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NAME OF AUTHOR........NICHOLAS F. SKINNER........

TITLE OF THESIS........PERSONALITY CORRELATES........
OF COMPLEX HUMAN........
LEARNING........

UNIVERSITY........U. OF ALBERTA........

DEGREE FOR WHICH THESIS WAS PRESENTED........Ph.D........

YEAR THIS DEGREE GRANTED........1971........

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DATED........24 FEB.........1971

NL-91 (10-68)

UNIVERSITY OF ALBERTA

PERSONALITY CORRELATES OF COMPLEX HUMAN LEARNING

by

(C) Nicholas F. Skinner

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY

EDMONTON, ALBERTA

SPRING, 1971

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Personality Correlates of Complex Human Learning," submitted by Nicholas F. Skinner in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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Supervisor

T. Weckowicz

Charles C. Anderson

Philip E. Vernon

Date: February 18, 1971

To my wife and parents this
dissertation is affectionately dedicated

ABSTRACT

The predictability of performance in eight standard laboratory learning situations (classified as (a) tasks vs. problems and (b) memory vs. perceptual-motor exercises) in terms of measured (by questionnaires) personality factors was investigated.

Multiple regression and factor analyses, combined with inspection of the personality-learning cross-media correlation matrix, revealed that:

(i) temperament and motivation interact with exercise difficulty in a reciprocal fashion, i.e., as exercises become more difficult, the contribution of motivation variables to performance decreases and the role of temperament variables increases in importance;

(ii) while, on the one hand, personality variables appear to be predictive of a substantial amount of that portion of the inter-subject variability in performance, which, in most previous studies, has been unaccounted for by abilities and exercise-specific factors, on the other hand,

(iii) in terms of total predictability, personality variables were explicatory of a relatively small proportion of the performance variability on any exercise, a finding which, in the light of a series of related but independent studies by Howarth, was imputed to the inadequacy of assessment characteristic of most currently available personality questionnaires.

The obtained results (a) supported the hypothesis that variability in learning is in part the product of interdependencies between personality and learning variables, and (b) emphasized the necessity for greater sophistication in the questionnaire measurement of personality.

ACKNOWLEDGEMENTS

The author wishes to express his gratitude to Dr. E. Howarth, without whose valuable guidance and consummate patience completion of this study would not have been possible.

Secretarial assistance in the preparation of the manuscript was given unstintingly by Miss U. Kreger.

The research was supported by a National Research Council of Canada Postgraduate Scholarship.

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INTRODUCTION

> Apart from such rarities as idiot savants, there certainly exist children and adults of mediocre *g* and educational attainment who develop outstanding talents in the fields of art or scientific invention, or become leaders in business, politics, warfare, etc. Such talents can to some extent be attributed to the possession of strong group factors, but personality influences, drives and interests are probably still more important.

With this comment, Vernon (1961, p. 36) succinctly summarized the necessity for an awareness amongst psychologists of the etiological contributions of individual differences to variability in human behaviour — and certainly many contemporary psychologists would probably thus agree with the notion, implicit in Vernon's position and directly asserted by Jensen (1965), that much of the subject matter of psychology will eventually have to be restructured within a framework of individual differences.

In the field of learning, particularly, individual differences must be considered, because "...like Mt. Everest they are there, and they loom large in our research on learning, the more complex the learning, the more conspicuous and unavoidable are the individual differences" (Jensen, 1965, p.3). However, an unfortunate by-product of the obeisance to the mean which has long characterized the research strategy of bivariate psychology, hitherto the principal empirical avenue to the study of learning, has been the disregard of experimental psychologists for the effects of individual differences on learning (particularly individual differences in personality), on the premise that through statistical comparisons between group means a science of learning can be developed independently of a consideration of personality variables, which, though "no doubt important,...are unsystematic,...cannot be reduced to any form of order" (Eysenck, 1967, p. 5) and are of value only as error variance. Careful analysis reveals that this position is questionable, for if the difference between group means is small, it is entirely possible (and typical) that the effects of the independent variable under study have been buried in the error term. The error term contains the Subjects X Independent Variable interaction, and only if this interaction is minimal can a confident psychological conclusion (based on group mean differences) be drawn with respect to the independent variable. For example, if the independent variable is a drug which greatly enhances learning in some individuals while impeding learning in others, then computing a group mean from the individual performance scores could lead to the erroneous conclusion that learning is not significantly affected by the drug.

It is clear, therefore, that in an assessment of the potency of an experimental variable, the Subjects X Independent Variable interaction should be the logical and legitimate centre of interest. Such was the theoretical and methodological touchstone of the present research, an investigation of the hypothesis that intersubject variability in learning is in part the product of an interplay between personality and learning variables.

As requisite background for the study, it was necessary to review the relevant literature in the area of personality effects on learning, as presented in the next section.

REVIEW OF THE LITERATURE

There are several reviews extant which, in general, provide a satisfactory picture of the current state of research on individual differences in learning (see Fleishman and Bartlett, 1969; Glaser, 1967; Mackay and Vernon, 1963; Stake, 1961). An important exception during the last decade, however, has been an adequate treatment of the role of personality variables in learning, and it was to rectify this situation that the following review was intended (within the constraint of selectivity dictated by relevance to the present study).

Strong support for the general suggestion that learning is in part a function of personality was offered by Jensen (1964), who obtained a significant correlation between extraversion and a fourth-order general-learning ability factor, and Howarth (1963), who found significant differences between extraverts and introverts on an extensive battery of learning and performance laboratory tasks, including arithmetic computation under slow set change conditions, line reproduction from memory, digit repetition, retention span and time estimation. Similarly,as outlined by Cattell and Scheurger (1970), the possiblity of assessing personality through objective [1] learning and performance measures was in large part the theoretical basis for the development of the High School Objective Analytic Personality Factor

1) One of the earliest suggestions that personality was discoverable through miniature behavioural situations was made by Guilford and Braly (1930), who stated that "having established the reality of such traits as extraversion and introversion, we are ready to look for simple objective tests...for them" (p. 105).

Battery (HSOA). One important criterion for choosing the best tests for each factor was a due diversity of types of tests — a pair of perceptual tests being less desirable than one perceptual test and another test requiring motor involvement — and thus, for example, Universal Index (U.I.; Cattell, 1953) Factor 19, Subduedness vs. Critical Independence, was assessed by a variety of learning and performance measures, including More Correct Drawings in Reverse, More Orderliness in Perceptual Series, More Correct in Searching Task, Greater Accuracy of Picture Memory and Immediate Memory of Reading.

Cattell and Butcher (1968) emphasized the necessity for, and utility of, including personality variables in a consideration of learning by demonstrating that the accuracy of prediction of school achievement increases from 25% to 60-80% when temperament and motivation data are added to intelligence measures. Cattell (1969) also proposed the integration of personality theory with learning theory by means of a structural model in which learning is described in terms of a comprehensive set of vector changes on traits, behavioural indices and situational modulators, rather than through changes on single response variables.

More specifically, reviewing the different kinds of learning, first, in the field of classical conditioning, a variety of physiological responses has been examined in relation to personality, including heart rate (Davidson, Payne and Sloane,(1969), galvanic skin response (Becker and Matteson,(1961) and salivation (Willett, 1960). However, the interest of the majority of investigators over the past ten years continued to centre primarily on the eyeblink response; most notably, Franks (1963) brought a degree of unity to the area by arguing that in eyeblink conditioning experiments, an adequate explanation of individual differences must include habit strength, with its excitatory-inhibitory component associated with extraversion (the Maudsley hypothesis; Eysenck, 1957), and drive strength, and its autonomic and other components associated with anxiety, neuroticism and emotionality (the Iowa hypothesis; Spence, 1956).

Greater diversity of research strategy was apparent in studies of personality and instrumental conditioning. For example, Wiesen (1965) explained the differential reinforcing effects of onset and offset of stimulation on the operant behaviour of normals, neurotics, and psychopaths in terms of the characteristic stimulus hunger of extraverts (Eysenck, 1967), a line of argument extended by Gale (1969), who attributed such stimulus-seeking behaviour to the drive properties (Berlyne, 1960) of a sub-optimal level of cortical arousal. In the first of a series of studies, Brady and his associates (1961) found that several operant variables derived from a multiple reinforcement schedule in an appetitive situation seemed to reflect more general personality traits in acutely psychotic patients. However, the two subsequent studies (Brady et al., 1962a,b) revealed that those operant variables which correlated highly with clinical improvement were not correlated to a significant degree with scores on the Edwards

Personal Preference Schedule (EPPS; Edwards, 1954) or the Minnesota Multiphasic Personality Inventory (MMPI; Hathaway and McKinley, 1951). The authors concluded that either the operant measures did not reflect more general personality traits, or the EPPS and MMPI did not assess those general traits. Finally, for instrumental avoidance conditioning, in which subjects attempted to minimize noxious sound stimulation, Penney and Croskery (1962) reported a significant main effect for anxiety while Otis and Martin (1968) found evidence for an interaction between anxiety and extraversion.

Rather than simple conditioning, the present study was concerned with the effects of personality variables on complex human learning, an area in which research has been less systematic. For example, in the field of perceptual-motor learning, performance has been related variously to responsiveness to the environment (Jaensch, 1930), intolerance of ambiguity (Frenkel-Brunswick and Sanford, 1945) and degree of field-dependency (Witkin et al., 1954). More recently, Fleishman (1965a), although able to predict level of acquisition of a wide range of psychomotor skills with respectable accuracy, emphasized that "...some of the unaccounted-for variance is 'motivational' or 'personality' variance [with the result that] there is an increasing interest in the interaction of personality and learning variables" (p. 173). For example, on a display control relations task, Fleishman (1967a) found that ability variables predicted individual differences in rate of learning at any stage of distributed practice, but that personality tests of rigidity-flexibility, anxiety and extraversion were better predictors under massed practice.

Howarth (1964) demonstrated significantly greater response emission by extraverts than introverts on a free button-pressing task, while in a more complex free-operant situation in which, by key pressing, four different sound reinforcements could be obtained to relieve mild sensory deprivation, Gale (1969) concluded that the stimulus hunger of extraverts prompted them to adopt a response strategy (frequent key-pressing and changing between sources of sound) which produced more stimulation than did the strategy of the introverts. Similarly, Frith (1968), using a complex tracking apparatus, showed that strategies determined by personality traits dominated the strategies required by the task—for example, extraverts maintained a high level of output even though a low-output strategy was more efficient.

The ability to inhibit motor movement correlated significantly with superior ego development (i.e., the ability to delay immediate gratification) in a study by Singer et al. (1956), although Hardyck (1966) was unable to replicate this result. Barratt (1967) found that impulsiveness as a personality predisposition was related more to control of motor outflow than to sensory processing in a reaction time situation.

Finding no differences in rate of acquisition and asymptotic performance between extraverts and introverts on a pursuit rotor, Yates and Laszlo (1965) concluded that Eysenck's (1967) theory of extraversion based on excitation differences was not supported; however, the failure to support Eysenck may have been attributable to the fact that the ease of the pursuit task precluded the generation of significant differences in excitation. Eysenck (1965) has suggested that reminiscence (an increment in performance following a programmed rest period), which characterizes the pursuit rotor performance of extraverts, is a function of the consolidation of learning, the effects of drive and the susceptibility of the task to involuntary rest pauses.

Personality and verbal behaviour has been another area of active research interest. Although, as mentioned above, conditioning studies were not of direct concern in the present study, it was instructive to note the contradictory nature of the evidence with respect to verbal conditioning and the often-investigated personality traits of anxiety and extraversion. For example, Taffel (1955), finding that high-anxious subjects gave more conditioned I-WE responses than low-anxious subjects, concluded that high-anxious people are more amenable to therapy due to readiness to discuss their problems. In contrast, Spielberger et al. (1965) interpreted their opposite results in accord with clinical findings that high-anxious people feel inadequate and thus would be reluctant to talk about themselves. With respect to extraversion, Eysenck (1959a) and Gelfand and Winder (1961), using the Taffel (1955) verbal conditioning paradigm, demonstrated superior conditionability of introverts as compared to extraverts. On the other hand, no significant differences were found by McDonnell and Inglis (1962) or Goodstein (1967).

In their discussion of personality and verbal learning, Schaie and Goulet (1970) suggested that verbal learning (rather than conditioning) paradigms are probably the best laboratory tasks for relating personality variables to learning, because (i) the theory and methodology of verbal learning is highly developed, so that it is easy to generate the verbal phenomena to be related to personality, (ii) verbal learning tasks are modifiable along several dimensions (e.g., length of list, meaningfulness, etc.),each of which can be related to the same dependent variable, and (iii) verbal learning studies may be designed to allow maximum control over pre- or extra-experimental transfer of learning. Consequently, there exists a substantial literature on verbal learning and personality, particularly with respect to Eysenck's (1957) second-order traits of extraversion and neuroticism, a representative sample of which is reviewed below.

Jensen (1962), using easy vs. difficult (i.e., 4-sec. vs. 2-sec. presentation rate) serial lists, found no significant difference in performance between extraverts and introverts on either list, but a markedly lower rate of learning for high-neuroticism subjects compared to low-neuroticism subjects on the difficult list. In an explanation similar to Taylor's (1956) formulation relating anxiety and performance, Jensen suggested that neuroticism acts as a drive which, à la Hull's (1943) theory, interacts multiplicatively with all habits elicited in a situation. Thus, incorrect responding (the dominant response tendency in the early stages of learning) was of greater strength in the high-neuroticism group.

