Activation by IMT: An alternative to within-subjects designs¹

EDWARD NEVA, ROBERT A. HICKS,² University of Denver, Denver, Colo. 80210, and WILLIAM W. HAHN, Children's Asthma Research Institute & Hospital

The within-Ss design is generally used when activation is varied because of the confounding effects of idiosyncratic patterns of reactivity. The present study investigates the possibility that induced muscular tension (IMT) by the weightlifting method may overcome this problem. The effects of IMT on HR and GSR with between-Ss and within-Ss designs are compared. The physiological functions obtained were found to correspond very closely.

In activation research, the within-Ss design is considered a necessary control for effects of idiosyncratic patterns of autonomic reactivity. While this procedure is generally effective (Malmo, 1959) it has serious limitations. It is largely restricted to employment with fairly simple dependent measures since it is often not feasible to develop alternate forms of standard complex tasks.

The present report investigates the possibility that the induced muscular tension (IMT) technique of varying activation may overcome the effects of individualized autonomic reactivity patterns and thus allow for the use of the between-Ss design. Pinneo (1961) demonstrated that IMT reliably produces regular and consistent changes in a wide variety of established physiological indicants; however, to the authors' knowledge there has been no attempt to evaluate IMT in a between-Ss design.

The present study employs IMT by weightlifting, a method which has been shown to be superior to the more widely employed hand dynamometer method (Eason, Harter, & Storm, 1964). Physiological indicants are incorporated as independent checks on the effects of IMT. The specific purpose is to compare heart rate (HR) and galvanic skin response (GSR) functions obtained with a between-Ss design with those obtained by Pinneo (1961) using a within-Ss design.

METHODS AND PROCEDURES

Subjects were 24 male and 24 female college students ranging in age from 17 through 25 years. Ss were randomly assigned into four tension level groups of 12 Ss each, 6 males and 6 females per group.

Activation was manipulated using IMT with a weightlifting apparatus. The maximum tension level a S could exert was determined. Maximum tension level was the S's maximum pull with his left hand against the spring coil. Each S's maximum tension level was determined by the following procedure. While the S was seated, he was shown how to pull on the handle. He was instructed to pull down as hard as possible for a duration of 5 sec and the number of pounds showing on the spring scale at the end of this period was recorded. This procedure was repeated five times, and the median of these five measures was the S's maximum tension level.

Predetermined tension level was the percentage of a S's maximum tension level that he was required to maintain during the recording of physiological measures. For this purpose weightlifter's weights, refined to an exactness of approximately 1 oz, were used. It was possible to match the percentage of maximum tension to the nearest 1/8 lb with the use of a variety of smaller weights that were constructed with shot encased in plastic containers. The tension levels for the various groups were: Group B, 5%; Group C, 15%; and Group D, 30%. Group A was by definition a no-tension group.

(Continued on page 151)

Responses were recorded continuously on an eight-channel Offner type R dynagraph. Ss were seated in a chair in a relatively soundproof room in front of the experimental equipment. The temperature of this room was maintained at 23 deg C $\pm$ 2 deg C, and relative humidity was less than 40%. Electrophysiological recording equipment occupied an adjoining room. HR and GSR were measured. For GSR, the measure was the mean number of spontaneous responses occurring while muscular tension was induced. For HR, the measure was a 10-beat mean computed during a period that followed 10 sec of IMT. GSR was recorded with Ag-AgCl disc electrodes of 0.90-cm diam which were attached to the middle segments of the first and third fingers on the right hand according to the method of Edelberg & Burch (1962). HR was recorded through large zinc electrodes attached to the right wrist and calf of the left leg. The contact medium was Redux electrode paste. A minimum adaptation period was provided which was determined by two criteria: The GSR preparation must have had 15 min in which to stabilize and the S must have been alone and resting for a minimum of 10 min.

Fig. 1. The relationship between tension level and physiological indicants.

