# EXPRESSIVE MOVEMENT AND LEARNING: A STUDY OF SCORE COMPLEXITY

By

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## INTRODUCTION

THE present report deals with two effects of movement variability as a function of practice in the drawing from memory of visually presented patterns. The first effect is found in initial practice stages only and appears to be related to the neurotic dichotomy of hysteria/dysthymia*. The second effect is specific to late practice stages and related to schizophrenics as against neurotics and controls. Results are mainly discussed to illuminate the problem of score complexity in motor learning. The aim is to show how, in learning involving motor activity, the extent and variability of movement components may affect the validity of learning scores in their relation to personality.

Jones (10), in his review on learning in abnormals, has noted considerable discrepancies between experiments employing different techniques. These differences in learning efficiency were largely explained in terms of individual differences in the reaction to varying degrees of "stress" associated with the different tasks. Theoretical models were constructed accordingly. This is one procedure to disentangle the reported discrepancies. An alternative approach, quite apart from the problems of difficulty, stressfulness and type of task, is to analyse whether the various learning scores used are in fact psychologically comparable. To quote an example from Jones' review, extraverts, as against introverts, were found to be inferior on certain learning tasks but superior on others. Before accepting this as a true result the possibility should be scrutinized that, dependent on the task employed, various forms of behaviour other than learning proper may affect the learning score to such an extent as to render results contradictory. If this is the case, the setting up of corresponding theoretical models appears premature.

The justification for this argument is derived from the following facts. In a number of pursuit-rotor experiments, performed in the Maudsley Hospital as quoted by Jones (10), correct performance (contact with the target disc) was consistently better for introverts than for extraverts, though predominantly not significantly so. The same result was obtained by the present author when using a motor task of tracing a target line while wearing prismatic inversion lenses (2). Essentially identical results were thus obtained despite some considerable variations in tests and method of presentation. On the surface, they tend to confirm Eysenck's extraversion theory on learning, which claims that amongst other variables rate of performance correlates negatively with extraversion (9).

At this point it should be borne in mind that learning efficiency was studied

* The terms hysteria/dysthymia and extraversion/introversion are used in accordance with Eysenck's theory of extraversion (8), the former representing the neurotic variants of the normal dimension of extraversion/introversion.



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through the medium of motor activity. This is of cardinal importance as the present author has, on a number of occasions, established the fact that movement extent and particularly movement variability are significantly related to extraversion (1, 2, 5, 6). As it is likely that in motor tracking tasks both movement extent and variability cause relatively poor or shortened contact with the target, the above stated inferior motor performance of extraverts may have resulted from their particular movement characteristics rather than from learning *per se*. This view is considerably strengthened by two facts. In the above-mentioned tracing experiment, with subjects wearing prismatic lenses (2), care was taken to analyse both correct tracing (on target) as well as error tracing (extent of movement off the target). While the amount of correct tracing was somewhat smaller for extraverts than for introverts, the amount of error tracing was very significantly larger. It follows from this that increase in target size leads to inclusion of more of the extraverted type of extensive off-target movement into the learning score until the result is reversed, i.e. extraverts perform superior provided the target is sufficiently large.

While further analysis of this problem is in preparation, an essentially identical analysis, using a very different type of task, is dealt with in the present paper. This task permits scoring of error in terms of several types of deviations from the stimulus found in drawn reproductions. A first analysis of learning an extremely difficult task has already shown that normal and abnormal extraverts performed preponderantly better than introverts, though not significantly so (3). Using a considerably easier task under short exposure condition —which, incidentally, proved to be specific to extraversion in contrast to long exposure—extraversion in neurotics correlated positively and very significantly with superior performance (4). The three error scores used in these analyses were designed to exclude movement extent and variability from interfering with the learning score.