The combination of Jensen's (1962) suggestion that neuroticism is analogous to a drive state and Eysenck's (1967) hypothesis that introverts are characterized by higher states of cortical arousal than extraverts enabled McLaughlin and Eysenck (1967) to classify subjects in a paired-associates exercise along a low-to-high arousal continuum—stable extraverts (SE), neurotic extraverts (NE), stable introverts (SI), neurotic introverts (NI)—on the assumption that level of drive and arousal (related to the degree of neuroticism and extraversion, respectively) summate to determine an overall level of arousal. On the easy list, the order of performance for the four groups of subjects was NE-SI-SE-NI, while on the difficult list the order was SE-NE-SI-NI. McLaughlin and Eysenck interpreted these results in terms of the Yerkes-Dodson law (e.g., Malmo, 1958) which states that optimal level of arousal (and thus performance) varies with task difficulty in an inverted-U relationship. Thus, the intermediate level of arousal typical of neurotic extraverts was optimal for performance on the easy list, whereas for the difficult list the lower level of arousal characteristic of stable extraverts was most suitable. Additionally, in confirming the prediction that extraverts would learn both easy and difficult lists faster than introverts, the authors supported empirically their hypothesis that the lower cortical arousal of extraverts results in poor consolidation but good integration of learned material in short-term memory situations.

Howarth and Eysenck (1968), using recall intervals of 0 min., 1 min., 5 min., 30 min., and 24 hours in a paired-associates task of medium difficulty, predicted a good initial performance by extraverts, followed by a deterioration, and vice versa for introverts. The data supported their prediction, with the crossover in performance level occurring at the 5 min. recall interval. Das (1969) proposed a neurodynamic explanation to the effect that rehearsal and encoding for long-term memory storage interfere with recall, and that the introvert is more seriously engaged in these activities at the time of short-term retrieval than is the extravert.

Shanmugan and Santhanam (1964) showed that extraverts perform better in the presence of distracting stimuli, and Jensen (1964) suggested that extraverts were more resistant to response competition. In a short-term memory study, Howarth (1969a) therefore employed an incremental interference technique in a three-list "colour-animal" paired-associates task and found that extraverts learned significantly faster than introverts. In a related experiment, Howarth (1968) used serial learning of number groups, with a previously learned list of number pairs as a distractor. As predicted, extraverts obtained greater percentage savings of learned material under distracting conditions. Howarth suggested two possible explanations for his findings: (1) differences in the strength of initial registration and/or rate of consolidation of the learned material; or (2) differences in resistance to response competition and/or distracting stimuli.[2]

Finally, to conclude the review of the literature, it can be pointed out that all of the studies cited dealt with second-order,

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2) Anderson (1968) stated that "the dominant trait of certain individuals, a function of their strong hippocampal activity, is the ability to concentrate on issues to the exclusion of irrelevant stimuli" (p. 887). The similarity of this idea to the Russian concept of "set", the basic unit in the Soviet study of personality, should be noted. Using the spheres test for set (Uznadze, 1966),

or surface, personality traits, presumably because, as Schaie and Goulet (1969) state, "...it is the behavioural equivalents of the surface trait which best denote the criterion behaviours which can be most directly related to the processes of acquiring and maintaining behaviour" [in this case, verbal behaviour] (p. 2). However, it should be noted that although very little research in the area of verbal learning has been conducted within a personality source trait framework, Schaie and Goulet speculatively conclude that "several of the basic personality factors (or source traits) identified by Cattell and his colleagues in the rating, questionnaire and objective test domains (cf. Cattell, 1957) lend themselves quite nicely to an investigation using a variety of verbal learning tasks." (p. 5)

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2) (cont'd) Norakidze (1966) has distinguished three personality types — harmonious, conflictive and impulsive — in terms of the differing nature and speed of set formation characteristic of each type. Although at present this work is not well known outside Russia, a parallel between the personality types of Norakidze and Western personality dimensions (e.g., extraverts: impulsive) is apparent, hence the possibility that the concept of set has implications for research into individual differences in learning.

PROBLEMS AND HYPOTHESES

Although of modest extent, and carried out almost solely by differential psychologists, research into the role of personality in learning can be regarded, in light of the foregoing review, as a useful and viable endeavour. In order to delimit the scope of the present study within this global context, it was necessary first to specify the denotations of the terms "personality" and "learning".

The personality classification adopted followed that of Cattell (1965, p. 28), who conceived a tripartite model of trait modalities — abilities, temperament and motivation.

> An ability is shown in the manner of response to the complexity of a situation when the individual is clear on what goal he wants to achieve in that situation. A temperament or general personality trait is usually stylistic, in the sense that it deals with tempo, form, persistence, etc., covering a large variety of specific responses. For example, a person may be temperamentally slow, or easy-going, or irritable, or bold. A dynamic trait has to do with motivations and interests. One is speaking of dynamic traits in describing an individual as amorous or ambitious or interested in athletics, or having an anti-authority attitude.

With respect to learning, however, for years many psychologists regarded level of ability as the only important source of individual differences, and thus numerous early studies were based on the intuitive appeal of the premise that all individual differences could be accounted for by a single trait of "general learning ability". But, as Mackay and Vernon (1963) stated in their review of individual differences in learning, "there is little evidence ... of a general learning ability" (p. 179), a conclusion also reached by Jensen (1964), who emphasized the continuing validity of the assertion by Spies (1959; cited in Jensen, 1964, p. 3) that "with one or two exceptions, no general factor has been found sufficient to account for the intercorrelations of scores on a number of different learning tasks". Psychologists thus drew the apparently logical conclusions that (a) different kinds of learning involve different abilities (e.g., verbal, numerical, psychomotor, etc.; Thurstone, 1938), and (b) if subjects could be selected for homogeneity on all ability factors, then individual differences in learning would be eliminated.

However, the studies cited in the preceding literature review consistently demonstrated that sources of variation other than ability factors are involved in learning, and that these additional influences markedly affect individual differences in learning. For example, Fleishman (1967a) discovered that while ability variables predicted individual differences in performance on a display control relations task under distributed practice, personality variables were better predictors when subjects were switched to massed practice. Coupled with Cattell and Butcher's (1968) demonstration of the improvement in prediction of school achievement when measures of intelligence ("....a combination of certain basic abilities which contribute to achievement in a wide range of different activities;" Fleishman, (1965b, p. 3) were complemented by temperament and motivation data, these studies provide empirical support for the first important dimension of the frame of reference of the present study— the view that individual differences in learning should be investigated from the standpoint of personality correlates, which, in the Cattellian sense, subsume not only abilities but temperament and motivation variables also.

The second major aspect of the study was the interpretation to be given to the term "learning" per se. The standard definition is "a relatively 'permanent' change in behaviour that is the result of past experience"; however, Jensen (1964) suggested that an arbitrary decision as to the minimal duration of a behavioural change in order for it to be called learning might by definition exclude important phenomena from investigation, particularly in the field of individual differences in learning. To give the widest possible scope to such research, Jensen proposed the following operational definition, which was adopted for the present study: "Learning is said to have occurred when there is a change in the probability of a specified response following the cessation of a specified stimulus-situation, excluding extrinsic physical or chemical alteration of the nervous system and changes due to physical growth" (p. 11).

A number of further distinctions with respect to learning were important. Firstly, it is generally accepted that there are two varieties of learning — simple and complex (Cohen, 1969). The present investigation was concerned with complex learning, which Cohen divided into perceptual-motor learning and memory (or verbal) learning, and which, in contrast to the homogeneous responses acquired in uncomplicated classical and operant conditioning situations, comprises varied and diverse responses integrated into a polished uninterrupted sequence and occurring in relatively complicated circumstances.

A second distinction concerned the nature of a learning exercise. When trial-and-error behaviour is necessary to the discovery of a goal, a learning <u>problem</u> is posed; when solution can occur without trial and error, a learning <u>task</u> exists[2] (Woodworth and Schlosberg, 1964).

While these distinctions are not mutually exclusive, it was the intent of the present study to examine the relationships between (a) the memory and perceptual-motor exercises (involving both problems and tasks) illustrated schematically in Table 1, and (b) personality, as assessed primarily by the Culture Fair Intelligence Test (Cattell and Cattell, 1959), the 16 Personality Factor

Table 1

Two-Dimensional Classification of Learning Exercises

	Memory Exercises	Perceptual-Motor Exercises	Memory and Perceptual-Motor Exercises
Tasks	Digit Reproduction Time Estimation	Letter Cancellation	Line Reproduction
Problems	Serial Anticipation Figure Reconstruction	Pursuit Rotor	Finger Maze

Questionnaire (Cattell and Eber, 1957), the Eysenck Personality Inventory (Eysenck and Eysenck, 1965) and the Motivation Analysis Test (Cattell and Horn, 1964).

2) This distinction could also be conceptualized in information-theory terms as the synthesis of sense-data into simultaneous (spatial) groups or successive (temporal) series (Luria, 1966).

In view of the variety of learning and personality measures employed, numerous a priori micro-hypotheses dealing with the interaction of a specific personality trait and particular learning measure could have been entertained — for example, with respect to verbal learning and Cattell's (1957) source traits, Schaie and Goulet (1969) hypothesized that rigid, Sizothymic (A-) and highly Excitable (D+) individuals would be subject to associative interference, Dominant (E+) persons might have difficulty following the detailed instructions characteristic of most laboratory learning exercises, and Surgent (F+) subjects would perform well if response speed and willingness to guess were important.

However, the broader strategy of the present study was to intercorrelate performance on several standard learning exercises from experimental psychology with scores from specified personality instruments and, by interpreting the resulting cross-media correlation matrix (that is, correlations between personality data from the questionnaire medium and learning scores from the objective-test medium) and regression and factor analyses, to generate empirical support for the general hypothesis that learning is, in part, a function of individual differences in personality — a possibility too often ignored by experimental psychologists. Additionally, it was hoped by so doing to demonstrate regularities in the effects of personality on specific aspects of learning from which to develop rigorous micro-hypotheses for future investigation.

METHOD

Subjects

As part of a demonstration of questionnaire and objective testing techniques in a senior psychology course, 128 undergraduates (79 females, 49 males; Mean Age 20.34, SD ± 1.89) served as subjects (Ss).

Procedure

Testing was divided into two sessions, approximately six weeks apart. The first session comprised classroom Group Testing, in which the following questionnaires were administered to all Ss:

1. Culture Fair Intelligence Test, Scale 3, Form A (CFIT; Cattell and Cattell, 1959)
2. Eysenck Personality Inventory (EPI; Eysenck and Eysenck, 1965)
3. Anxiety Scale Questionnaire (ASQ; Cattell, 1963)
4. Manifest Anxiety Scale (MAS; adapted from Taylor, 1953)
5. Social Desirability Scale (SDS; Crowne and Marlowe, 1960)
6. Sensation Seeking Scale (SSS; Zuckerman, Kolin, Price and Zoob, 1964).

Additionally, Ss' scores on the 16 Personality Factor Questionnaire, Form A (16 PF; Cattell and Eber, 1957) were obtained from a contemporary study (Howarth, 1971).

During the second session, Individual Testing, S first completed the Motivation Analysis Test (MAT; Cattell and Horn, 1964) in a waiting room. The experimenter (E) then conducted S into the experimental chamber, a well-lighted room (13' x 14') with bare, pale grey walls. At stations arranged on tables against two walls, S was given a series of learning exercises (as described below), in an order calculated to minimize possible fatigue and/or monotony effects.

(1) Serial Anticipation

A Kodak Carousel AV-900 projector with a cycling rate of 5 sec. and an exposure interval of 4 sec. was used to present a serial list of 10 nonsense syllables (CVC) of intermediate association value. S was seated 5 ft. from the screen and during the first trial (one complete presentation of the list) was instructed to spell aloud each syllable as it appeared. For all subsequent trials, whenever a syllable was presented, S's task was anticipatory spelling of the next syllable on the list. The beginning of a trial was indicated by the word "SIP", while colour naming for 12 sec. was used between trials. A correction procedure was employed , and S was trained to a criterion of one correct anticipation of the complete list. Trials to Criterion and Number of Errors were recorded.

(2) Pursuit Rotor

S stood in front of a table-mounted pursuit rotor (Lafayette Instrument Co. Model No. 2203 A) and was instructed to keep the hand stylus in contact with the target whenever the turntable was rotating. There were five trials at each of three speeds — 15, 30 and 45 rpm — occurring in a pre-determined random order; trial length was 21.5 sec. and the inter-trial interval was 15 sec. Mean Time on Target at each speed and Mean Overall Time on Target were recorded.

(3) Figure Reconstruction

A sequence of four slides was shown by a Kodak Carousel AV-900 projector. Slide One, adapted from Brengelmann (1958),was called the Stimulus Slide, and consisted of a white background on which five black shapes (cross, square, oblong, triangle and semi-circle) were arranged around a black central circle; Slides Two and Three contained four different squares of colour, while Slide Four was blue. Exporsure intervals were 2 sec. for Slide One and 4 sec. for Slides Two-Four.

S sat 5 ft. from the screen and was provided with 10 response sheets, each containing a solid central circle (1/2" diam.) within an otherwise blank 6" square. After describing the Stimulus Slide, E gave these instructions:

> On each of 10 trials the Stimulus Slide will be shown for a short period of time, followed immediately by colour slides. Do not try to learn the colours — simply name aloud as many colours as you can on each slide. The appearance of a plain blue slide signals the end of a trial. Your task is then to draw the shapes which you saw on the Stimulus Slide on the sheet which you have in front of you, trying to give each shape exactly the same relative size and position as seen on the Stimulus Slide. Note that the Stimulus Slide is identical in all trials; that is, the Stimulus Slide in Trial One is the same as the Stimulus Slide in Trial Two, Trial Three, and so on. All shapes are to be drawn on each trial even if you have to guess. After you have filled in the response sheet with all five shapes, put it to one side, face down, and indicate to me that you are ready for the next trial. Remember: do not draw any shapes until the blue slide appears on each trial.

