THE MEASUREMENT OF MOTIVATION THROUGH THE USE OF OBJECTIVE INDICES

By

H. J. EYSENCK

and

R. A. WILLETT*

WHILE abilities and attitudes are frequently subjected to measurement, motivation has largely escaped the attention of experimental psychologists and psychometrists. Attempts to use subjective and interpretive techniques have not met with any notable success, and it would seem that this whole area represents one of the most neglected fields of psychology, in spite of its obvious major importance both from the fundamental and from the applied points of view. We would argue that the objective measurement of motivation or drive in human beings is an essential requirement for clinical psychology, and we would further suggest that such objective measurement can only be accomplished in terms of some theoretical system in which drive has a recognized place and mode of interaction with measurable variables. It has been suggested by Eysenck and Maxwell (1961) that only the Hullian system provides such an account, and some evidence is to hand (Kimble, 1950; Wasserman, 1951; Claridge, 1960; Eysenck and Maxwell, 1961) to reinforce the view that deductions can be made from this system which will generate testable hypotheses relating to the measurement of motivation.

According to the theory in question, massed practice (e.g. on the pursuit rotor) produces reactive inhibition (I_R), which grows as a linear function of duration of practice. I_R is regarded as a negative drive which cancels out part or all of the positive drive (D) active in the testing situation. When $I_R=D$, performance stops and an involuntary rest pause (I.R.P.) ensues. During this I.R.P. inhibition, being a fatigue-like product, dissipates, and when I_R falls sufficiently below D, performance begins again. I_R accumulates again until another I.R.P. is enforced, and once the critical level has been reached where I.R.P.s interrupt performance, these rest pause, will occur regularly, until a lengthy programmed rest pause allows I_R to dissipate completely. This dissipation is shown in performance as *reminiscence*, i.e. an improvement in performance when massed practice is resumed after the rest pause, as compared with the level of performance just preceding the rest pause.

The sequence of events may be shown diagrammatically as in Figure 1, where minutes of practice are plotted on the abscissa and amount of drive on the ordinate. The line slanting across the figure represents the growth of I_R for a low drive group (L) and a high drive group (H), respectively. It will be seen that for the low drive group (whose drive for the purpose of demonstration is assumed to be equal to 0·5 units) the critical level where I.R.P.s occur is reached after two minutes; I_R never grows beyond this level, as it can never exceed the value of D. The high drive group, whose drive level is arbitrarily

* We are indebted to the Society for the Investigation of Human Ecology for a grant which made this study possible.

assumed to be 1·50 units, continues to show a growth of I_R until the critical level is reached after six minutes of practice; no further growth of I_R is possible after that point.

It will be clear from what has been said that reminiscence is a good measure of I_R, provided the programmed rest pause is sufficiently long to allow all or nearly all of the I_R to dissipate. But I_R is a direct measure of D at and after the moment when the critical level has been reached. "It follows that reminiscence, in these circumstances, may be regarded as a direct measure of motivation or D and it can be predicted that high drive levels should give rise to greater reminiscence scores than low drive levels" (Eysenck and Maxwell, 1961).

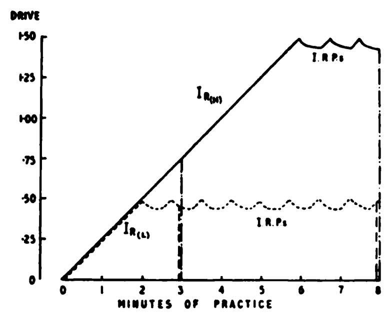

FIG. 1.—Diagrammatic representation of the growth of reactive inhibition (I_R) in low (L) and high (H) drive groups after varying amounts of practice. Involuntary rest pauses (I.R.P.s) arise when I_R=D.

In an experimental study of this hypothesis, these authors chose high and low drive groups totalling 120 Ss. Both groups were given massed practice on the pursuit rotor, time-on-target being summed for each successive 10-second period. Half the Ss practised for three minutes, the other half for eight minutes; a six-minute rest pause followed practice, and this in turn was followed by another four-minute post-rest practice period. (The first post-rest trial was preceded by two seconds of practice, in order to make this trial properly comparable with the last pre-rest trial.) Reminiscence score used was: first post-rest trial minus last pre-rest trial. The reminiscence scores for the short practice groups were 0·80 (high drive group) and ·54 (low drive group). For the long practice groups, the reminiscence scores were 1·51 (high drive group) and ·51 (low drive group). Analysis of variance disclosed that differences in length of practice were significant at the 5 per cent. level, differences in drive strength were significant at the 1 per cent. level, and the interaction was significant at the 2 per cent. level. These values are in line with the hypothetical state of affairs shown in Figure 1, and strongly support the general hypothesis.

