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# The development of personality and its relation to learning

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## THE DEVELOPMENT OF PERSONALITY AND ITS RELATION TO LEARNING

#### by H. J. EYSENCK

#### The Experimental and the Pragmatic Approach

All organisms learn, even the lowliest; worms can be conditioned, and in our genetic laboratory we have just carried out studies on the fruitfly, Drosophila melanogaster, attempting to assess the genetic basis of its learning capacity. We tend to think of learning mainly in cognitive terms; to some theorists intelligence is identical with the ability to learn. Yet relationships between learning and intelligence have never been very high when put to the test (Woodrow, 1938; Birren & Woodruff, 1973; Carroll, 1975; Hundal & Horn, 1977), and similarly correlations between different tests of learning tend to be low. In such tests, rate-of-change is largely independent of IQ; this suggests that perhaps there are other factors which play an important role in learning, whether of the experimental, laboratory kind, or the everyday, scholastic kind.<sup>1</sup> There is now good evidence to show that personality factors play an important part in learning, and that this influence can be demonstrated equally well in the laboratory as in the classroom. The former type of experiment has the advantage that it can be better con-

<sup>1</sup> This paper deals with personality, while the preceding contribution by A. Jensen deals with intelligence. The distinction is important, but it should not be thought that the two aspects of individuality are entirely separated, even though correlations between them are mostly small or nonexistent. Mohan & Kumar (1976) and Goh and Farley (1977) have shown that there are interesting interactions between the two concepts; e.g. the former have shown that while introverts and extraverts have similar total scores on the Progressive Matrices test, extraverts have more items correctly solved among the easy items, introverts among the difficult items. Extraverts have more items wrong among the easy items, introverts among the difficult ones. Extraverts abandon items more frequently when these are difficult, introverts when they are easy. Extraverts do not attempt items that are difficult more frequently than introverts; the reverse is true for easy items. In other words, even when total scores are identical, extraverts and introverts behave in quite dissimilar fashion to achieve their equal scores. This point is made in considerable detail by Eysenck (1973b), who also goes into the theoretical rationale for a more analytical consideration of intelligence test results than these normally receive.

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trolled, that precise hypotheses can be put to the test, and that results are relatively unequivocal. The latter type of experiment has the advantage that the results are of practical importance, that they are obviously relevant, and that direct application is possible. Both types of research should be cultivated, and both should be run in tandem—we need to use the experimental laboratory approach in order to test specific hypotheses, some of which are thrown up by the school work, and we need the school work in order to see to what extent laboratory-based theories are viable in everyday life.

My contention would be that there is much that the experimental psychologist has discovered that would be of great use to the teacher in this connection; yet this point is often doubted by those who would have the task of applying the fundamental findings. This raises a profound question. In the physical sciences it is taken for granted that a technology is based on fundamental research (but see Ziman, 1976); in the social sciences this is by no means so. Here we have research psychologists, on the one hand, concerned with fundamental work on learning, memory, emotion, personality, and so forth; on the other hand we have educationists and teachers, psychiatrists and social workers, criminologists and judges, and all those people whose task it is to use psychological and sociological knowledge in their interaction with pupils, mental patients, criminals and others. Yet there is no intermediate group of 'psychological technologists' whose task it would be to translate the fundamental findings of the first group into language intelligible to the second, and to work out practical ways of using this knowledge in educating pupils better, curing neurotics and psychotics, or rehabilitating criminals. It is customary to hear complaints about the lack of relevance of fundamental psychological research; it seems to me that this lack of relevance is imaginary. What is needed is a group of psychological technologists whose task it would be to point out the relevance of this type of research, who would carry out applied research to demonstrate the way new methods of teaching, of treating mental patients, or criminals, could be put to use, and embody positive results in the teaching requirements of prospective teachers, psychiatrists, and criminologists and jurists. The recent success of behaviour therapy in the psychiatric field, and the development of a profession of clinical psychologists, illustrates both the promise of this approach, and the difficulties involved.