Means were tabulated over Trials 1-5, 6-10 and 1-10 for each of three learning measures: (i) Rotation Error, or mean axial displacement of the individual stimulus shapes, measured to the nearest

15 degrees; (ii) Rotation Variability, or the change of Rotation Error between successive trials, in degrees, disregarding the direction of change; and(iii) Distance Error, or radial displacement of the stimulus shapes, either centripetal or centrifugal, scored in terms of the number of positions away from the correct position.

(4) <u>Letter Cancellation</u>

<u>S</u> was seated before a printed sheet containing 40 different computer generated random sequences of all the letters of the alphabet; to the left of each alphabet sequence were five different letters, also randomly determined. The sheet was divided into four sections (A,B,C,D), each containing 10 alphabet sequences and their associated five-letter groups.

<u>S</u> was instructed to locate each of the letters from the five-letter group within the corresponding alphabet sequence and put a pencil line through it. The exercise was timed (60 sec. per section with 10 sec. between sections); consequently <u>S</u> was asked to work as rapidly as possible and advised not to spend an inordinate amount of time looking for a particular letter. Measures recorded were Number of Correct Letters Cancelled in each section, and Total Correct Letters Cancelled.

(5) <u>Line Reproduction</u>

<u>S</u> sat at a table and was given a three-page booklet. In the centre of Page One was a straight line, 72 cm in length, called the Standard Line; Pages Two and Three were blank.

The experiment had two parts, in both of which S was required to attempt to draw 20 lines equal in length to the Standard Line. In Part One (Aided Reproduction), S could refer to the Standard Line at any time when drawing his 20 lines; however, during Part Two (Unaided Reproduction), at no time was S allowed to look at the Standard Line or the lines drawn in Part One. Lengths of the Shortest and Longest Lines drawn in Parts One and Two were recorded and the corresponding ranges calculated.

(6) Time Estimation

E gave the following instructions to S, who was seated 6 ft. away with his back to E:

> At the beginning of each trial I will say "Ready" and tap my desk with a pencil. Then, after the passage of a definite time known as the Test Interval, I will tap the table again. Your task is to give a third tap when you estimate that the time elapsed since the second tap equals the length of the Test Interval. In other words, you will tap when you estimate that the length of time between Tap Two and Tap Three equals the length of time between Tap One and Tap Two.

S was told that there would be a number of trials which might differ in length and was asked not to count or use any other aids to time estimation.

The standard Test Interval for Trial One was 15 sec. and, as in the procedure developed by Llewellyn-Thomas (1959), there were nine further trials in which S was successively given his last estimation as the new Test Interval. Trials were separated by approximately 5 sec. Error/Trial and Mean Error/Trial were recorded.

(7) Digit Reproduction

S sat facing away from E at a distance of 6 ft. Following a procedure adapted from Howarth (1963), span of apprehension was first established. On each trial E read a series of digits in an evenly modulated tone, except for the last digit which was accented as a signal for the end of the series; S's task was to reproduce aloud the series of digits in the order of presentation. Beginning with four digits, series length was progressively increased by one digit after each correct reproduction. The longest digit series correctly reproduced before S gave an incorrect response twice in succession at the next series length was recorded as the Base Span.

Secondly, retention was determined by introducing a delay interval between presentation and reproduction, beginning with a 5-sec. delay and increasing in 5-sec. steps until S failed twice at each series length, starting with a four-digit series. In order to minimize rehearsal effects, S's task during the delay was to read the alphabet backwards and aloud from a 3" x 5" card. E signalled the end of the delay by tapping his desk with a pencil, at which time S attempted to reproduce the digit series. The Retention scores obtained were the intervals at which S made his final successful reproduction at each series length.

Computer-generated random digit sequences were used, with no digit appearing twice in a single series until the series reached 11 digits in length.

(8) Finger-Maze

S sat blindfolded in front of a table-mounted finger maze (Lafayette Instrument Co. Model No. 2706A). The Start and End were linked by one connected series of pathways which ran through 10 choice points. At each choice point an incorrect choice led into a blind alley, while a correct decision led to the next choice point. The pathways, were made up of straight sections joined to each other at right angles.

On each trial E placed the index finger of S's preferred hand in the Start and gave the signal to begin. S had been instructed that if he entered a blind alley he was required to retrace his path only to the previous choice point (i.e., not to the Start) before resuming his progress. A trial consisted of one solution of the maze and there were 10 trials. Measures taken were Total Solution Time, Retracing Errors (defined as movement backward from a choice point to the previous choice point) and Blind Alley Errors (defined as movement to the end of a blind alley).

Completion time for the eight learning tasks varied between 5 min. and 15 min., while the inter-task interval was about 5 min. At the conclusion of the second session, which lasted approximately 2 hrs., S was given a brief explanation of the purpose of the study.

Data Analysis

The data were examined in three stages, as outlined below.

1. Analysis of the Cross-Media Correlation Matrix

By inspection of the raw data matrix of cross-media correlations between the 49 personality measures and 48 learning measures (see Appendix I), it was possible to (a) delete a number of personality measures on the basis of similarity or duplication, and (b) select the single measure from each learning exercise which satisfied the criterion of having the greatest number of significant correlations ($p < .05$) with the remaining personality measures (a justifiable procedure because, as inspection of the raw data matrix revealed, the pattern of significant correlations with personality variables was similar for most learning variables within the task). The resulting Reduced Data Matrix (RDM) consisted of 27 variables (as shown in Table 2), for each of which means, standard deviations and reliability coefficients were calculated and tests for normality and homoscedasticity applied.

2. Multiple Regression Analysis

Using MULRØ6 (Carlson and Hazlett, 1969) a stepwise regression program in which it was possible to specify the level of significance for adding and for deleting predictor variables (the 5 per cent level was adopted), multiple regression equations for prediction of performance on each learning exercise, in terms of (a) Eysenckian and (b) Cattellian personality measures (see Appendix I) were obtained.[3,4]

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3) Since the Social Desirability and Sensation seeking measures per se were not part of the systems of Cattell or Eysenck, they were omitted from the regression analysis.

4) In recognition of the possibility of a quadratic relationship between learning and anxiety, squared terms for Cattell's second-order Anxiety measure and Eysenck's Neuroticism measure were included as predictor variables.

3. Factor and Components Analysis

Guiding the investigation of the structure underlying the intercorrelations of the Reduced Data Matrix were Harris' (1967) suggestions of the utilization of a variety of analyses and rotations, and acceptance of only those dimensions characterized by comparability across solutions and amenability to meaningful psychological interpretation. In accordance with this strategy an initial common factor analysis was carried out using FACTØ3 (Precht, 1969a), which yielded principal axis factors rotated to an orthogonal (Varimax; Kaiser, 1958) solution. However, because FACTØ3 inserted 1's in the principal diagonal of the correlation matrix, sometimes regarded as a questionable procedure (particularly with small matrices) due to its preclusion of possible suppressing effects of unreliability (error) and specific content of the variables, a second factor analysis was carried out with FACTØ2 (Hunka and Precht, 1969), an alpha-factor extraction program employing communalities (iterated to convergence at the .005 tolerance level) in the principal diagonal to give a Varimax solution.

Lastly, in recognition of (a) the frequent occurrence of correlated dimensions in psychological data and (b) the fact that in the common factor model the common and unique portions of the variance of each variable can never be known but only estimated, Precht's (1969b) FACTØ4 (which also substituted unities[5] in the principal

5) In summary, while FACTØ2 inserts communalities into the correlation matrix, in the light of a considerable literature which suggests that "...communality estimates are not as important for a small N [sample size] as they are for a large N [see Burt's

diagonal) was employed to resolve the data into principal components[6], which were then rotated to an oblique (Promax; Hendrickson and White, 1964) simple structure solution.

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5) (cont'd) similar statement in Footnote 10], FACTØ3 and FACTØ4 ignore the communality problem" (Precht, 1971) and employ unities in the principal diagonal.

6) Since a principal component analysis yields as many components as there are variables, in order to achieve parsimony in terms of meaningful data reduction, an "incomplete" components solution (Kaiser, 1961) was adopted by retaining only those components having eigenvalues greater than 1 (see Appendix II)—an heuristic followed with FACTØ2 and FACTØ3 also, even though Thurstone's (1947) criterion specified a maximum of 20 factors which could be uniquely determined by 27 variables.

RESULTS

Prior to performing a multivariate analysis per se, it was necessary to demonstrate that the data satisfied certain statistical criteria. Firstly, with respect to reliability,

> ...it is impossible to interpret a correlation matrix or the factor analysis thereof without knowing something about the reliabilities of the measurements that went into the correlations. If a particular test has low correlations with other tests in the battery..., one wishes to know whether this is because what the test measures actually does have little in common with the other tests or simply because the reliability of the test is too low to allow it to correlate substantially with any other tests. In the second place, when tests differ widely in reliability, the tests of low reliability do not carry their weight in the identification of factors. Their loadings will necessarily be low on any factors, and tests which may actually be less representative of the factor but which have higher reliability will outweigh the relatively unreliable test when it comes to the interpretation of the factor (Jensen, 1964, p. 24).

Although the determination of reliabilities for learning measures, in contrast to personality variables, proves very difficult in practice — for the simple reason that learning scores specify change, and individuals learn (i.e., their performances change) at different rates — this argument is, nonetheless, correct in principle, and, therefore, it was desirable to establish, where possible, the existence of acceptable reliabilities for the measurements of the variables comprising the personality-learning cross-media correlation data matrix of the present study.

Reliability for standard personality questionnaires is usually determined by correlating equivalent forms of the questionnaire, test-retest scores or split-halves (first half vs. second half or odd vs. even items). Since test-retest reliabilities were inadequate (the dependability coefficient of short-term test-retest being susceptible to inflation due to memory carry-over, and the stability coefficient of long-term test-retest being subject to inaccuracy due to possible changes in a trait as a function of experience or maturation) and equivalent forms were not extant for all the questionnaires administered, split-half coefficients were considered most suitable for the reliabilities of the personality measures.

In ascertaining the reliability of a <u>learning</u> score, because the chief difficulty is that the "thing" being measured changes over trials, test-retest "...will not represent measures of the same function, nor will any scheme analogous to equivalent forms avoid this difficulty, since 'forms' which are comparable will permit transfer" (McNemar, 1969, p. 169). Wherever possible, therefore, split-half reliability coefficients based on odd vs. even trials were calculated for the learning measures of the present study, on the assumption that this technique balances to a certain extent the effects of practice (although it was recognized that this method would yield a value which was higher than the "true" reliability if, under chance circumstances, an error influenced even and odd trials in an identical manner, for example, minimal effort by a subject over a portion of the total number of trials).

For the variables associated with five of the eight learning exercises (Letter Cancellation, Pursuit Rotor, Figure Reconstruction, Time Estimation and Finger Maze), the split-half (odd-even) reliability coefficients were derived from the data of the present study. Because the variables in the remaining three exercises (Line Reproduction, Digit Reproduction and Serial Anticipation) entailed discrete measurement, in the sense that they were not composed of items or parts, it was not possible to calculate their reliabilities directly; fortunately, however, from a parallel study by Howarth (1971) and similar research by Jensen (1964), respectively, split half-reliability for Line Reproduction and test-retest reliabilities for Digit Reproduction and Serial Anticipation were available.

For the personality variables, split-half reliability coefficients were obtained from the appropriate questionnaire handbook or definitive journal article. The magnitude and source of all reliability coefficients are summarized in column 4 of Table 2, which revealed that all the reliability coefficients were substantially above 0.227, the value required for significance at the 1% level (df = 127), indicating that, for any variable, errors of measurement did not exceed chance proportions and, therefore, that for the correlation, regression and factor analyses the risk of contamination due to measurement error was minimal.

Because raw data constituted the bases for analysis, in addition

Table 2

Means, Standard Deviations (SD), Reliabilities and Measures of Skewness for the Variables of the Reduced Data Matrix

Variable		Mean	SD	Reliability Coefficient/ Source	Measure of Skewness
1. Sex	16 PF Second Order Factors (2–4)	0.383	0.488		
2. Exvia		31.219	12.583		
3. Anxiety vs. Good Adjustment		32.758	10.509		
4. Cortertia		22.523	4.834		
5. Low vs. High Ego Strength	16 PF First Order Factors (5–9)	15.547	3.754	0.869 / Handbook for the 16 PF	
6. Desurgency vs. Surgency		17.070	4.679	0.724 / " " " " "	
7. Harria vs. Premsia		11.008	3.201	0.613 / " " " " "	
8. Alaxia vs. Protension		7.938	3.029	0.626 / " " " " "	
9. Group Dependence vs. Self Sufficiency		11.039	3.158	0.653 / " " " " "	
10. Extraversion	EPI Factors (10–11)	13.078	4.075	0.757 / Manual for the EPI	
11. Neuroticism		9.430	4.229	0.812 / " " " "	
12. Home-Parental Sentiment	MAT Factors (12–16)	16.445	3.291	0.700 / Handbook for the MAT	
13. Sweetheart-Spouse Sentiment		15.813	2.769	0.580 / " " " "	
14. Self-Sentiment		60.500	6.407	0.640 / " " " "	
15. Assertiveness Erg		15.898	2.751	0.470 / " " " "	
16. Fear Erg		11.289	2.578	0.540 / " " " "	
17. Intelligence		26.414	4.301	0.890 / Handbook for the CFIT	
18. Sensation Seeking		21.938	5.386	0.710 / Zuckerman et al. 1964	
19. Social Desirability		16.203	5.516	0.890*/ Crowne et al. 1960	
20. Digit Reproduction (Base Span)		6.789	1.221	0.700*/ Jensen, 1964	0.332
21. Serial Anticipation (Trials to Criterion)		11.984	5.230	0.710*/ " "	0.369
22. Letter Cancellation (Total Correct Letters Cancelled)		72.664	15.366	0.864 / Skinner, 1970	0.384
23. Pursuit Rotor (Mean Time on Target, 45 rpm)		10.133	3.290	0.867 / " "	0.449
24. Figure Reconstruction (Rotation Error, Trials 1 - 5)		19.297	9.293	0.718 / " "	0.505
25. Time Estimation (Error, Trial 8)		10.992	4.710	0.766 / " "	0.443
26. Finger Maze (Total Solution Time)		7.961	3.138	0.656 / " "	0.433
27. Line Reproduction (Range, Unaided Reproduction)		8.453	4.524	0.350 / Howarth, 1970	0.510

* Test-retest reliability coefficient; all other entries are split-half reliability coefficients

to reliability it was necessary to demonstrate the normality of the distribution of scores for each variable, to preclude the emergence from the multivariate solution of artifactual dimensions which might suppress viable interactions of learning variables and personality factors. With respect to the latter, it could be assumed that the distributions were normal, "...as most human traits are" (Guilford and Guilford, 1934, p. 385).