The question is now asked whether, on re-analysis of the experiment in question (3) so as to permit movement characteristics of the type discussed to affect the learning score, extraverts do in fact perform worse than introverts. If so, considerable doubt is thrown on the feasibility of relating most of the known types of motor learning to extraversion. The problem may now be defined in a more specific manner. The rotary pursuit and motor tracing experiments, referred to above, have consistently shown that increase in rate of performance of extraverts is inferior to that of introverts in early stages of practice. With prolonged practice, means of these two subgroups converge until they are virtually identical. The present analysis considers this effect by expecting that differences with respect to a complex movement/learning score between extraverts and introverts are largest in early stages of learning and diminish steadily with practice.

The general hypothesis underlying these arguments is that extraversion correlates negatively with rate of learning if certain style of movement is allowed to interfere with learning performance proper. If scored without such interference, learning is not negatively related to extraversion regardless of the difficulty level of the task employed. Instead, provided certain medium levels of difficulty and/or certain exposure conditions are used, extraversion will correlate positively and significantly with learning. Under other conditions it will not correlate significantly while other personality traits will be of greater importance.

As was stated in the beginning, a second effect specific to late practice stages and to psychotics, in the main schizophrenics, is reported. This was

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observed empirically and without anticipation. However, as it was successfully cross-validated the report of this effect appears justified.

## METHOD

### 1. *The Figure Reconstruction Test (FRT)*

The main score used in the present analysis is termed *distance variability*. It is the fourth error score derived from the Figure Reconstruction Test (FRT), a pattern of which is seen in Figure 1.

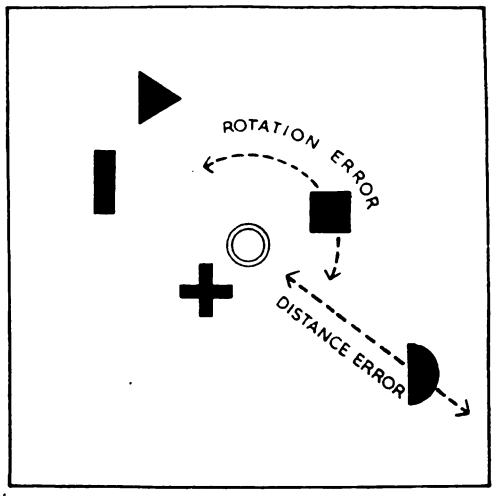



FIG. 1.—FRT pattern demonstrating axial (rotation error) and radial (distance error) error types. Two patterns of this kind, successively exposed, formed the learning stimulus of the experiments described.

On previous occasions, two such patterns were exposed consecutively and reproduced on two separate response sheets of 31 cm. square. The actual test shapes (semi-circle, triangle, square, oblong and cross) had to be drawn around the central reference point used for scoring only. Twelve such trials were asked for in a first experiment (Exp. I) as against twenty trials in a second experiment (Exp. II). Drawn reproductions may be analysed for deviation from the stimulus in terms of error axial (rotation error) and radial (distance error) to the central reference point. Method and results have been described fully in an earlier publication (3).

### 2. *Description of Error Scores Uncontaminated by Expressive Movement*

We now describe three of the four error measures. The first three were designed to prevent individual variation in the area covered in drawing and the respective variability in area between successive drawings to contaminate the error score. The three scores are:

*Rotation Error:* Mean axial displacement of the individual stimulus elements, measured in degrees.

*Rotation Variability:* Change of rotation error between successive reproductions in degrees, disregarding the direction of change.

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*Distance Error:* Radial, either centrifugal or centripetal, displacement of test shapes, measured in terms of number of places away from the stimulus position.

The first two scores, dealing with displacement about the centre, are, for logical reasons, quite unlikely to be influenced systematically and significantly by movement extent and variability. Radial error, however, will be greatly affected by such movement characteristics unless special precaution is taken. In the stimulus the distance of the five test shapes from the centre increases arithmetically. From the drawings the reproduced distances are determined first and then compared with the stimulus order. Distance error is scored in terms of discrepancy between stimulus and reproduced orders, or in terms of number of places a shape was reproduced away from the stimulus order. This operation completely rules out effects due to extent of movement and greatly reduces effects of movement variability. This has already been discussed elsewhere (6, Table IV) and the correlations quoted in Table I demonstrate the effected high degree of independence of error from movement.