The experiment to be reported now represents a duplication and extension of the Eysenck and Maxwell study. It can be seen that after two minutes of practice there should be *no* difference in the reminiscence scores of the high drive and low drive groups because at that point the low drive group is only just beginning to produce I.R.P.s. To test this hypothesis the two-minute practice period was chosen as one of the variables in the new experiment. The other period chosen for the massed practice preceding the rest pause was six minutes because, as will be seen from Figure 1, it is at this point that I.R.P.s should begin to occur for the high drive group provided that the growth of I_R is linear and passes through the zero point on the abscissa. If this were true, then reminiscence scores for the high drive group should be equal after six and after eight minutes of massed practice.

A total of 148 Ss was used in the experiment, half of whom were tested under low drive motivation, the other half under high drive motivation. As in the previous experiment, all the Ss were young industrial apprentices, 16 to 18 years of age; all were male. The high drive group took the test as part of an entrance examination for engineering apprentices at one of the biggest car-making firms in England; they were under the impression that the score on this test would play some part in determining their success or failure in the examination. The Ss in the low drive group had already been accepted as apprentices, and were working with the firm in question; under Trade Union agreement they were guaranteed advancement regardless of how well or how poorly they worked, so that they had no particular motivation to do well on the pursuit rotor test, which they were told was of experimental interest to psychologists only.

Each group was, in turn, subdivided into two, differing with respect to the amount of pre-rest practice; each of the final four groups consisted of 37 Ss. The long-practice groups received six minutes of practice (thirty-six 10-second trials), while the short-practice groups received two minutes of practice (twelve 10-second trials); this was followed by a six-minute rest period, and this, in turn, by a six-minute post-rest practice (thirty-six 10-second trials). (The reason for having the post-rest practice two minutes longer than in the previous study was to enable us to obtain further evidence on the role of motivation in determining performance as such; this point will be discussed later. In all other respects the experimental treatment of the groups was identical with that in the first experiment, so that reminiscence scores are fully comparable.)

Results

The performance curves of the high drive and low drive groups respectively are given for the two-minute pre-rest practice groups in Figure 2, and for the six-minute pre-rest practice groups in Figure 3. Time-on-target is shown on the ordinate in each case. It will be seen that in no case are the groups differentiated with respect to performance, a point which will be discussed in detail later on.

Reminiscence scores were calculated as before for the four groups and are

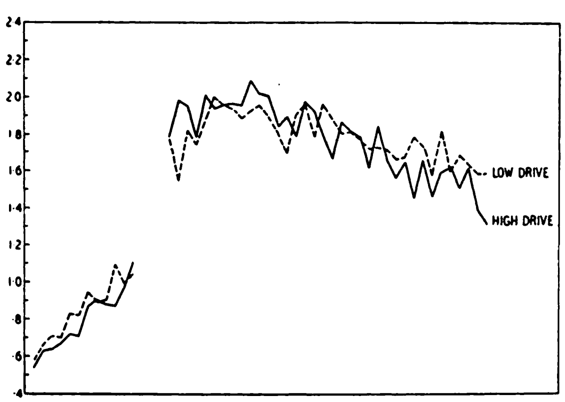

FIG. 2.—Performance on the pursuit rotor of high and low drive groups during two minutes preceding and six minutes succeeding a six-minute rest pause.

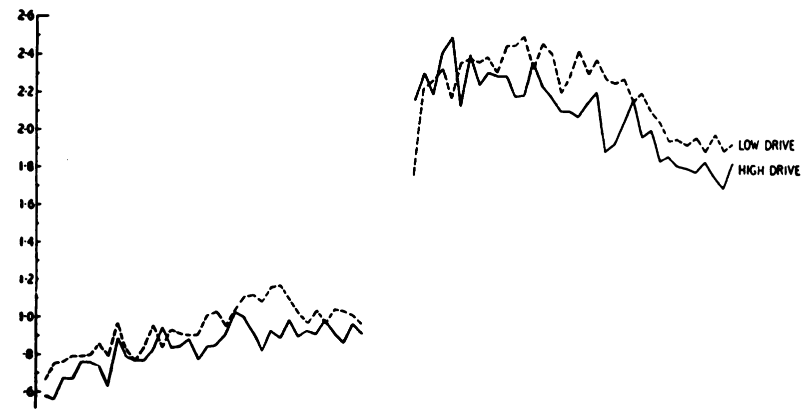

FIG. 3.—Performance on the pursuit rotor of high and low drive groups during six minutes preceding and six minutes succeeding a six-minute rest pause.

given in Table I. It will be seen that as predicted, the high drive long practice group has a higher mean reminiscence score than the low drive long practice group. It will also be seen that as predicted, there is no difference between the short practice groups in response to high or low drive.