However, there existed the possibility that the degree of difficulty of a learning exercise might generate a skewed distribution of scores, either negatively skewed (pointed toward the left) with an easy exercise or positively skewed (pointed toward the right) with a hard exercise, thereby generating an instrument factor of difficulty. While by inspection the frequency distributions constructed for the learning variables appeared to be normal (that is, bell-shaped curves bisected at their maxima by the mean), all distributions, particularly those for which a finite limit as to the duration of the exercises did not exist (for example, number of trials to criterion in Serial Anticipation), were characterized by a slight positive tail. A measure of skewness (recommended only if the number of observations is greater than 100; McNemar, 1969) was therefore calculated for each learning distribution, as reported in the fifth column of Table 2. At the one per cent level, the standard error for the measure of skewness with $N = 128$ was 0.54, and as all the values obtained were less than 0.54, the hypothesis that the sampling distributions were drawn from symmetrically distributed populations was not rejected.

Further, since distributions may differ in dispersion (horizontal and vertical) and accuracy of prediction by means of a regression equation is dependent on the error of estimate, which is a function of the dispersion of the array, it was also desirable to establish that the vertical dispersions of scores on each learning exercise were approximately equal, or homoscedastic. Since it is only"...when distributions are markedly skewed that significant departures from homoscedasticity occur" (Guilford, 1942, p. 224), the failure of the skewness measures in Table 2 to reach significance suggested that it was permissible to assume the presence of homoscedasticity in the data.

Finally, cognizance was taken of Carroll's (1961) emphasis on the importance of a clear understanding of the nature of the data in guiding the choice of the appropriate correlation coefficients on which to base a dimensional analysis (in the present study, a choice made automatically by contingencies incorporated into the regression, factor and components analysis programs used to reduce the dimensionality of the data). Since it was permissible to assume some kind of a continuous distribution for the responses to items on personality questionnaires (Guilford & Guilford, 1934), and because the learning variables were scored on continuous scales, the Pearson product-moment-correlation coefficient[7] was deemed suitable

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7) Carroll (1961) emphasized that, although the computation of a Pearson product-moment correlation coefficient need not be based on any assumptions, "...the interpretation of its meaning certainly depends upon the extent to which the data conform to an appropriate statistical method for making this interpretation" (p. 349). The limits of the correlation coefficient contract with

for determining the cross-media interrelationships between personality and learning. The remaining variable, Sex, was both dichotomous and truly discrete, and therefore, following McNemar (1969), the customary convention of using the point biserial correlation coefficient for specifying the degree of relationship between dichotomous and continuous variables was adopted for relating Sex to the learning variables.

Having thus justified the application of the techniques of multivariate assessment to the data, the findings of that assessment were interpreted in terms of the three stages of data analysis outlined in the Method section.

1. <u>Analysis of the Cross-Media Correlation Matrix</u>

Amongst the 702 elements of the 27-variable Reduced Data Matrix, in addition to 52 significant correlations between personality variables and four significant correlations between learning variables (which were not considered further since they did not constitute the focus of the study), there were 28 significant cross-media correlations[8] ($\underline{r} > 0.160$, $\underline{p} < .05$, $\underline{df} = 127$), as illustrated in Table 3,

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7) (cont'd) the departure of the data from the model. For example, if a Pearson coefficient is based on disparate data distributions, the possible range of the coefficient—and thus, the rank of the correlation matrix and the ensuing factor solution underlying the matrix—will be depressed to the degree that the distributions differ. While the exact limits of a correlation coefficient in such cases may be calculated by a technique which is general to all types of correlation coefficient (Carroll, 1961), the demonstration of normality and homoscedasticity in the present study precluded the contraction of the range of the coefficients employed, and thus the necessity for carrying out such a correction procedure.

8) Extrapolating from the <u>Tables of the Cumulative Binomial Probability Distribution</u> (1955), the probability of obtaining 28 (of a possible 152) significant cross-media statistics by chance was $\underline{P} = 0.00000$. (Strictly speaking, the binominal distribution assumes

Table 3

Significant Cross-Media Correlations between the Variables of the Reduced Data Matrix

Learning Exercises	Memory Exercises		Perceptual-Motor Exercises	Memory and Perceptual Motor Exercises
Tasks	Digit Reproduction	Time Estimation	Letter Cancellation	Line Reproduction
Variable	Base Span	Error, Trial 8	Total Letters Cancelled	Range, Unaided Reproduction
Correlated Personality Variables	Cortertia .183 Sex .163	Extraversion -.291 Desurgency vs. Surgency -.251 Exvia -.194 Neuroticism .190	Home-Parental Sentiment .224 Sex -.202 Alaxia vs. Protension -.174 Extraversion .163	Assertiveness Erg .201 Sex .178
Problems	Serial Anticipation	Figure Reconstruction	Pursuit Rotor	Finger Maze
Variable	Trials to Criterion	Rotation Error, Trials 1 - 5	Mean Time on Target, 45 rpm	Total Solution Time
Correlated Personality Variables	Neuroticism -.194 Intelligence -.176 Sex .175	Intelligence -.211 Sensation Seeking .198 Home-Parental Sentiment -.161	Extraversion .239 Low vs.High Ego Strength .204 Cortertia .196 Intelligence .192 Harria vs. Premsia -.165	Group Dependence vs. Self-Sufficiency .225 Intelligence -.202 Low vs. High Ego Strength -.176 Sex -.170 Anxiety .161

and while it was apparent that across exercises there was not a unitary pattern amongst these correlations, detailed examination did reveal a number of regularities, as follows.

(i) Five of the seven significant cross-media correlations containing the second-order factors of extraversion and/or anxiety involved Eysenckian rather than Cattellian measures, suggesting, perhaps, in the former, greater sensitivity to the contribution to learning of individual differences in personality (which point will be elaborated upon in the Discussion section).

(ii) Intelligence was positively correlated with performance on every problem (i.e., the higher the Culture Fair Intelligence Test score, the better the performance), but did not correlate significantly with any of the tasks. In addition, although on only one problem (the Pursuit Rotor) were Cortertia (sheer speed at the neurological level combined with general high alertness; Cattell, 1965) and Intelligence both correlated with performance, the direction of the correlation was positive in each instance.

Notwithstanding the likelihood that this prominence of the quality of intellect as a correlate of performance was undoubtedly in large measure responsible for the fact that these were 15% more significant correlations between personality and learning problems (16/28) than between personality and learning tasks (12/28) these percentages did, however, imply a direct relationship between the degree of involvement of personality in performance on a learning

8) (cont'd) independent statistics; although they were not independent in the present study—a few of the personality variables were themselves correlated—use of the binominal distribution was acceptable as an approximation.)

exercise and the difficulty of that exercise—that is, as exercise difficulty increased (as discriminability decreased and/or the number of probable acceptable response alternatives grew; Dunn, 1968), personality variables became more important to successful performance.

(iii) Finally, while it was instructive to note the unusual nature of some of the motivation-learning correlations—for example, while the positive correlation between Assertiveness and greater variability in the range of Line Reproduction was interpretable without difficulty, the relationships between Sentiment to Home and performance on the Letter Cancellation and Figure Reconstruction exercises would not have been predicted _a priori_—explanations of these phenomena required clarification in terms of the results of the multiple regression and factor analyses.

However, before proceeding thus, as a necessary complement to the above overall survey of the cross-media correlation matrix, the clusters of significant personality-learning correlations for each individual exercise were examined in turn.

Digit Reproduction. Base Span was positively correlated with Cortertia and Sex. In the light of subject's responses (following establishment of Base Span) to the question, "How did you remember the numbers?", these correlations suggested that the capacity for rapid cerebral functioning facilitated the development of more efficient methods of grouping, and more so in females than males.

Time Estimation. In accordance with Lynn's (1961) finding that extraverted neurotics showed greater negative time errors than introverted neurotics in the judgement of time intervals, Error of Time Estimation correlated with Neuroticism and Extraversion.

Serial Anticipation. Number of Trials to Criterion was correlated negatively with Intelligence and Neuroticism and positively with Sex, which suggested an interaction (particularly in females) of intellect and emotional stability with mastery of the serial list.

Figure Reconstruction. The positive correlation between Rotation Error (in reproducing the locations, within a rapidly-exposed figure, of five shapes) and Sensation Seeking was interpretable in terms of the distractability and short duration of attention associated with the latter, while the negative correlation with Intelligence was consistent with the findings of Brengelmann (1958), the inventor of the Figure Reconstruction Test.

Letter Cancellation. Apart from the finding that performance was correlated with Sex (males were superior), the diverse nature of this correlation cluster made it the most difficult to interpret.

For example, the relationship between Total Letters Cancelled and Home-Parental Sentiment was unexpected, but was certainly, it being the largest correlation, of interest, as will be shown later. The negative correlation between performance and Alaxia vs. Protension may have been a function of the suspicion (characteristic of protensive individuals; Cattell, 1965) that, in this instance, the letters to be cancelled were not all present in each randomized alphabet sequence. Finally, the emergence of Extraversion as a significant correlate of timed Letter Cancellation was perhaps a reflection of the facilitatory effect on performance of the stimulus hunger of extraverts (Eysenck, 1967; Gale, 1969), that is, rather than searching diligently for a letter that was difficult to locate, the extravert would proceed quickly to the next letter to be found.

Pursuit Rotor. Eysenck (1967) suggested that the ongoing consolidation of learned behaviour, and its consequent unavailability for short-term retrieval, renders introverts inferior to extraverts in learning exercises having rest periods up to 15 min. in duration—an hypothesis supported in the present study (with inter-trial intervals of 15 sec.) by the correlation of Extraversion with Mean Time on Target at 45 rpm. In addition, Cortertia, Intelligence and the lack of emotionality associated with Ego Strength and Premsia would be expected to contribute favourably to the development of the visual-motor expertise necessary for efficient Pursuit Rotor performance.

Line Reproduction. The generation of sex-linked variability in performance was the inference drawn from the correlations of Assertiveness and Sex with Range of Unaided Line Reproduction.

Finger Maze. The overall implication of the correlations of Group Dependency vs. Self-sufficiency, Low vs. High Ego Strength and Anxiety with Total Solution Time for the Finger Maze, an exercise which required subjects to make a commitment at 10 different choice points, was one of the importance of general "self-confidence" to rapid solution (especially in females). Such a characteristic would also undoubtedly be potentiated by intelligence—hence the negative correlation of Intelligence with maze performance, that is, the greater an individual's intellect, the less time he would take to master the maze.

Analysis of the cross-media correlation matrix having been carried out in detail, the assumption of an affirmative answer to the question,"Can the interpretations made be taken at face value?," would nonetheless have been premature in light of the ever-present realities that (a) correlation does not imply causation and (b) any one correlation might be attributable to chance, both of which pointed up the shortcomings of analyzing the correlation matrix *per se* and emphasized the necessity for discovering the dimensional substratum underlying the obtained intercorrelations.

2. Multiple Regression Analysis

Several aspects of the multiple regression analysis (outlined in Table 4), which generated equations for the prediction of perfor-

Table 4

Prediction of Performance on each Exercise through Separate Multiple Regression Analyses of the Reduced Data Matrix Variables of Cattell (C) and Eysenck (E)

Exercise	Prediction Equation ($p < .05$)	Variance (%) Accounted for	Standard Error of Prediction
Serial Anticipation	Y_C = 20.499 + (-.350) (Alaxia vs.Protension) + (2.456) (Sex) + (-.253) (Intelligence)	10.609	5.000
	Y_E = 17.417 + (-1.001) (Neuroticism)	6.887	5.087
Time Estimation	Y_C = 10.627 + (-.276) (Desurgency vs. Surgency) + (.321) (Sweetheart-Spouse Sentiment)	9.790	4.509
	Y_E = 15.388 + (-.336) (Extraversion)	8.458	4.524
Pursuit Rotor	Y_C = 10.362 + (.180) (Cortertia) + (-.135) (Low vs. High Ego Strength)	8.091	3.179
	Y_E = 7.611 + (.193) (Extraversion)	5.704	3.208
Finger Maze	Y_C = 9.459 + (.229) (Group Dependence vs. Self Sufficiency) + (.153) (Intelligence)	9.440	3.010
Figure Reconstruction	Y_C = 31.337 + (-.456) (Intelligence)	4.450	9.119
Digit Reproduction	Y_C = 7.828 + (-.046) (Cortertia)	3.334	1.205
Letter Cancellation	Y_C = 59.087+ (.958) (Home-Parental Sentiment) + (-5.707) (Sex)	8.257	14.836
Line Reproduction	Y_C = 1.859 + (.372) (Assertiveness Erg) + (1.758) (Sex)	7.620	4.383

mance on each of the eight learning exercises in terms of 19 personality variables (see Appendix I), were worthy of comment. First, it was interesting to note that (a) in terms of incidence of occurrence, the second-order temperament measures were more prominent predictors than the primaries, which appeared in the regression analysis in only three instances (as did the motivation variables), and (b) the maximum number of significant predictor variables in any equation was three, thereby supporting Guilford's (1942) contention that"...it rarely pays to bring into a multiple prediction situation more than four or five independent variables, [because] by the time that this many are combined, they have fairly well covered what any additional one can do for us" (p. 258).