3. *Description of Expressive Movement Scores Uncontaminated by Error*

The four movement scores shown were scored so as to minimize the effect of error on movement. They are defined as follows:

*Distance:* mean distance of reproduced shapes per trial from the centre of the reproduction sheet.

*Distance variability between pattern means* (*DV pattern*)*:* variability between distance means of patterns, or, the mean deviation of a given number of distance scores from their mean.

*Distance variability within ranges* (*DV ranges*)*:* identical to the preceding score, except for measuring separately at each of the five distances, or ranges, at which Ss choose to draw.

*Distance spread:* mean deviation of shapes from the mean distance within trials.

Correlations between movement and error scores are now shown in Table I.

TABLE I

*Extent and Variability of Movement in Drawings Correlate Lowly with Error Scores Designed to be Uncontaminated by such Movement Characteristics*

| Correlations of Expressive Movement with Error Scores | | Distance | Spread | DV Pattern | DV Ranges |
|---|---|---|---|---|---|
| Rotation Error | I | 0·23* | 0·09 | 0·24* | 0·19 |
| | II | −0·21 | −0·13 | 0·19 | 0·20 |
| Rotation Variability | I | 0·24* | 0·13 | 0·09 | 0·22* |
| | II | 0·06 | −0·08 | 0·34† | 0·41† |
| Distance Error | I | 0·01 | −0·20* | 0·18 | 0·16 |
| | II | −0·07 | −0·07 | 0·08 | 0·08 |

Exp. I=100 neurotics, II=67 normals, neurotics and schizophrenics.
Levels of significance: *=5 per cent., †=1 per cent.

The general picture emerges that extent of movement (distance and spread) is inconsistently related to error. The coefficients for the two variability scores (distance variability for pattern and ranges) are consistently positive but low

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in the average. It is concluded that the first three error scores used are essentially independent of the movement characteristics present during reproduction.

4. *Description of a Complex Expressive Movement/Learning Error Score**

We now turn to the fourth error score, termed *distance variability* (*error*), designed to be a complex score made up of movement and error components. This score is defined as the change in mms. between successive trials of the distance from the centre, at which the individual shapes are drawn. It includes extent of movement. Variability of distance was expected to reflect both movement/variability *per se* and uncertainty as to the correct placement of test shapes (error). This expectation was fully borne out, as demonstrated further below, and distance variability may justifiably be used as a complex score. The choice of variability over the extent (distance) of movement was necessitated by the fact that the latter does not display systematic practice effects as expected from an error score (6, Fig. 2).

5. *Subjects*

The scores described are analysed with respect to the samples quoted below and employed in two experiments.

| | Experiments | |
|---|---|---|
| | I | II |
| Normal controls .. .. .. .. .. | 40 | 22 |
| Neurotics .. .. .. .. .. .. | 100 | 30 |
| Hysterics .. .. .. .. .. | 39 | 15 |
| Dysthymics .. .. .. .. .. | 61 | 15 |
| Psychotics .. .. .. .. .. | 28 | 15 |

A detailed description of these samples has already been given (3). Suffice it to say that groups were equated for age and intelligence and that there were not gross differences with regard to social status. In I, an unselected sample of neurotics was used; in II, in accordance with Eysenck's theory of extraversion, only clear-cut cases of hysterics and dysthymics were chosen, using pooled clinical ratings and Guilford's Rathymia score as criteria. The psychotics of I were all schizophrenic except for seven endogenous depressions. In II, they were all schizophrenics.

## Results

1. *Distance Variability as Related to Hysteria/Dysthymia*

Results on distance variability are first related to the dichotomy of hysteria/dysthymia, as shown in Figure 2.