RESULTS

The primary response measure consisted of the change in frequency, from baseline to test, with which S selected his shock stimulus. The mean selection frequencies for the NV group were 12.1 and 7.55 for the baseline and test phases, respectively; analysis of these data by *t* test for correlated means revealed that the difference between these means was significant ($t = 6.14$, $df = 19$, $p < .001$). For AV Ss, the difference between the mean frequencies of 14.45 and 18.70 was also found to be significant ($t = 2.74$, $df = 19$, $p < .01$).

DISCUSSION

The results of the present experiment show directly that in stimulus selection, as in response selection, avoidability of punishment is a determining factor. Where a given stimulus has been associated with unavoidable punishment, selection of that stimulus from among nonpunished stimuli is decreased. On the other hand, stimuli associated with the avoidance of punishment are increasingly selected.

In view of these findings, it is argued that the opposing tendencies of punished Ss, some to be active and verbal and others to be silent and passive, were responsible for the previously contradictory results regarding the effect of (unavoidable) punishment on stimulus selection. Further support for this position derives from the demonstration (Freeman & Pathman, 1942) that even activity which appears to be maladaptive is associated with more rapid recovery from stress than is complete immobility.

(Continued from page 149)

Each S was given a brief explanation of the nature and purpose of the recording of bodily functions. It was strongly emphasized to the S that he would not be shocked or hurt in any way. Maximum tension was determined and the appropriate amount of weight was attached to the handle of the apparatus. The S was told, if he had been assigned to a tension group, that when asked to do so he was to pull down on the handle, continue to hold it down, and not to let up on it until told to do so. Ss in the no-tension group were told to place their left hand on a mark on the table top under the handle. While Ss either pulled down on the handle or maintained their left hand on the table top, they performed various tasks. Physiological measures were monitored for 10 sec prior to commencement of the tasks and for 10 sec after their completion.

RESULTS

The results on both physiological indicants show physiological activity commensurate with changes in amount of IMT. Figure 1 graphically presents the relationship obtained between tension level and HR and that obtained between tension level and GSR spontaneous responses.

A distribution-free *k*-sample test against ordered alternatives (Jonckheere, 1954) was computed because it is especially sensitive to both the differences between group means and the order in which they occur. For HR, a $Z = 1.64$ was computed with $p < 0.05$. A Z of 5.12 was computed for GSR with $p < 0.001$.

DISCUSSION

An increasing monotonic function between IMT and physiological activity, as represented by GSR and HR, supports the conclusion of Pinneo (1961). That investigator concluded that IMT was an effective and reliable method for

Coupled with the Ayllon & Sommer (1956) and Pustell (1957) studies, the present results appear to contain a practical implication for research involving shock training, namely that each S should be observed for his responsiveness to the shock. The reason for this is that it is possible, in spite of E's intention, to obtain "avoidance" results when these are undesirable.

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NOTE

1. This research was the basis of the author's M.A. thesis at the University of Arizona, 1967. The author wishes to express his appreciation to Dr. Dorothy I. Marquart for her guidance.

systematically varying activation level. In this study the between-Ss design was used and the HR and GSR functions correspond very closely with those of Pinneo who employed a within-Ss design. These results suggest that IMT may be a method of manipulating activation which overcomes the effects of idiosyncratic patterns of activation within individuals.

An important implication of these findings when considered with those of Pinneo (1961) is that an E might be justified in assuming that he has varied activation effectively if he has used the IMT technique even when corroboration by electro-physiological measures is not available. This implication should be validated by replication of the methodological procedures used in this study with an extended range of activation levels.

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NOTES

1. This report is a portion of a paper presented at the annual meeting of the Rocky Mountain Psychological Association, Albuquerque, N.M., 1966. It is part of a M.A. thesis submitted to the faculty, at the University of Denver by the first author under the direction of the second and third authors.

2. Presently at the following address: Department of Psychology, San Jose State College, San Jose, California.