Second, whereas for each exercise a regression equation composed of significant Cattellian predictor variables was derived, performance was predictable in terms of Eysenckian variables for only three exercises. However, this was undoubtedly due in part to the greater number of Cattell's measures (15, as opposed to only three of Eysenck's) examined as possible predictors, and did not obscure the observation that for two of the three exercises in which regression equations could be compared, the predictor variables were similar in nature: facility in Serial Anticipation was predicted by Neuroticism (Eysenck) and by Alaxia vs. Protension, a first-order constituent of Anxiety (Cattell); and Extraversion (Eysenck) and Desurgency vs. Surgency, a primary component of Exvia (Cattell), were the principal predictor variables for errors of Time Estimation.

Only on the Pursuit Rotor exercise was a lack of comparability apparent, with performance predictable on one hand by Eysenck's Extraversion and on the other by Low vs. High Ego Strength, another component of Cattell's Anxiety.

Third, with respect to the nature of the learning exercises, although no patterns of prediction were discernible within the context of memory and/or perceptual-motor involvement, in terms of the distinction between tasks and problems an important observation was made—that while temperament variables emerged as predictors in all problems (and only two tasks), motivation variables were involved in three (of four) tasks but no problems. This finding engendered a much clearer explication of the hypothesis, generated earlier by the cross-media correlation matrix, of a direct relationship between exercise difficulty and the contributions of temperament and motivation variables to performance. It now appeared that the relationship might be a reciprocal one: on easy exercises motivation played a major role in performance, but with increasing exercise difficulty, a decline in this role was accompanied by a concomitant increase in the contribution of temperament variables.

Fourth, in accordance with statistical theory, a comparison of the cross-media correlation and multiple regression results revealed that, with one exception (Alaxia vs. Protension as a Cattellian predictor of performance on Serial Anticipation), for each learning exercise the individual difference variable which appeared as a predictor in the multiple regression analysis (Table 4) was also found to be a significant personality correlate of performance on that exercise (Table 3) and, indeed, the order of emergence of the variables as either predictors or correlates was identical in almost every instance.[9] Thus the conclusion to be drawn from this congruence was that the cross-media correlations were not obtained by chance but rather were indicators of veridical linear relationships, a finding which lent strong empirical support to the basic approach of the present study—the demonstration of personality determinants of complex human learning.

Finally, notwithstanding this encouraging observation, the multiple regression equations demonstrated that, in terms of total predictability, personality variables were accounting for only about 10% of the variance in performance on any exercise—a finding which resembled Guilford's statement (paraphrased in Vernon, 1961, p. 158) that only"...2 to 4% of the variance of creative thinking abilities among high-grade normal adults can be ascribed to non-cognitive traits". However, in the light of some rigorous research by Fleishman and his associates, this was not so damaging to the hypothesis of personality determinants of learning as might first appear to be the case, as will be shown in the Discussion section, which follows the description of the results of the factor analysis.

3. Factor and Components Analysis

The Reduced Data Matrix, having been subjected to three separate multivariate analyses as outlined in the Method section, yielded

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9) Thus the necessity for individual explanation of each regression equation was obviated, since the interpretations (made earlier) in terms of cross-media correlations could also be applied—and now with greater justification—to the regression equations.

the nine-dimensional solutions compared in Table 5 (in which 0.350 was taken as the level of significance required for reporting a factor loading, or salient). Because the most prominent feature of the comparison was the near identity of the solutions, following Howarth (1971)—"my experience in a variety of recent large scale studies has persuaded me that Guilford's preference for orthogonality has a great deal to commend it" (p. 13)—it was acceptable to restrict further examination of the results to the orthogonally rotated principal axis factor solution[10] (centre entry of Table 5), beginning with a description of the factors themselves.

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10) To the question, "How many variables (tests, or the like) are needed to render it permissible to substitute unities for communalities in the leading diagonal of the correlation matrix?," Burt's (1970) answer was that"...it depends on the size of the observed correlation coefficients which the matrix contains. The influence of the two conditions may, I think, be most readily indicated as follows.

To clarify the tendencies involved let us take the simplest case that can possibly be conceived. Consider a correlation table which, when communalities are inserted, becomes a matrix of rank one. And to simplify the algebra still further, let us substitute the average of the communalities instead of the actual values: so that all the factor loadings are identical and all the entries identical. Let the factor loading be designated $\bar{r}$; then the communalities will all be equal to r^2 (I drop the bar). Then, when unities are inserted, the total for any one column will evidently be $1 + (n - 1)\, r^2$, and the grand total for the whole matrix will be $n\,[1 + (n - 1)\, r^2]$. Hence the factor loadings for the first factor will be

$$\sqrt{\frac{1 + (n - 1)r^2}{n}};$$

the difference between the factor-variance contributed by any one test or variable will be

$$\frac{1 + (n - 1)r^2}{n} - r^2 = \frac{1 - r^2}{n}\ .$$

Table 5

Comparison of the Salients of the Factor and Components Solutions

Factors	Alpha Factors, Orthogonal (Varimax) Rotation: Variable	Loading	Principal Axis Factors, Orthogonal (Varimax) Rotation: Variable	Loading	Principal Axis Components, Oblique (Promax) Rotation: Variable	Loading
I	Desurgency vs. Surgency	.851	Desurgency vs. Surgency	.858	Desurgency vs. Surgency	.886
	Exvia	.834	Exvia	.846	Exvia	.843
	Extraversion	.801	Extraversion	.818	Extraversion	.837
	Sensation Seeking	.583	Sensation Seeking	.683	Sensation Seeking	.721
	Group Dependence vs. Self-Sufficiency	-.422	Group Dependence vs. Self-Sufficiency	-.483	Group Dependence vs. Self-Sufficiency	-.444
II	Low vs. High Ego Strength	.744	Low vs. High Ego Strength	.777	Low vs. High Ego Strength	.826
	Neuroticism	-.598	Social Desirability	.660	Social Desirability	.703
	Anxiety vs. Good Adjustment	-.551	Anxiety vs. Good Adjustment	-.656	Anxiety vs. Good Adjustment	-.648
	Social Desirability	.538	Neuroticism	-.638	Neuroticism	-.648
	Home-Parental Sentiment	.365	Home-Parental Sentiment	.430	Home-Parental Sentiment	.373
			Alaxia vs. Protension	-.371		
III	Cortertia	.848	Cortertia	.862	Cortertia	.884
	Harria vs.Premsia	.645	Harria vs. Premsia	.768	Harria vs. Premsia	.799
			Intelligence	-.354	Intelligence	-.408
IV	Figure Reconstruction	.645	Figure Reconstruction	.678	Figure Reconstruction	.844
	Time Estimation	.454	Time Estimation	.644	Time Estimation	.615
	Pursuit Rotor	-.418	Pursuit Rotor	-.559	Pursuit Rotor	-.559

Table 5 (cont'd)

	Alpha Factors, Orthogonal (Varimax) Rotation		Principal Axis Factors, Orthogonal (Varimax) Rotation		Principal Axis Components, Oblique (Promax) Rotation	
Factors	Variable	Loading	Variable	Loading	Variable	Loading
V	Line Reproduction	.596	Line Reproduction	.820	Line Reproduction	.847
	Home-Parental Sentiment	-.362	Home-Parental Sentiment	-.485	Assertiveness Erg	.433
			Assertiveness Erg	.449	Home-Parental Sentiment	-.403
VI	Finger Maze	.510	Finger Maze	.641	Finger Maze	.701
	Serial Anticipation	.432	Serial Anticipation	.617	Serial Anticipation	.644
	Intelligence	-.354	Intelligence	-.581	Intelligence	-.553
VII	Self-Sentiment	.419	Digit Reproduction	.820	Self-Sentiment	.680
	Digit Reproduction	.410	Self-Sentiment	.629	Digit Reproduction	.679
	Alaxia vs. Protension	.358	Alaxia vs. Protension	.468	Alaxia vs. Protension	.445
VIII	Sweetheart-Spouse Sentiment	-.533	Fear Erg	-.631	Sweetheart-Spouse Sentiment	-.727
			Sweetheart-Spouse Sentiment	-.561	Fear Erg	-.608
			Group Dependence vs. Self-Sufficiency	.414	Intelligence	.391
IX	Letter Cancellation	.543	Letter Cancellation	.824	Letter Cancellation	.897

Factor I. The emergence of Cattell's Exvia (plus two of its first-order components, Desurgency vs. Surgency and Group Dependence vs. Self-Sufficiency) and Eysenck's Extraversion (which correlates positively with Sensation seeking; Farley and Farley, 1967) as salients justified the interpretation of Factor I as Extraversion.

Factor II. The presence of Cattell's Anxiety vs. Good Adjustment (with its primary components, Low vs. High Ego Strength and Alaxia vs. Protension) and Eysenck's Neuroticism (with which Social Desirability is negatively correlated; Farley, 1966) strongly suggested the identification of Factor II as Anxiety, within which context the contribution of Sentiment to Home (i.e., strength of attitudes attaching to parental home) was readily incorporable.

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10) (cont'd) Thus the discrepancy between the results obtained by the two procedures will vanish as either r^2 approaches unity or n approaches infinity. The actual size of the discrepancy will depend on the size both of r^2 and of n.

Unless the number in the sample (e.g.,number of individuals tested) is unusually large, these discrepancies, I imagine, would not in themselves be very serious. I think the limiting size for the sample, viz. 150 or thereabouts, may be accepted as marking a fairly safe condition. ...Hence, if your group is as small as this, I think the substitution of unities would be permissible".

Thus, in the present study, the discrepancies between the loadings of the alpha and principal axis factors (left and centre columns of Table 5) were generated by the insertion of unities rather than communalities in the principal diagonal of the correlation matrix underlying the latter solution, and although in some cases (particularly late in the factor series), these discrepancies exceeded the expected factor-variance difference of .014 (obtained by applying the above formula to the principal axis solution; $n = 27$, average $r^2 = .633$), following Burt's argument (i.e., unities are acceptable with less than 150 S's), in the light of the sample size of 128 S's, they were therefore not regarded as having an appreciable affect on the factor interpretation.

Factor III. Cattell (1957) reported that Harria vs. Premsia was (a) correlated with Harric Assertiveness, an objective test-factor indicative of"...fast, determined, effective action and self-expression" (p. 236) and (b) though correlated with intelligence, a distinct factor. Combined with Cortertia, the pattern implied by Factor III was thus one of speed and efficiency of cerebral function, and it was accordingly labelled Alertness.

Factors IV and VI. In contrast to the first three factors, the salients for Factors IV and VI, though few in number, presented a general picture of good memory and/or perceptual-motor performance on five learning exercises; the only personality salient to emerge was Intelligence, a necessary prerequisite for efficient learning. Factors IV and VI were not, therefore, personality factors, but performance factors, and hence were called Performance A and Performance B.

Factor V. Although the magnitude of the Line Reproduction salient suggested that Factor VI might be simply an instrument factor representing that exercise, the presence of the Assertiveness Erg (which, it will be remembered from Table 3, was positively correlated with Line Reproduction) raised the possibility of a veridical relationship between motivation and Unaided Line Reproduction, in the sense that high Assertiveness (and, conceivably, the remaining salient, low Sentiment to Home, although again this would not have been predicted *a priori*) might generate uncontrolled, variable performance in a variety of situations, and thus Factor V was labelled Self-Control.

<u>Factor VII</u>. Digit Reproduction (which salient by itself might have been regarded representative of an instrument factor), Self-Sentiment and Alaxia vs. Protension formed a group of salients that, in addition, to being sparse, was too diverse in composition to allow unequivocal interpretation.

<u>Factor VIII</u>. Even though there were only three salients, the positive loading of Group Dependence vs. Self-Sufficiency (which weighted the loading towards the Self-Sufficiency pole) plus the negative loadings of the Fear Erg and Sweetheart-Spouse Sentiment suggested the identification of Factor VIII as an Independence dimension.

<u>Factor IX</u>. Although its nature was indicative of an instrument factor of Letter Cancellation, the emergence of only a single salient precluded factor evaluation.

Having described the factors <u>per se</u>, the final concern was an examination of the overall solution for evidence of contributions of measured aspects of personality to performance on the learning exercises administered in the present study. Of the seven interpretable factors, IV and VI were clear-cut performance dimensions while I, II, III andVIII were pure personality factors (which, interestingly, bore strong resemblance to the second-order factors of the 16 PF Questionnaire; Cattell and Eber, 1957). For Factors V and VII however (even though the latter was not interpreted), a case could have been made for attributing at least a portion of the variability in performance on specific exercises to the influence of particular personality variables.

In summary, at least within the constraints of the present study, the evidence found for the interaction of personality and learning, though encouraging, was characterized by a somewhat limited degree of generality, which was suggestive of the existence of personality and learning variables in only partially overlapping domains. In this context, therefore, it was instructive to align this finding with similar results from an independent but parallel study by Howarth (1971)—a comparison described in the following Discussion section.