Large practice effects are seen in all groups suggesting that we are dealing with error curves. The hysterics scored higher than the dysthymics throughout, whereas the psychotics and controls, with the exception of late practice stages, assumed an intermediate position. Furthermore, differences between the means

* As points 3 and 4 show, there are two types of distance variability scores. The first type is scored disregarding the identity of test shapes. For "DV pattern" the correct location on the response sheet of the individual shapes is irrelevant. The same is true for "DV ranges", where the reproduced ranges were used regardless which test shape was placed on a particular range. Error is thus automatically excluded. In the case of distance variability (error), test shape identity is regarded. The question is now how much each particular shape varies its position between successive trials.

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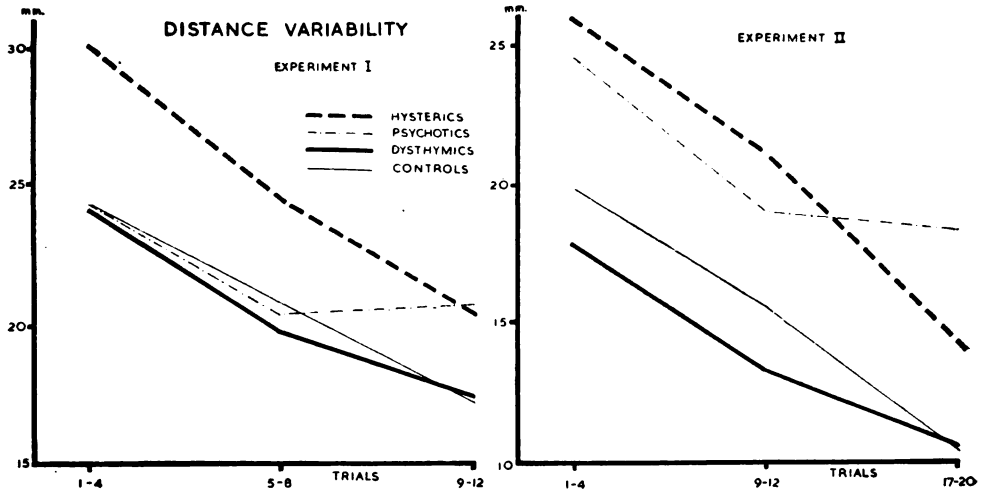



FIG. 2.—Distance variability, an error score contaminated by movement extent and variability, is in early practice stage related to hysteria/dysthymia (primary variability). With prolonged practice psychotics tend to score highest (secondary variability). In I three-quarters and in II all of the psychotics are schizophrenics.

of the hysterics and dysthymics decreased with practice. The significance of the differences between the latter two groups was tested by means of analysis of variance, as shown in Table II.

TABLE II

*Analysis of Variance Between the Hysterics and Dysthymics Separated for Three Blocks of Trials*

| Experiment I | d.f. | s.sq. | m.sq. | F-ratio | Significance (Per cent.) |
|---|---|---|---|---|---|
| Between trials .. | 2 | 3,161·447 | 1,580·724 | 20·256 | 0·1 |
| Between groups .. | 1 | 1,465·479 | 7,465·479 | 18·779 | 0·1 |
| Interaction T×G .. | 2 | 99·141 | 49·571 | — | N.S. |
| Between classes .. | 5 | 4,726·067 | — | — | — |
| Within classes .. | 294 | 22,943·600 | 78·039 | — | — |
| Total .. .. | 299 | 27,669·667 | — | — | — |
| Experiment II | | | | | |
| Between trials .. | 2 | 760·424 | 380·212 | 6·858 | 1 |
| Between groups .. | 1 | 378·000 | 378·000 | 6·817 | 5* |
| Interaction T×G .. | 2 | 707·400 | 353·700 | 6·379 | 1 |
| Between classes .. | 5 | 1,845·824 | — | — | — |
| Within classes .. | 84 | 4,657·332 | 55·444 | — | — |
| Total .. .. | 89 | 6,503·156 | — | — | — |

Nearly 1 per cent.