TABLE I

Drive	2 Minutes	6 Minutes	Mean
Low	·72	·84	·78
High	·68	1·29	·99
Mean	·70	1·02	

A variance ratio test of the significance of the differences between the values in Table I leads to Table II, part 1.

TABLE II, PART 1

Source of Variance	Sum of Squares	d.f.	Mean Square
Between groups	8·8754	3	2·9585
Within groups (error)	115·1989	144	·8000
	124·0743	147	

Although the variance between the means of the groups is not large (7·15 per cent. of the total) the number of observations is sufficient to demonstrate its significance: $F=3{\cdot}70$ and $\cdot05>P>\cdot01$.

The exceptional mean, as predicted, is that of the group with high drive and long practice. The sum of squares of the variance between groups can be broken down as in Table II, part 2. The variance between the means of the

TABLE II, PART 2

Source of Variance	Sum of Squares	d.f.	Mean Square
Variance between the high drive, long practice group and the remaining groups	8·4082	1	8·4082
Variance of the remaining groups among themselves	·4672	2	·2336

remaining groups has a smaller m.s. than the error variance in Part 1, so a general mean of ·75 can reasonably be derived for the three. This is also the expected mean for the high drive, long practice group, on the assumption that the conjunction of high drive with long practice has no specific effect on reminiscence. The large variance between the mean for the high drive, long practice group, 1·29, and the general mean for the remaining groups, ·75, with its variance ratio $F=8{\cdot}4082/{\cdot}8000=10{\cdot}51$ and $P<{\cdot}01$, shows the significance of the specific effect observed in this experiment.

Figure 4 shows in diagrammatic form the combined results of the present experiment and the one reported by Eysenck and Maxwell (1961). It will be seen that the low drive groups have reminiscence scores which between the limits of the experiment (from two minutes of massed practice to eight minutes of massed practice) remain constant at a level of about ·65. The reminiscence scores of the high drive group, between the same limits, exhibit a linear increase from the two-minute period where they equal with those of the low drive group,

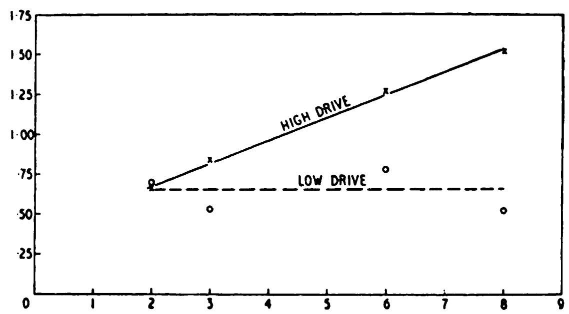

FIG. 4.—Reminiscence scores of high and low drive groups plotted as a function of the number of minutes of massed practice preceding the rest pause.

to the eight-minute period where they are between two and three times as high as those of the low drive group. The rise in score of the high drive group between six and eight minutes is unexpected and, if confirmed, would invalidate the hypothesis that the increase in I_R with practice is linear; extrapolating the results from the high drive groups backwards in a linear fashion, it will be seen that the ordinate at the point of zero practice is cut at a level considerably above zero, which is nonsensical. It seems possible, therefore, that the growth of I_R below the point represented by two minutes' practice is *curvilinear*, or else that it is linear but has a different *slope* from growth after the two-minute practice period. Which of these hypotheses is true must remain a problem for further research. So must the question of the level at which the high drive group accumulates enough I_R to equal D; it is impossible from the data presented, to be sure that no further growth would occur with longer practice periods than eight minutes. It seems safe to conclude, however, that for the purpose of measuring motivation or drive, relatively long periods of practice are optimal; to have a period of practice which does not enable the high drive group to reach the point where I_R equals D, leads to a minimization of the difference between it and the low drive group.