DISCUSSION

Before proceeding with an overall evaluation of the present results, a number of specific findings merit further examination. (1) Many psychologists have maintained that if differences in intellectual abilities could be eliminated, there would still exist considerable discrepancy in performance or achievement as a function of individual differences in personality. For example, Cattell (1965, p. 314) suggested that the contributions of intelligence, temperament and motivation to school achievement are roughly 25, 40 and 20%, respectively. However, if a degree of comparability between laboratory learning and academic performance can be assumed, the relatively low predictability of learning in terms of personality variables in the present study stood as a substantial qualification of Cattell's position. Also explicatory was the possibility (discussed earlier) that the relative contributions of temperament and motivation were contingent upon exercise difficulty. Essentially, these findings indicated that Cattell's percentages, even if they were not overly optimistic, were perhaps not readily applicable to performance in general. In other words, prediction of achievement in terms of personality must also take into consideration (at least) type of performance and level of difficulty. In summary, the following quotation from Vernon (1961) was apropos: "Although interesting attempts have been made to measure personality factors relevant to scholastic success, it is doubtful whether any are practically applicable on a large scale" (p. 38).

(2) As described earlier, a number of the correlations between motivation and learning, because of the nature of the motivation variables involved, would not, on an intuitive basis, have been predicted _a priori_ (e.g., the relationships between Sentiment to Home and performance on the Letter Cancellation and Figure Reconstruction exercises). However, it will be remembered that the congruence of the personality measures emerging as both performance correlates in the cross-media correlation matrix and predictors of performance in the regression analysis demonstrated that, rather than being chance events, these relationships represented real dependencies existing between personality and learning variables.

What these findings indicate, therefore, is the need for increased flexibility and open-mindedness in the generation of hypotheses about, and greater refinement and sophistication in the measurement of, the roles of personality variables in relation to learning, particularly with respect to the motivation modality of personality.

(3) The regression analysis also revealed, as did the factor analysis, the dominance of second-order over primary personality dimensions as predictors, thereby demonstrating the veridicality and stability of second-order factor structure. For example, the resemblance of Factors I, II and III to Cattell's Exvia, Anxiety and Cortertia was clear, and, indeed, even the fourth personality dimension (Factor VIII) was not dissimilar to Cattell's second-order factor of Independence. These results were in accord with the findings

of Howarth (1971), who concluded from his attempt to replicate and evaluate Cattell's objective personality factors, using specifically selected marker variables, that "if cross-media, matching is to be obtained, we should concentrate on the Q [questionnaire] secondaries" (p. 2), because the inclusion of the 16 PF primaries as additional markers yielded a factor solution of considerably less clarity than the solution in which they were not included.

On the other hand, in an independent cross-media study of objective test performance as predicted by questionnaire factors from the Eysenck Personality Inventory (Eysenck and Eysenck, 1965) and the Howarth Personality Questionnaire 2 (HPQ2; Howarth, 1970b) (the latter being a revised version of the HPQ1[11]; Howarth, 1970a), Howarth and Marceau (1971) found that, in contrast to second-order factors, their primaries were of much greater utility in generating (multiple regression) predictions than in the present study. In explanation of this difference between the two studies there were two alternatives: (i) The greater predictability by primaries of performance on objective personality tests (i.e., Howarth-Marceau) than on objective learning tests (i.e., the present study) suggested that personality and learning dimensions may exist in different factor space (a possiblity which will be discussed later); (ii) The primaries of the HPQ2 and the EPI may be superior to those of the 16 PF

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11) The HPQ1 was a 100-item questionnaire constructed by adapting 67 marker items from Sells, Demaree and Will (1968) and 10 from Eysenck and Eysenck (1969), and in the attempted replication to determine whether the restructured items would reappear as factors in item-factor analysis, 44 of 77 markers assumed appropriate positions (Howarth and Browne, 1971a). This led to the development of the 150-item HPQ2, which contained 60% new items for factor hypotheses purposes. Thus the

as measures of first-order personality structure—and in support of this contention it is relevant to: (a) recall that in the present study all but two of the significant personality-learning correlations containing the second-order factors of extraversion and/or anxiety involved Eysenckian rather than Cattellian measures, the latter being, of course, no more than composites of the 16 PF primaries; and (b) quote a statement from Howarth and Browne (1971b) made on the strength of a 10-factor solution obtained by item-factoring the 16 PF—which revealed a mean percentage of intra-scale correlations of only 33.4% for Cattell's scales, as compared to 78.3% for the Howarth-Browne factors (indeed, the Sociability and Social Shyness factors possessed perfect intra-scale agreement while the best 16 PF scale (H) achieved only 76.9% and the percentages for A,B,C,L,M,N and Q1 were very low)—that "...the 16 PF does not measure the factors which it purports to measure at the primary level" (p. 20), a conclusion which confirmed and extended the findings of other independent item-factor analyses, among them that of Eysenck and Eysenck (1969), who remarked that "there is very little support...for the picture of personality structure which Cattell has presented at the first-order level of description" (p. 225).

(4) It may be said that the intention of the present study to demonstrate cross-media dependencies between personality variables

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11) (cont'd) Howarth-Marceau predictors included (i) HPQ2 primaries—Adjustment-Emotionality, Sociability, Super-Ego, Shyness, Relaxed Composure, Impulsiveness, Individual Tolerance, Considerateness, Group Tolerance, Physical Prowess, General Activity, Trust vs. Suspicion, Group Affiliation, Rhathymia and Paranoia (ii) E.P.I. primaries—Anxiety I, Anxiety I^2, Sociability, Anxiety II, Anxiety II^2 and Impulsivity.

and learning measures (further discussion of the specific natures of which was unnecessary, since these relationships were examined in detail in the Results Section) was realized. Within this context, two important points emerged. First, the essential bifurcation of the dimensional solution into personality factors and learning factors indicated that, rather than by factor analysis, cross-media correlations are best interpreted through the techniques of multiple regression.

Second, although regression analysis did generate equations for predicting learning from personality variables, a substantial amount of the variance in learning was not being accounted for and, therefore, the overriding question became, "Why was the proportion of learning variance predictable from personality relatively low?" There were a number of possible explanations, both procedural and substantive, which will now be considered in turn.

(A) Procedural Explanations

Firstly, it could have been argued that testing conditions were unsatisfactory—Group Testing being prejudicial to the probity of subject's questionnaire responses and Individual Testing sessions too long, resulting in fatigued, uncooperative subjects. However, supervision was strict and, on the whole, excellent subject cooperation was forthcoming during both Individual and Group Testing sessions.

Inadequate examination of the data could also be ruled out, since all possible approaches were employed to determine the structure underlying the Reduced Data Matrix, to ensure that the obtained cross-media relationships were not simply artifacts of insufficient or inappropriate analysis.

Thirdly, were the exercises employed deficient in their capacity to elicit learning? Such could not have been the case, as, it will be remembered, the criterion of selection was that of repeated usage in standard laboratory learning experiments.

Another possible procedural shortcoming was the acceptance of questionnaire responses not as Q' data (in which"...no dependence is placed on the ordinary meaning of language, and it is taken only as behaviour, the real meaning of which, in reference to the behaviour mentioned in words, must be determined by experiment with criteria representing that and other behaviour"; (Cattell, 1957, p. 161), but as truly descriptive statements about the subject and his consciousness (Q-data). However, in the present instance (and, it must be admitted, in many other studies) the rationale adopted was that the numerous demonstrations by both Cattell and Eysenck of congruence between their respective questionnaire and objective test factors permitted personality measurement by questionnaire alone. The personality data obtained were,of course, vulnerable to the drawbacks of questionnaire assessment (Cattell, 1957) —self-ignorance, motivated self-distortion and the effects of repetitive, itemetric test procedures (i.e., reduction in the variety of behaviour that can be studied, narrow response patterns, and boredom and/or fatigue)—but, in the sense that these limitations apply both to Q and Q' data, they were unavoidable.

Finally, it was recognized that there are perils in correlating putative surface measures with factor source traits. For example, in the field of personality investigation per se, Howarth (1969b) derived five putative personality dimensions via the criterion, "What are the most common, easily observable traits of the kind used when one asks 'What kind of person is Mary Jones?'" Initially these traits appeared to correspond well with Cattell's (1946) 17 nuclear clusters; however, upon closer examination it was clear that they encompassed little more than half of the dimensions contained in Cattell's personality sphere. Thus, Howarth concluded that, because putative traits too often are sets of personality characteristics which, though correlated, do not form a factor, description at the surface level was not acceptable "...for carefully separating the measurement (psychometric) aspects of these dimensions" (p. 12).

Although the present study was predicated on the correlations of surface measures of learning with personality source traits, because of the quantifiable nature of the learning measures in terms of an absolute standard (i.e., learning to a criterion), they could be empirically removed from the realm of semantic evaluation characteristic of personality assessment at the surface level, thus allowing them to be regarded as entities which could be justifiably correlated with measured questionnaire source traits of personality. (Indeed, rejection of this rationale would tend to invalidate a great deal of research, particularly of a bivariate nature, in which personality is correlated with performance on a single learning exercise).

(B) Substantive Explanations

(1) The Inadequacy of the Assessment of Personality by Questionnaire

The necessity for assessing personality by questionnaires with acceptable psychometric foundations prompted the decision to employ the instruments of Cattell and Eysenck, although it was recognized that there were discrepancies in the correspondence between the two systems. For example, with respect to Anxiety and Neuroticism, Howarth (1969b) has pointed out that although they

> ...are highly correlated in the questionnaire realm, they do not appear to be the same thing conceptually. In fact, Cattell's use of the terms anxiety and neuroticism is exactly opposite to that of Eysenck. Cattell regards anxiety as basic and neuroticism as acquired, whereas Eysenck regards neuroticism as a basic proneness to emotional response due to differences in thresholds in the visceral brain, and anxiety as acquired by conditioning, in which extraversion-introversion differences in conditioning rate play a part (p. 92).

Additionally, it was difficult to draw any comparative conclusions with respect to Exvia and Extraversion because of the contradictory atmosphere surrounding the nature of their primary components. For example, though they regarded it as a unitary factor, Eysenck and Eysenck (1963) admitted that the measure of Extraversion obtained from the Maudsley Personality Inventory (Eysenck, 1959b) contained two distinct components, Sociability and Impulsiveness. On the other hand, in a later study in which they factor-analyzed the matrix of intercorrelations between each of the 57 items of the

Eysenck Personality Inventory (EPI; Eysenck and Eysenck, 1965) and salivary reactivity to pure lemon juice, a physiological indicator of extraversion (Corcoran, 1964)—that is, salivation was inversely related to degree of extraversion[12]—Eysenck and Eysenck (1967) extracted two factors corresponding to Extraversion and Neuroticism. The salivation test loaded -0.74 on Extraversion and 0.02 on Neuroticism, allowing the conclusion that "...the items of the EPI Extraversion scale measure a factor which is, as far as this experiment is concerned, unitary" (p. 389).

In contrast, Cattell's (1965) second order factor of Exvia contained at least four primary components—Sizothymia vs. Affectothymia, Desurgency vs. Surgency, Threctia vs. Parmia and Group Dependence vs. Self-Sufficiency.

In view of such contradiction and disagreement, the requirement that "from a practical standpoint...it is absolutely imperative that we understand the make-up of introversion-extraversion [and any other personality characteristic under study] before we can secure a valid measure of it" (Guilford and Guilford, 1934, p. 378) has clearly not yet been met. Thus, insofar as "...there is no better court of appeal at the present time [than] the common judgement of those who have tried to define and describe this very thing [personality]" (Guilford and Guilford, 1934, p. 378), a conceivable explanation for the fact that higher percentage predictability of

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12) Howarth and Skinner (1969), finding markedly lower mean salivation levels for both extraverts and introverts than those reported by Corcoran (1964) and Eysenck and Eysenck (1967), suggested that the identification of "...the salivary response to lemon juice as a pure measure of extraversion...must be regarded as premature" (p. 227).

learning in terms of personality variables was not obtained in the present study may have been the use of inadequate questionnaires which reflected not the veridical nature of personality traits but rather the idiosyncratic predilections of their authors.[13]

(2) The Existence of Questionnaire and Objective-Test Dimensions in Different Space.