The "between trials" analysis shows that highly significant practice effects occurred, which supports the view that distance variability may be classified as an error variable. The "between groups" variation is almost equally significant for both experiments and permits the conclusion that distance variability is both reliably and significantly higher for hysterics than for dysthymics. With

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these results the first expectation is borne out, viz.: extraverts (hysterics) score inferior to introverts (dysthymics) provided a complex error score is used containing both movement variability and a measure of error proper. In contrast to this, the same extraverts tended to score better on three learning measures, discussed in the method section, uncontaminated by movement variability and derived from the same experiment (compare 3). These results had not been significant.

2. *The Dependency of the Movement Effect on Practice*

Table II reveals furthermore that the interaction term for I is insignificant but significant at the 1 per cent. level for II. This indicates that the postulated decrease of the differences obtained between the hysterics and dysthymics depends on the amount of practice given, which was greater for II. This effect is more closely examined by means of critical ratios between the group means which were computed using the "within classes" variance of the analysis of variance tables. Corresponding results are presented in Table III.

TABLE III

*Differences in Distance Variability Between Hysterics and Dysthymics Decrease with Practice*

| Trials: Experiment I | | 1–4 | 5–8 | 9–12 |
|---|---|---|---|---|
| Means | Hysterics | 30·077 | 24·231 | 20·487 |
| | Dysthymics | 24·164 | 19·590 | 17·443 |
| t-ratio | | 3·261 | 2·560 | 1·679 |
| Significance | | 1% | 2% | N.S. |
| **Trials: Experiment II** | | **1–4** | **9–12** | **17–20** |
| Means | Hysterics | 26·133 | 21·067 | 14·333 |
| | Dysthymics | 17·800 | 13·333 | 10·400 |
| t-ratio | | 3·065 | 2·844 | 1·446 |
| Significance | | 1% | 1% | N.S. |

D.F.: I=294, II=84.

The consistent result emerges that differences in distance variability between hysterics and dysthymics are largest in initial practice stages and decrease with practice.

3. *Distance Variability as Related to Psychosis*

Experiment I revealed that psychotics, after scoring relatively low in the beginning, tended to form a plateau and to equal the mean score of hysterics during late practice stages (Fig. 2). This result was confirmed in II. Moreover, and apparently due to the increased number of trials, the schizophrenic mean was now higher than that of the hysterics during the last block of trials. The significance of these results is assessed in Table IV.

The upper portion of Table IV shows that hysterics and psychotics (mainly schizophrenics) did not differ significantly as regards distance variability at the second trial block. With further practice, as measured by the difference between the second and third trial blocks, the psychotics improved hardly at all, whereas the hysterics improved significantly over the psychotics. These results strongly suggest that high distance variability, after prolonged practice, is a psychotic feature. At the third trial block of Experiment II (trials 17–20) differences

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TABLE IV

*Practice Scores of Distance Variability, Computed Between the Two Last Trial Blocks, Differentiated Significantly Between Hysterics and Psychotics (mainly Schizophrenics)*

Distance Variability

| Level Score (2 block of trials) | | Hysterics | Psychotics (I) Schizophrenics (II) | t-ratio |
|---|---|---|---|---|
| Experiment I (trials 5–8) | $\bar{X}$ | 24·231 | 20·429 | 1·811 |
| | SD | 51·739 | 44·619 | (65 DF, N.S.) |
| Experiment II (trials 9–12) | $\bar{X}$ | 21·067 | 19·000 | 0·197 |
| | SD | 32·817 | 26·834 | (28 DF, N.S.) |
| Practice Score (2–3 block of trials) | | | | |
| Experiment I (trials 5–8 to 9–12) | $\bar{X}$ | 3·744 | −0·464 | 2·736* |
| | SD | 44·016 | 25·395 | (65 DF, 1%) |
| Experiment II (trials 9–12 to 17–20) | $\bar{X}$ | 6·733 | 0·733 | 2·401† |
| | SD | 27·293 | 23·810 | (28 DF, 2%) |

*=one-tail test, †=two-tail test (just short of 1 per cent. level).

between the three groups—schizophrenics, hysterics and dysthymics/controls combined—were significant at the 0·1 per cent. level, as assessed by an analysis of variance (DF=2/64), the F-ratio being 8·417.

