and 50 sec and were administered at irregular and unpredictable intervals.

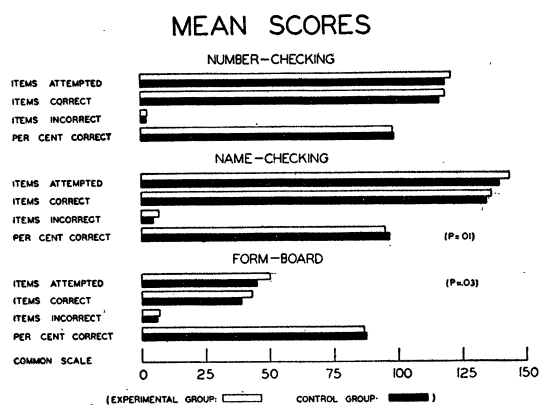

FIG. 1. Comparison of mean scores on all tests; for experimental group ($n = 35$) and control group ($n = 34$).

The principal data resulting from the experiment are summarized in Figs. 1 and 2. Fig. 1 compares the mean scores of the experimental group with those of the control group; it will be observed that each test was scored in the dimensions of (1) number of items attempted (including items passed over); (2) number of items correct; (3) number of items incorrect (or passed over); and (4) percentage of attempted items correct. Fig. 2 presents comparatively the standard deviations associated with each of the mean scores of Fig. 1.

The differences in performance revealed by Fig. 1 are quite consistent. In each test the experimental group attempted more items, got more items correct, and got more items incorrect; however, in the experimental group the percentage of accuracy was lower. Two of the differences achieved conventional levels of

[3] The stimulus was produced by amplifying the thermal noise of a continuously conducting gas triode. The output from initial amplification was fed in parallel to a Bogen EX-35 and to a Bogen E-14 amplifier. The first amplifier drove in parallel two G-E S1201D speakers, directed from the two sides of the auditorium toward its center; the second amplifier drove a single Jensen A-12 PM speaker, mounted at the front of the auditorium. Sound level measurements were made with a Scott 410A hand meter, on the "Flat" setting, and are reported in db re 2×10^{-4} dynes per cm^2. Sound spectra were obtained through the use of an Altec-Lansing 21B condenser microphone, a Hewlett-Packard 300A wave analyzer, and an Esterline-Angus AW recording milliammeter.

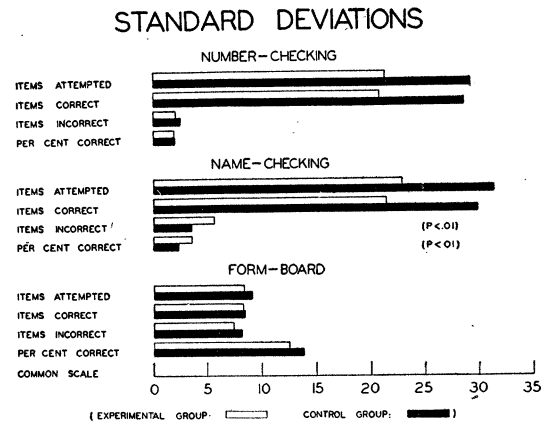

FIG. 2. Comparison of standard deviations associated with mean scores; for experimental group ($n = 35$) and control group ($n = 34$).

statistical significance, and the P-value for each of these differences is noted. One (form board, items attempted) was significant at the 0.03 level of confidence, another (name-checking, percentage correct) at the 0.01 level. Evidently the extraneous noise tended to encourage productivity but to discourage accuracy. The question remains as to whether these tendencies were of practical as well as statistical significance.

The variability differences, as portrayed in Fig. 2, were somewhat more substantial. With two exceptions, the experimental group showed in every case a standard deviation smaller than that of the control group, and the differences were sometimes considerable. Statistical analysis revealed, however, that it was only the two reversals (name-checking, items incorrect and percentage correct) that achieved statistical significance. The only reliable indication, then, is that the stimulus produced in one task an increment of variability in number of unacceptable responses and in over-all accuracy.

It has thus been found that the effect upon short-term mental performance of bursts of intense noise is to increase the quantity and decrease the quality of response, but that these effects are of such magnitude as to suggest that they are practically negligible.[4] It may be that the allegedly malignant effects of extraneous noise are to be found primarily in terms of depreciation in sustained performance, or of interference with functions other than adequate output.

References

1. BERRIEN, F. K. *Psychol. Bull.*, **43**, 141 (1946).
2. BARRETT, A. M. Unpublished Ph.D. thesis. Pennsylvania State College (1950).
3. EGAN, J. P., *et al. J. Acoust. Soc. Am.* (abs.), **19**, 292 (1947).
4. VITELES, M. S., and SMITH, KINSLEY R. *Trans. Am. Soc. Heating Ventilating Engrs.*, **52**, 167 (1948).

[4] Analysis of results for the male subjects alone, as a particularly homogeneous group, supported the same conclusions.