An alternative to questionnaire assessment is objective testing (i.e., miniature, non-fakeable behavioural situations in which the subject is not aware what aspect of his behaviour is under scrutiny), and while a detailed examination of the entire approach was beyond the scope (and interest) of the present discussion, it was desirable to comment further upon the work of Cattell and his co-workers (already alluded to in the Review of the Literature) in the field of objective personality measurement. Operating from the principle of indifference of medium, which supposes that "...source trait structures are inherent structures in the personality itself, and that it is a matter of comparative indifference—indeed, a mere issue of convenience—whether we measure them by questionnaire or objective test methods" (Cattell, 1965, p. 119), to complement Cattell's questionnaire devices, the Objective-Analytic Personality Factor Battery (OA Battery; Cattell and Hundleby, 1967) and the High School

13) The poor showing of Cattell's primaries factors in the item-analysis of the 16 PF Questionnaire (Cattell and Eber, 1957) by Howarth and Browne (1971b) was described earlier. In a parallel item-factorization of the Eysenck Personality Inventory (EPI; Eysenck and Eysenck, 1965) scores of 1319 S's, Howarth and Browne (1971c), on the strength of their findings that, although the EPI primary factors (Sociability 1, Adjustment-Emotionality, Inferiority, Impulsivity, Mood Swings-Readjustment, Sleep, Superego 1, Jocularity, Sociability II, Dominance, Social Conversation, Hypochondriac-Medical, Superego II and two Lie factors) were replicable,

Objective-Analytic Battery (HSOA; Cattell and Scheurger, 1970) were developed. Extensive research with both instruments, each of which contains 10-test Single Factor Batteries for 12 Universal Index factors (U.I. 16, 17, 19, 20, 21, 23, 24, 25, 26, 28, 32 and 33), revealed that the U.I. factors were congruent with the second-order factors from the questionnaire medium (the difference in strata coming about "presumably because the questionnaire items are, as it were, smaller particles than the sub-tests in an objective test battery" (Cattell, 1965, p. 119). The Single Factor Battery for U.I. 19, illustrated in Table 6, exemplified the variety of tests characteristic of Cattell's approach to objective

Table 6

Single Factor Battery for U.I. 19,
Subduedness vs. Critical Independence
(adapted from Cattell and Scheurger,1970)

Subtest	Psychologist's Title
1	Gottschalt Figures
2	More drawings in reverse correct
3	Higher accuracy/speed in practical numerical
4	More orderliness in perceptual series
5	Higher index of carefulness
6	More correct in searching task
7	Greater accuracy of picture memory
8	Myokinesis; low deviation size of model
9	Immediate memory on reading
10	Severity of judgement on productions

13) (cont'd) Extraversion and Neuroticism are not univocal scales, suggested that "...until a more comprehensive and accurate inventory to assess primary factors is available, ...the EPI be scored for primary factor scales in order to present a more detailed picture of Extraversion and Neuroticism for the clinician and the researcher" (p.1).

personality measurement. It was noted that many of the tests were learning and/or performance exercises, similar in nature to several of the exercises used in the present study. The question then was, "Why was there not a greater relationship between performance on these exercises and Cattell's second-order questionnaire factors?"

Given his success in formulating such objective performance exercises as markers for Universal Index factors, which aligned in turn with questionnaire factors, Cattell has often claimed that cross-media correlations were not difficult to demonstrate, and dismissed any failure to obtain them with the explanation that "...in extreme instances a source trait may have such small variance in certain areas of manifestation that it will virtually appear in only one medium" (Cattell, 1957, p. 322).

An alternative to this explanation was provided by Howarth (1971), who attempted an independent factor analytic replication of Cattell's main objective personality factors, using first- and second-order scores from the 16 PF Questionnaire (Cattell and Eber, 1957) in combination with a set of objective tests containing specially selected marker variables. The ensuing solution, rather than being characterized by factors loaded by both questionnaire and objective-test salients, in the main simply reflected the nature of the constituent marker variables, yielding (a) questionnaire personality dimensions and (b) factors representing performance on psychomotor exercises (e.g., Line Length, Letter and Number Comparison) and interpersonal objective situations (e.g., Have you Ever, Which Would You Rather Do?).

As a result of this and other related studies, Howarth hypothesized that questionnaire and objective-test factors exist in different space, that is, factors in behaviour (objective) data are oblique in general, whereas factors in questionnaire data are orthogonal, or nearly so, and thus the feasability of obtaining cross-media relationships will depend on how close the obliquities in the behaviour data are to orthogonality (Howarth, personal communication to Guilford, 1970). Support for this hypothesis came from Guilford's (1970) reply, which stated that

> on the question of finding the same or aligned factors in both questionnaire and objective test variables, I am not nearly as optimistic as Cattell seems to be. I suspect that there are many traits for which we can find fair to good evidence from one approach and not from the other[14], [that is, we isolate]...phenotypes, whereas what I would hope to find is in the category of genotype".

To summarize, a number of explanations for the low number of interrelationships between questionnaire-assessed personality factors and objective learning measures have been considered. Several possible procedural shortcomings—poor testing conditions and subject co-operation, inadequate analysis, uncritical acceptance of questionnaire responses as veridical indices of consciousness, and the inherent dangers of correlating source traits (questionnaire factor scores) with putative surface measures (performance on learning exercises) — were rejected upon close examination. Of the two substantive explanations entertained (the inadequacy of personality assessment by questionnaire and the existence of questionnaire and objective-test factors in different space), empirical support from

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14) Guilford concluded with the comment, "I dislike to think of the alternative that the factors we find from either source are largely 'evidence' variables, what Cattell calls 'instrument'factors."

this and other studies favoured the latter.

Nonetheless, one additional explanation was conceivable—that in the intuitively appealing premise of the prediction of learning from personality, there may be operating what has been called the 'error of common sense' (Howarth, 1969b). In other words, because it is felt a priori that personality does play a prime contributory role in learning, attempts to demonstrate the fact are performed without due consideration of the possibility that such a frame of reference might be deficient in its initial assumption—and certainly the bifurcation into personality factors on one hand and performance factors on the other of the solutions of the present study, and that of Howarth (1971), did indeed at least suggest that some other dimensional domain might be the major determinant of individual differences in learning.

In this context, it was most instructive to consider an hypothesis proposed by Jensen (1964,1967). Individual differences in learning, Jensen's argument began, arise from a variety of different sources, each of which could be regarded as an interaction between subjects and an independent variable. Such a source of individual differences Jensen termed a phenotype. He further pointed out that without the assumption of regularities in individual differences in learning—"a wholly warranted article of faith" (Jensen, 1964, p. 5)—the superfluity of independent variables would yield such a multitude of phenotypes as to defy the development of systematic study in the area. These consistencies underlying phenotypic individual differences in learning Jensen called genotypes (the same descriptive terms, it will be remembered, were also used by Guilford), commenting that"...the idea that they are there seems to be worth pursuing. It seems most unlikely that learning abilities should be completely chaotic, without structure, and specific to every single task and condition of learning" (Jensen, 1964, p. 5).

As to the nature of genotypes, Jensen distinguished two categories,(i) intrinsic, that is, individual differences in learning and (ii) extrinsic,or, the effects of individual differences on learning. Intrinsic individual differences are not independent of learning phenomena but rather are inherent in learning, that is, they consist of inter-subject variability in the learning process itself. Examples of such hypothetical sources of variability are strength of initial registration of the stimulus trace, speed of consolidation of the stimulus trace and resistance to interference with consolidation of a memory trace. Extrinsic individual differences are those characteristics of a learner which have no resemblance to the learning process as it is generally conceived, but which may nonetheless affect performance on a learning exercise (examples include chronological and mental age, intelligence, sex, attitudes and personality traits[15]). Furthermore,

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15) "In some cases,however, a personality trait must be regarded on theoretical grounds as belonging to the intrinsic type of ID's [individual differences], when the development of the personality trait itself is based on some essential variable in the learning domain. A case in point is Eysenck's conception of extraversion, which is hypothesized to develop as a consequence of ID's in the rate of buildup and dissipation of cortical inhibition. Where such forms of inhibition play a role in learning we should expect to find correlations with the trait of extraversion. In other words, the personality trait and the learning performance both would have some ID

of direct relevance to the present study was Jensen's statement that although extrinsic individual differences "...contribute to between-subjects variance in learning,...even when this variance is completely accounted for, a great deal of true variance remains. The sources of this remaining variance are probably intrinsic to the learning process" (Jensen, 1964, p.6)—and it is thus the contention here that in combination with the extensive work of Fleishman and his associates in the area of perceptual-motor learning, Jensen's is an extremely powerful hypothesis, as illustrated by the following example.

In the Discrimination Reaction Time Task, Fleishman and Hempel (1955) required the subject to react as quickly as possible with one of four switches in response to the spatial arrangement of a set of red and green lights. Figure 1 depicts the factor-analytic results. The size of the labelled areas represents the amount of variance (%) contributed by each performance factor at each stage of practice (the cumulated time of reaction for a block of 20 settings). It can be seen that approximately one third of the variance was "unaccounted for", another third was attributable to eight perceptual-motor abilities, while the remainder was imputed to as task-specific factor (which was not predictable in terms of any category of variables measurable before, during or after performance) —and it is argued here that the task-specific factor (which Fleishman

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15) (cont'd) 'genotype' in common. On a more superficial level the trait of extraversion might also have extrinsic effects on the subjects' performance in a learning situation, and this would occur even when the learning task does not involve any inhibitory factors. It would result from generalized tendencies associated with the extraverted syndrome, such as not taking the experiemnt seriously, not being conscientious, and wishing to get the whole thing over with as quickly as possible" (Jensen, 1967, p. 122).

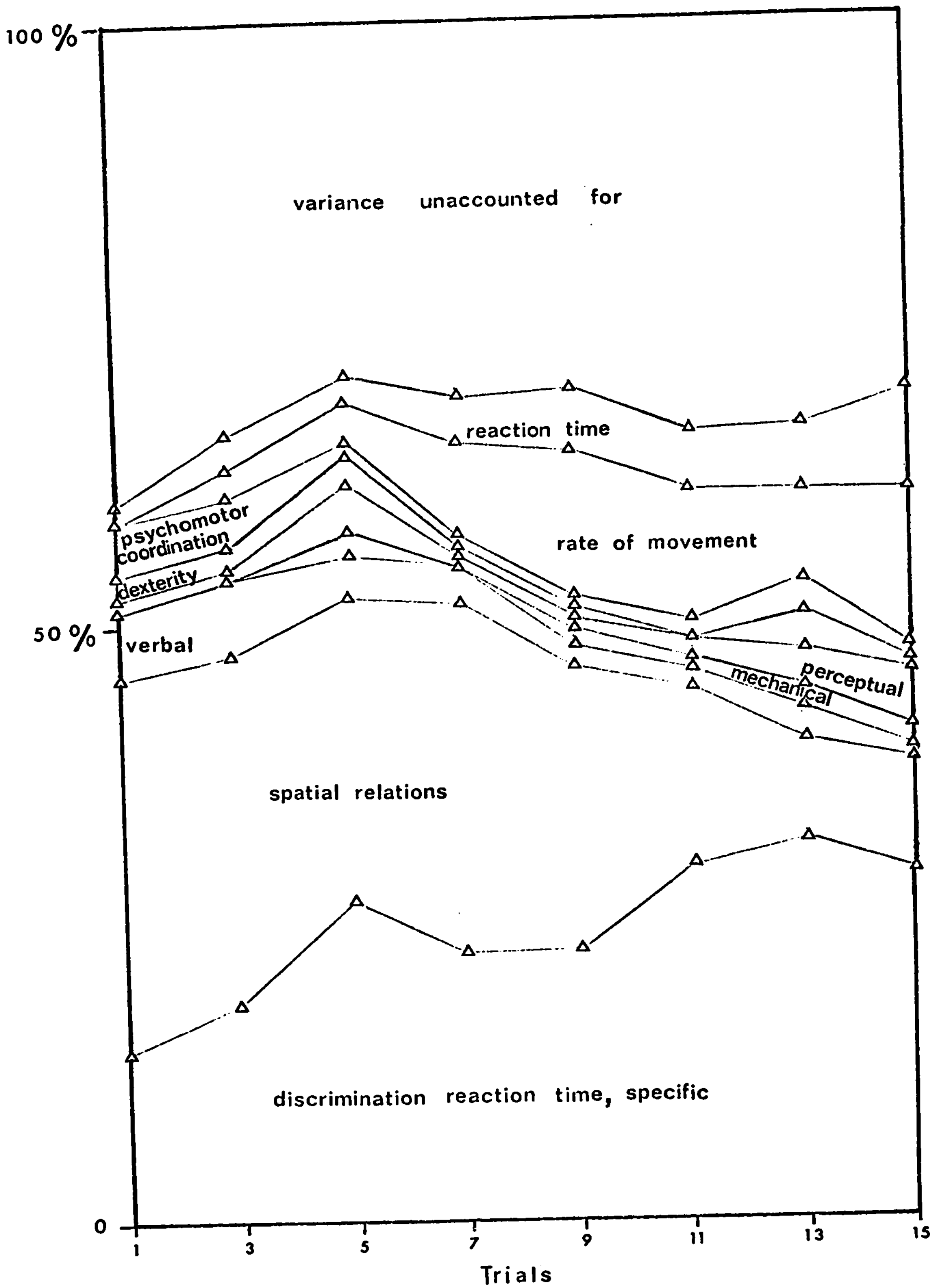

Figure 1 Percentage of variance accounted for by each performance factor at different stages of practice on the Discrimination Reaction Time Task (after Fleishman, 1965a).

has found in varying but always substantial magnitudes in all his studies) is exactly the sort of thing Jensen is referring to when he speaks of intrinsic individual differences in learning.

Generalizing (as Fleishman does) these findings in the perceptual-motor area to other types of learning, the implication in the past has been that, because of the generation of task-specific factors, there exists an upper limit to the predictability of performance in terms of extra-task variables—that is, abilities and those determinants (whatever they might be) of the "unaccounted-for" variance.

However, the fact that at least 30% of the variance in performance was "unaccounted for" is probably the most important aspect of Figure 1, for it is strongly suggested here that it is in this sphere that personality variables (Jensen's extrinsic individual differences) are operative—indeed, as Fleishman (1965a) puts it, "there is, of course, the question that some of the unaccounted for variance is 'motivational' or 'personality' [temperament] variance, [with the result that] there is an increasing interest in the interaction of personality and learning variables, [and] studies are planned to investigate this possibility" (p. 173)—and thus, applying this formulation to the present study, while on any exercise no more than 10% of the variance in performance was predictable in terms of personality variables, this was not 10% of a possible 100% but, using Fleishman's numbers for purposes of illustration, 10% of a possible 30%, that is, one third of the 30% of the variance which was "unaccounted for".

While, admittedly, direct application of Fleishman's percentages to the present study is probably somewhat optimistic, the point being made is clear—that to be able to explain such a substantial amount of the "unaccounted for" variance in learning by personality variables alone is an encouraging and positive achievement, and one which provides strong empirical support for the hypothesis of the present research (stated in the Introduction) that "intersubject variability in learning is <u>in part</u> the product of an interplay between personality and learning variables".