4. *Correlation Analysis*

Table V contains a number of correlations which were computed both in the interest of the present analysis and for completeness of knowledge of this aspect of the FRT. Correlations were computed separately for four groups, three of them derived from I for which trial blocks 1–4 and 9–12 were used. As to II, where twenty trials had been used, coefficients based on all 67 subjects are quoted additionally for the final block of trials 17–20. In the case of all error measures correlations were computed separately for trial blocks. Thus, rotation error of trials 1–4 was correlated with distance variability of trials 1–4, rotation error of trials 9–12 with distance variability of trials 9–12, and so forth. For the remaining FRT scores, distance, size and size variability, which previously had not revealed systematic practice effects, a total score for all trials was used for correlation with the various practice stages of distance variability. "Size" is the actual size of the reproduced test shapes measured in mms. "Size variability" was computed as "between trials" plus "between shapes" variability between successive trials. These expressive movement scores have been described elsewhere (6). Other scores used earlier were excluded from the present analysis on account of their unreliability and lack of demonstrated validity. Correlations are now shown in Table V.

An FRT (learning) task of the present high level of difficulty and test length produces a practically linear increase in variance of error scores with practice. The intercorrelation of such scores is known to increase accordingly. If distance variability is to qualify as an error variable, its correlation with the three "pure" error scores should also increase with practice, which is in fact fully confirmed.

The next result, referring to score complexity, deals with trial block 9–12

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TABLE V

*Correlations of Distance Variability, a Complex Movement/Error Score, with Pure Movement and Error Scores, as well as I.Q. and Age*

| Distance Variability | | Trials 1–4 | Trials 9–12 | Trials 17–20 |
|---|---|---|---|---|
| Rotation error | 1 | 0·34† | 0·56† | — |
| | 2 | 0·13 | 0·15 | — |
| | 3 | 0·02 | 0·61† | — |
| | 4 | 0·11 | 0·35† | 0·52† |
| Rotation variability | 1 | 0·25* | 0·64† | — |
| | 2 | 0·40* | 0·46* | — |
| | 3 | 0·31 | 0·55† | — |
| | 4 | 0·19 | 0·57† | 0·70† |
| Distance error | 1 | 0·13 | 0·34† | — |
| | 2 | 0·38* | 0·26 | — |
| | 3 | −0·15 | 0·32* | — |
| | 4 | −0·14 | 0·32† | 0·53† |
| Distance | 1 | 0·42† | 0·59† | — |
| | 2 | 0·53† | 0·73† | — |
| | 3 | 0·70† | 0·32* | — |
| | 4 | 0·67† | 0·47† | 0·37† |
| Size | 1 | 0·19 | 0·23* | — |
| | 2 | 0·42* | 0·53† | — |
| | 3 | −0·14 | −0·18 | — |
| | 4 | 0·22 | 0·07 | 0·09 |
| Size variability | 1 | 0·23* | 0·29† | — |
| | 2 | 0·53† | 0·62† | — |
| | 3 | −0·17 | −0·13 | — |
| | 4 | 0·20 | 0·23 | 0·26* |
| I.Q. | 1 | −0·16 | −0·39† | — |
| | 2 | −0·01 | −0·11 | — |
| | 3 | −0·24 | −0·07 | — |
| | 4 | 0·02 | −0·15 | −0·32† |
| Age | 1 | 0·01 | −0·09 | — |
| | 2 | 0·17 | 0·26 | — |
| | 3 | −0·08 | 0·02 | — |
| | 4 | −0·10 | 0·02 | 0·10 |

*=5 per cent. level; †=1 per cent.
1=Exp. I: 100 neurotics.
2=Exp. I: 28 psychotics.
3=Exp. I: 40 controls.
4=Exp. II: 67 normals and abnormals.

only and is discussed jointly with results drawn from two previous publications on the same experiments and samples (3, 6). The expectation is that correlations within a group of relatively pure error scores and within a group of relatively pure expressive movement scores should be highest. Correlations between pure error and pure expressive movement scores should be lowest. Correlations between the movement contaminated error score (distance variability), on the one hand, and pure error and expressive movement scores on the other, should, due to the complexity of distance variability, assume an intermediate position. This expectation is fully borne out as the following mean correlation shows (means of several normal, neurotic and psychotic groups).