DISCUSSION

In one sense, it may be said that the data here presented constitute a justification of the writers' belief in the value of the Hullian theory in making possible the measurement of motivation. It is unlikely that in the absence of this theory, and its development by Kimble (1950), reminiscence would have been used in this manner. In another direction, however, our results throw some doubt on the general applicability of the Hullian formula for performance as a function of drive and habit, i.e. ${}_{S}E_{R}=f\ (D\times {}_{S}H_{R})$. According to this very widely accepted formulation, which is accepted even by learning theorists otherwise critical of Hull, we would expect that performance on the pursuit rotor would be better for the high drive than for the low drive group. In the experiment by Eysenck and Maxwell (1961), it was already found that "the evidence for differentiation effects of drive on performance is rather poor. While such differences as are observed are in the expected direction, and achieve significance at one point, yet the total differentiation is not very impressive." In the present experiment this differentiation is even less impressive; indeed, on the whole the low drive group does, if anything, better than the high drive group, although the differences do not, at any point, approach significance. Reasons for this failure of drive to influence performance may be many and various; only one suggests itself as a likely explanation. The tasks used by psychologists for the measurement of performance may be assigned a position on a continuum, ranging from subject-paced at one end to experimenter-paced at the other. In an experimenter-paced task, the subject, if he co-operates at all, co-operates fully, and differences in drive beyond the minimum required for co-operation do not have much chance to affect performance. In a subject-paced task, however, such as the five-choice serial reaction time experiment (Venables, 1959; Claridge, 1961), where the subject's reaction automatically produces the next task, motivation has a good opportunity of affecting the speed of performance at all levels. There is little evidence to support this hypothesis, but it is in line with the theory presented here that on the pursuit rotor, extraverts have equal performances with introverts, but higher reminiscence scores (Eysenck, 1960a), while on the five-choice serial reaction time test extraverts have poorer performance but equal reminiscence scores (Claridge and Herrington, 1960). This may be interpreted in terms of the general theory that extraverts accumulate more inhibition than do introverts; under experimenter-paced conditions, as on the pursuit rotor, this excessive inhibition shows itself in greater reminiscence scores. Under subject-paced conditions, as in the five-choice serial reaction time test, this excessive inhibition shows itself in a generally poor performance, leading to equal reminiscence scores (i.e. inhibition is being dissipated throughout the performance period). This hypothesis, of course, is highly speculative and should not be recorded as being based on a firm footing; nevertheless it suggests some interesting research possibilities.*

It will have been noticed that in our experiment we have paid no attention to individual differences among Ss. These are quite considerable, as shown by the high variances, and it is possible that there may exist considerable differences between Ss with respect to the degree of motivation elicited by a standard set of experimental tasks and instructions. This could easily be investigated by correlating reminiscence scores of a given set of Ss working under equal drive-inducing conditions on a variety of different tasks. It would not be unexpected if positive correlations were found between reminiscence

* This explanation is not adequate by itself to account for the failure to find differences in performance due to drive; it is likely that recourse will have to be had also to the Yerkes-Dodson Law. It would be idle to indulge in further speculation at this point; clearly duplications of this experiment with different tasks are required to provide the factual basis for theoretical discussions.

scores on these different tasks, at least as long as these tasks were all located towards the experimenter-paced end of the continuum. It is certainly notable that widely different tests of persistence are usually found to correlate together (Eysenck, 1960b), and there is an obvious similarity between persistence and high drive. This whole problem, however, is likely to be complicated by possible differences in drive between extraverts and introverts, neurotics and normals, or other groups which may be used for experimental purposes. Even when there are no differences directly attributable to say, extraversion, interaction effects are still a possible source of complication (Eysenck, 1957; Eysenck, 1960a).

One further complication that should be mentioned is due to differences likely to arise in studies with certain types of abnormal Ss. Low reminiscence scores are evidence of lack of drive *only when the rest pause involved is long enough to ensure complete dissipation of* I_R. In a number of unpublished studies we have found that psychotics, in particular schizophrenics, showed complete absence of reminiscence on the pursuit rotor under conditions where normal Ss and neurotics have never failed to show reminiscence. It would be tempting to interpret this finding in terms of lack of drive on the part of our schizophrenic Ss, but an alternative hypothesis was elaborated stating that the rate of dissipation of I_R in psychotics may be abnormally slow, so that a 10-minute rest pause, while sufficient for normal and neurotic Ss to dissipate practically all the I_R accumulated during rest practice, did not suffice with the schizophrenic groups to dissipate more than a minute fraction of the I_R accumulated. In a critical experiment, normal and psychotic groups were tested with 10-minute and with 24-hour rest periods, and while the longer rest period did not increase the reminiscence scores of the normal group, results with the schizophrenic groups showed a lack of reminiscence after 10 minutes' rest but a reminiscence score even greater than that of the normals after the 24-hour rest period. This example will make it clear that the use of reminiscence scores as measures of motivation requires a very careful theoretical analysis, particularly when experiments are planned dealing with abnormal Ss. It is, nevertheless, our opinion that such experiments will be all the more fruitful because of the firm theoretical underpinning which the use of reminiscence scores as measures of motivation receives from modern learning theory.

Summary

Certain deductions from modern learning theory have been outlined according to which reminiscence on the pursuit rotor should constitute a good measure of motivation. Groups of young male industrial apprentices were tested under conditions of high and low drive, and the results confirmed predictions made on the basis of this theory. No differences were found with respect to performance between high drive and low drive groups.

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H. J. EYSENCK
R. A. WILLETT
Institute of Psychiatry (Maudsley Hospital), University of London.

The British Journal of Psychiatry

The Measurement of Motivation Through the Use of Objective Indices

H. J. Eysenck and R. A. Willett
BJP 1961, 107:961-968.
Access the most recent version at DOI: 10.1192/bjp.107.450.961

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