CONCLUSIONS

In addition to providing empirical justification for the rationale underlying the study (and thereby obviating criticism in terms of the "error of common sense"), the present results furnished some useful guidelines for future investigation into the roles of personality variables in relation to learning.

Firstly, support was generated for the tripartite conception of personality modalities (abilities, temperament and motivation; Cattell, 1965) adopted in the study. The necessity for considering the contributions of abilities to learning, long championed by differential psychologists—Spearman (1927), Vernon (1956, 1961), Fleishman (1965a) and many others—was re-emphasized, while the finding that, in contrast to the direct relationship between exercise difficulty and the effects of temperament variables on performance, motivation and difficulty appear to interact in a reciprocal fashion, underlined the necessity for rigour in research design, particularly with respect to the specification of procedural variables such as exercise length, distribution of practice and the just-mentioned difficulty variable. In other words, as Jensen (1967) suggested, in the systematic inclusion of measures of procedural variables within factor-analytic studies, whereby the interactions between individual differences and experimental variance from this source may be clarified, lies, in part, the key to discovering the effects of individual differences (e.g., personality) on learning.

Secondly, the relative dissimilarity amongst the multiple regression prediction equations obtained in the study, a function of the diverse set of learning exercises employed, indicates the desirability of investigating exercises of a fairly homogeneous nature in order to allow comparability of the effects of individual differences in performance. Furthermore, their contributions in the present exercises suggest that maximum utility will be realized with empirical demonstrations of the roles of such effects in more complex learning situations (e.g., conceptual or problem-solving).

Thirdly, the present results show that, because of task-specific, ability and other miscellaneous factors, personality variables are predictive of only a portion of the total variance in performance on any learning exercise. Rather than dismissing his percentages of "variance accounted for" as trivial, however, the investigator of personality-learning interdependencies must recognize the great utility in being able to isolate the source of any amount of variance, no matter how small, and thus the percentages obtained in the present study and the independent cross-media study of Howarth and Marceau (1971)—10% and 20%, respectively—were regarded as encouraging initial ventures into the investigation of a very complex field.

An example of this complexity was the contrast between the superiority of second-order over primary personality factors as predictors in the present research and the occurrence of the reverse in the Howarth-Marceau study. It will be remembered that, following Howarth and Browne (1971b), the inadequacy of Cattell's primary factors as compared to the primaries of the HPQ2 (Howarth, 1970b), was offered in explanation of this contrast. Clearly, therefore, the argument here is that research into personality correlates of learning must be predicated upon what Howarth (1969) has called "prior multivariate operational definition" of concepts, one facet of which is the development of suitable batteries for satisfactory questionnaire measurement of personality structure at both the first- and second-order factor level (see Footnote 13).

To this end, Howarth has constructed two independent instruments. The etiology of the Howarth Personality Questionnaire series —the HPQ1 (Howarth, 1970a), with marker items from Sells, Demaree and Will (1968) and Eysenck and Eysenck (1969), and its subsequent evolution into the HPQ2 (Howarth, 1970b), containing 60% new items for factor hypotheses purposes—has already been described (see Footnote 11). The second questionnaire is the Comprehensive Survey (COS; Howarth and Browne, 1970). The product of a distillation of more than 3000 items from 20 different questionnaires published since 1924, the COS contains 400 uniform and balanced items, 20 items for each of 20 putative primary factors[16] which, in combination with the primaries of the HPQ2, it is hoped will provide a definitive questionnaire resolution of personality structure at the first-order level—and perhaps temper somewhat Eysenck and Eysenck's (1969) conclusion that,

16) The putative factors of the COS are: Sociability, Mood Swings-Readjustment, Impulsivity, Sensation-Seeking, Adjustment-Emotionality, General Activity, Thinking Introversion, Sex, Superego, Paranoia, Rhathymia, Hypochondriac-Medical, Ascendance, Social Conversation, Inferiority, Social Responsibility, Social Shyness, Group Tolerance, Persistence, and Cooperativeness-Considerateness.

regardless of the questionnaire employed, prediction from primaries is a poor and questionable strategy.

Thus, it is anticipated that the sequel to the present study of personality correlates of learning, while operating within the same basic frame of reference as its predecessor, will take cognicance of those guidelines for future research described above, particularly the (a) measurement of personality by the primary factor questionnaire developed from the HPQ2 and the COS, and (b) investigation of a more complex, homogeneous and, perhaps, factorially-based (e.g., Stake, 1961) sample of learning exercises.

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APPENDIX I

Inclusive List of Personality and Learning Variables

Variable Number	Source of Variable	Designation of Variable
1* (1)		Sex
2* (2)		Age
3* (3)	16 PF	Exvia
4	" "	Anxiety vs. Good Adjustment
5* (4)	" "	Cortertia
6	" "	Independence
7	" "	Sizothymia vs. Affectothymia
8	" "	Low Intelligence vs. High Intelligence
9* (5)	" "	Low vs. High Ego Strength
10	" "	Submissiveness vs. Dominance
11* (6)	" "	Desurgency vs. Surgency
12	" "	Low vs. High Superego
13	" "	Threctia vs. Parmia
14* (7)	" "	Harria vs. Premsia
15* (8)	" "	Alaxia vs. Protension
16	" "	Praxernia vs. Autia
17	" "	Artlessness vs. Shrewdness
18	" "	Assurance vs. Guilt-Proneness
19	" "	Conservatism vs. Radicalism
20* (9)	" "	Group Dependence vs. Self-Sufficiency

APPENDIX I (cont'd)

Variable Number	Source of Variable	Designation of Variable
21	16 PF	Low Integration vs. High Self-Concept
22	" "	Low Ergic Tension vs. Ergic Tension
23* (10)	EPI	Extraversion
24* (11)	"	Neuroticism
25	ASQ	Anxiety
26	MAS	Manifest Anxiety
27	MAT	Career Sentiment-Unintegrated (U)
28	"	Career Sentiment-Integrated (I)
29 } *(12)	"	Home-Parental Sentiment-U
30 }	"	" " " -I
31 } *(13)	"	Fear Erg - U
32 }	"	" " - I
33	"	Narcism-Comfort Erg - U
34	"	" " " - I
35	"	Superego Sentiment - U
36	"	" " - I
37 } *(14)	"	Self-Sentiment - U
38 }	"	" " - I
39	"	Mating Erg - U
40	"	" " - I

APPENDIX I (cont'd)

Variable Number	Source of Variable	Designation of Variable
41	MAT	Pugnacity-Sadism Erg-U
42	"	" " " -I
43 } *(15)	"	Assertiveness Erg-U
44 }	"	" " -I
45 } *(16)	"	Sweetheart-Spouse Sentiment-U
46 }	"	Sweetheart-Spouse Sentiment-I
47*(17)	CFIT	Intelligence
48*(18)	SDS	Social Desirability
49*(19)	SSS	Sensation Seeking
50*(20)	Digit Reproduction	Base Span
51	" "	Retention Interval
52	Letter Cancellation	Number of Correct Letters Cancelled, Part A
53	" "	Number of Correct Letters Cancelled, Part B
54	" "	Number of Correct Letters Cancelled, Part C
55	" "	Number of Correct Letters Cancelled, Part D
56*(21)	" "	Total Correct Letters Cancelled
57	Serial Anticipation	Number of Errors
58*(22)	" "	Trials to Criterion
59	Pursuit Rotor	Mean Time on Target, 15 rpm.
60	" "	" " " " , 30 "

APPENDIX I (cont'd)

Variable Number	Source of Variable	Designation of Variable
61*(23)	Pursuit Rotor	Mean Time on Target, 45 rpm
62	" "	" " " " , overall
63*(24)	Figure Reconstruction	Rotation Error, Trials 1-5
64	" "	" " , " 6-10
65	" "	" " , " 1-10
66	" "	Rotation Variability, Trials 1 - 5
67	" "	Rotation Variability, Trials 6 - 10
68	" "	Rotation Variability, Trials 1 - 10
69	" "	Distance Error, Trials 1-5
70	" "	Distance Error, Trials 6-10
71	" "	Distance Error, Trials 1 - 10
72	Time Estimation	Error, Trial 1
73	" "	" , Trial 2
74	" "	" , Trial 3
75	" "	" , Trial 4
76	" "	" , Trial 5
77	" "	" , Trial 6
78	" "	" , Trial 7
79 *(25)	" "	" , Trial 8
80	" "	" , Trial 9

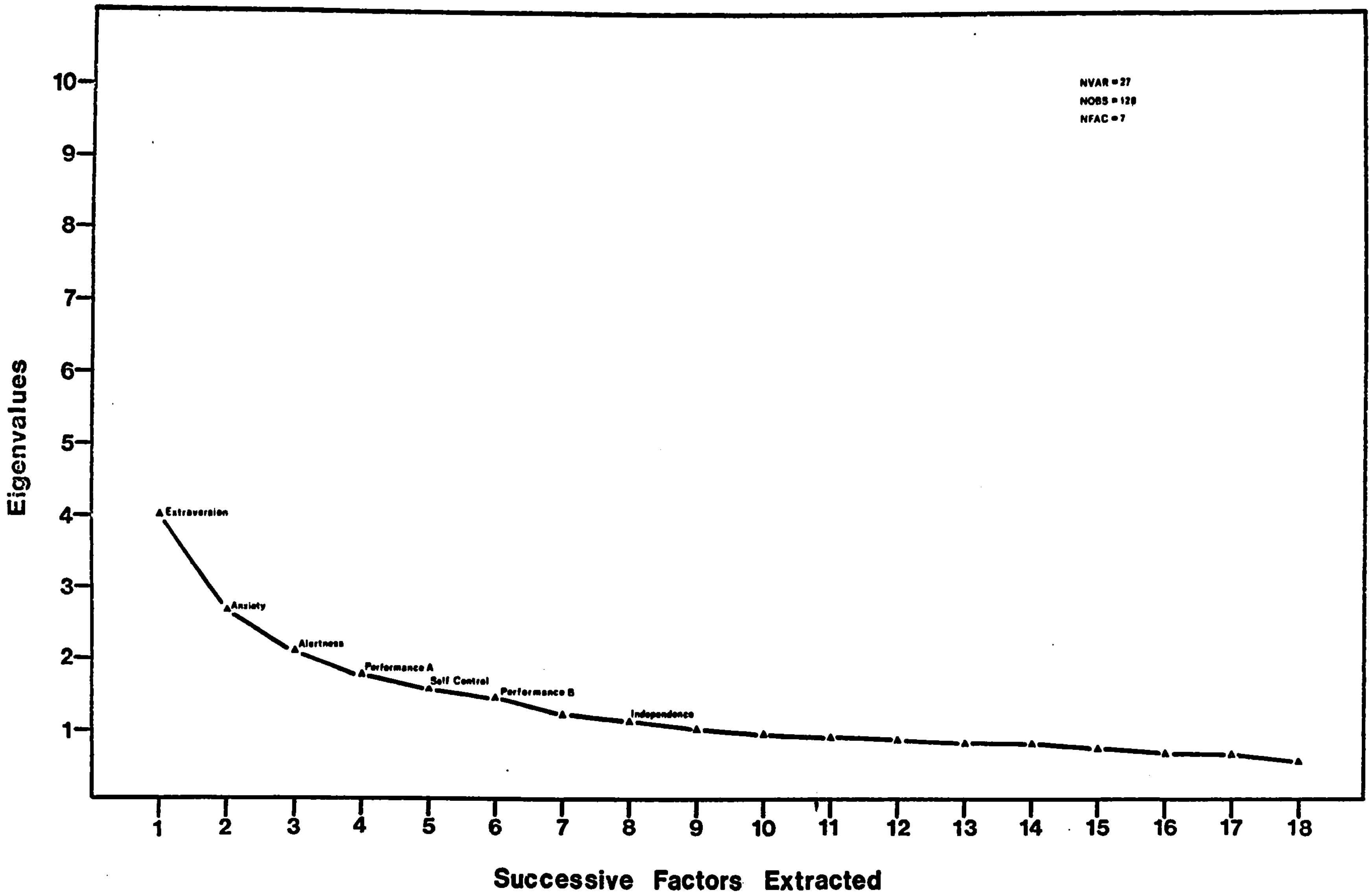
APPENDIX I (cont'd)

Variable Number	Source of Variable	Designation of Variable
81	Time Estimation	Error, Trial 10
82	" "	Mean Error
83	Finger Maze	Errors, Odd Trials
84	" "	" , Even Trials
85	" "	Total Errors
86	" "	Solution Time, Odd Trials
87	" "	" " , Even Trials
88*(26)	" "	Total Solution Time
89	Line Reproduction	Shortest Line, Aided Reproduction (AR)
90	" "	Range, Aided Reproduction (AR)
91	" "	Shortest Line, Unaided Reproduction (UR)
92*(27)	" "	Range, Unaided Reproduction (UR)
93	" "	Standard-Mid. Range, AR + Constant (20)
94	" "	Standard-Mid. Range, UR + Constant (20)
95	" "	[89-91] + Constant (20)
96	" "	[90-92] + " "
97	" "	[93-94] + " "

Note: (1) *Indicates variables retained in the Reduced Data Matrix (RDM), with RDM Variable Number shown in brackets.

(2) The MAT variables retained in the RDM were the combined Unitegrated and Integrated components of each erg or sentiment

(3) For the Regression Analysis only, Variables 18 and 19 were omitted from the RDM and replaced by $[\text{Anxiety vs. Good Adjustment}]^2$ and $[\text{Neuroticism}]^2$



APPENDIX II Eigenvalue Plot of the Principal Axis Factor Solution (FAC1Ø3)