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| | |
|---|---|
| Mean intercorrelation of error scores (rotation, rotation variability and distance error), uncontaminated by expressive movement (3) | 0·70 |
| Mean intercorrelation of expressive movement scores (distance, size, size variability), uncontaminated by error (6) .. .. .. | 0·61 |
| Distance variability vs. three error scores, uncontaminated by expressive movement (Table V) .. .. .. .. .. | 0·43 |
| Distance variability vs. three expressive movement scores, uncontaminated by error (Table V) .. .. .. .. .. | 0·31 |
| Movement uncontaminated error scores vs. error uncontaminated expressive movement scores (6) .. .. .. .. .. | 0·10 |

Correlations of distance variability with intelligence are somewhat higher than those for expressive movement measures *per se*, which may be explained as due to the error content of distance variability.

## Discussion

It has been demonstrated that the use of a complex error score, involving components of expressive movement in addition to error, may lead to contradictory results in terms of relationships to personality criteria. If learning scores proper, i.e. scores not contaminated by irrelevant factors like expressive movement, are used, the consistent result apparently is that extraversion is not significantly related to learning or, under certain conditions, that extraverts perform superior to introverts. Inconsistencies introduced by recent motor pursuit experiments, reviewed by Jones (10), have thus been resolved, and the models proposed to explain the discrepancies may now be considered redundant. We readily agree with Jones, however, that the earlier conceptions of learning as related to extraversion require considerable change. Eysenck (7) expected practice effects to be lower in extraverts due to their stronger "inhibitory potential" and to be higher in introverts due to their stronger "excitatory potential". After the present analysis of score complexity, however, either the opposite is true, or the inhibitory phenomena under discussion are not significantly related to extraversion, or extraversion plays a part under certain restricted conditions which are impossible or difficult to predict on a purely rational basis. The present author favours the latter explanation.

If extraversion is to be further investigated in relationship to learning, the indications are now that control of movement characteristics of the kind described is a *conditio sine qua non* and that significant sources for the measurement of extraversion may be derived from a systematic variation of stimulus and task conditions. It has already been shown that level of difficulty and/or exposure time are of importance in this respect (4). A carefully manipulated condition analysis would then lead to the construction of an empirically rather than conceptually derived learning model which, to be of any great use, must include other factors already known to, or claiming to, play an important part (4). Rigidity, for example, has already been demonstrated to be significantly related to learning and Taylor's Manifest Anxiety Scale, despite its somewhat high correlation with Eysenck's dimension of neuroticism, may be expected to play a specific role.

Of the various results one point is particularly outstanding. Differences in distance variability, a complex movement/error score, were by far greatest

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during early practice and disappeared with prolonged practice. This is quite atypical of pure learning scores, derived from the same test and the same subjects, where individual and group differences are smallest in the beginning and increase with practice. The most obvious interpretation of this discrepancy is that differences found in early practice stages are due to differences in the movement component rather than error. This explanation appears equally applicable to pursuit-rotor and related performances, where differences between extraverts and introverts were largest in the early stages and practically absent during later stages of practice (2, 7, 9, 10). This apparent learning paradox is then satisfactorily resolved by using expressive movement as a basis for interpretation rather than learning proper.

The point just made permits one further generalization. If, in complex movement/error scores, the movement component is of greatest importance it is obvious that reminiscence will be affected similarly to level or practice scores. One would expect then that reminiscence scores obtained during early practice stages correlate higher with extraversion than those obtained during later stages. This was in fact found to be the case (7, 9, 10). As this point is elaborated in a separate study we confine ourselves at the present to the general suggestion that, in practice and reminiscence scores of motor learning alike, results relating to extraversion are easily explained in terms of expressive movement but difficult to understand in terms of learning proper.

The results obtained with the psychotic groups, which consisted mainly of schizophrenics, are difficult to explain. Although highly variable with respect to the actual size of test shapes reproduced psychotics were, in early practice stages, not particularly variable on distance scores, regardless whether error was involved (Fig. 2) or not (6). Although on pure learning scores psychotics scored significantly highest error at trial block 9–12 (3), this was not the case for distance variability. It has, however, been shown that distance variability of the psychotics tends to become highest with prolonged practice (trial block 17–20), regardless of the inclusion (Fig. 2) or exclusion (6) of error from distance variability. This may suggest that the movement component is of greater importance. Results certainly are in agreement with the long known observation that schizophrenics lack ability to maintain a level of mental preparedness over a long time. This inefficiency appears to be of a highly general kind, as it has been demonstrated with regard to reaction time, pursuit learning, learning of visual patterns, exposure time in recall and movement variability (compare 4).

## Summary

A learning test requiring drawn reproductions of visually presented patterns was analysed for two types of error scores, either contaminated or not contaminated by characteristics of expressive movement. When related to hysteria/dysthymia, the abnormal variants of Eysenck's dimension of extraversion/introversion, hysterics scored inferior to dysthymics on a score contaminated by movement extent and variability. When movement effects were controlled, opposite results were obtained, i.e. hysterics tended to score superior. This finding was used to question the validity of a number of pursuit-rotor experiments in their relationship to extraversion, on the ground that the inferior performance of extraverts found is solely due to their greater movement extent and variability. In contrast to this, learning efficiency proper is shown to be higher in extraverts than in introverts, or not related to extraversion at all. A specific effect dealing with prolonged practice was demonstrated in a schizophrenic group.

## References

1. Brengelmann, J. C., "Figurrekonstruktion: Grösse und Variabilität der Grösse von Reproduktionen als Bestimmer der Extraversion-Introversion", *Mschr. Psychiat. Neurol.*, 1955, **130,** 209–233.
2. *Idem*, "Extraversion, neurotische Tendenz und Rigidität im Umkehrversuch (Prismenbrille)", *Z. exp. und angew. Psychol.*, 1957, **4,** 339–362.
3. *Idem*, "Learning in neurotics and psychotics", *Acta psychol.*, 1958, **13,** 371–388.

https://doi.org/10.1192/bjp.105.438.81 Published online by Cambridge University Press

4. *Idem*, "The effects of exposure time in immediate recall on abnormal and questionnaire criteria of personality", *J. Ment. Sci.*, 1958, **104**, 665.
5. *Idem*, "Expressive movement". *in* Eysenck, H. J. (ed.), *Handbook of Abnormal Psychology*, 1959. London: Pitman Med. Publ. To appear.
6. *Idem* and MARCONI, J., "Expressive movement in abnormals, with particular reference to extraversion and psychoticism", *Acta psychol.*, 1958, **14**, 200.
7. EYSENCK, H. J., "Reminiscence, drive, and personality theory", *J. abnorm. soc. Psychol.* 1956, **53**, 328–333.
8. *Idem*, *The Dynamics of Anxiety and Hysteria*, 1952. London: Routledge & Kegan Paul Limited.
9. *Idem*, CASEY, S., and TROUTON, D. S., "Drugs and personality. II. The effect of stimulant and depressant drugs on continuous work", *J. Ment. Sci.*, 1957, **103**, 432, 645–649.
10. JONES, H. G., "Learning and abnormal behaviour", *in* Eysenck, H. J. (ed.), *Handbook of Abnormal Psychology*, 1959. London: Pitman Med. Publ. To appear.

https://doi.org/10.1192/bjp.105.438.81 Published online by Cambridge University Press