Prime among these difficulties is the fact that whereas new discoveries in the physical field, or in chemistry, enter upon an empty stage, so to speak, the stage is by no means empty where psychology is concerned. From time immemorial there has been a need to educate young people, to tend and try to cure the mentally ill, and to deal with criminals; thus the problems have always been recognized, and groups of people officially designated by society to deal with them. Hence any new discoveries in psychology have to become accepted by tradition-bound teachers, psychiatrists, jurists, and other members of ancient and honourable professions who jealously guard their birthright, and resent newcomers criticizing their efforts, and professing to be able to improve upon their methods of working! Psychology is a Johnny-come-lately in all these fields, and has to tread carefully because of the inevitable jealousy of entrenched professionals.

In this paper I shall try to fill this role of intermediary, looking at the kinds of ways in which personality influences the way people learn, and pointing out certain ways in which this knowledge could be of practical use to the educationist. My aim is more to kindle interest in psychological research than to be too specific about recommendations; these would in any case require far more applied research than has been forthcoming so far. But there is already a certain amount of such research, and where possible I shall quote examples. Psychology has proved its value in practical terms as far as psychiatric disorders are concerned; behaviour therapy is now the method of choice for the treatment of many neurotic disorders (Eysenck, 1973a). Outside the field of intelligence testing, psychology has not proved its value in the educational field in a similarly convincing manner. I hope very much that it will do so in time.

#### Personality and Scholastic Achievement

In applying personality concepts in the field of learning, we must first agree on the measures to be considered; I shall here concentrate entirely on two major dimensions of personality, namely neuroticism (N)-stability and extraversion (E)-introversion (Eysenck, 1967, 1976). These two dimensions emerge from practically every large-scale investigation of personality parameters; they are firmly anchored in physiological reality; and they have a strong genetic component. Furthermore, they are connected to psychological laboratory experiments through an explicit theory amply confirmed by numerous experiments. I shall not go into the theory, or the mode of measurement of these personality dimensions in any detail; if what I have said sounds too peremptory and dogmatic I must plead pressure of space, and refer the reader to the references given above for support of my position.

My first task will be to demonstrate that personality dimensions like E and N are indeed related to activities of interest to the educationist. Roughly speaking the evidence strongly supports the view that high scores on N tests nearly always work against scholastic achievement, although for the youngest groups the relation seems to be inverted, with high neuroticism/anxiety pupils having the higher achievement scores. Fig. 1 illustrates the relationships observed at three ages, i.e. at 12-13 years, at 13-14 years, and at student level (Leith & Davis, 1972). It will be clear that at the youngest age the low neuroticism pupils have the poorest achievement scores, in the middle age group both high and low neuroticism scorers have poorer scores than the average, while for the students it is the high scorers who have the poorest achievement scores. There is thus a perfect progression in academic failure, from the young to the student level. Except in the primary school, therefore, neuroticism works against scholastic achievement.

This is true, not only in the university, but also in the applied setting. Jessup & Jessup (1971) tested a group of 205 Royal Air Force pilots early in their training programme and compared their scores on E and N with their success or failure in passing out. Failure rates were as follows: stable introverts, 14 per cent; stable extraverts, 32 per cent; neurotic extraverts, 37 per cent; neurotic introverts, 60 per cent. These differences are quite large, and it should be remembered that they are independent of the selection techniques in use at the time. The study illustrates very powerfully the importance of personality for achievement. This importance is specially marked when selection for intelligence has already taken place, as for instance at university, in grammar schools or in the case of air pilot training; the exaggerated stress on selection for IQ, to the detriment of attention being paid to personality, has probably had very unfortunate effects on education.

In a similar manner, high E scorers seem to be handicapped as compared with low E scorers as far as secondary school and university education are concerned. In primary school high E



Fig. 1. Relationship between neuroticism and scholastic achievement at three ages: (a) 12-13 years, (b) 13-14 years, (c) college. From Leith, 1974.

scorers seem to do well, and even better than low E scorers (Eysenck & Cookson, 1969; Wilson, 1972; Elliott, 1972; Entwistle, 1972). The cause of this reversal from primary to secondary school is not precisely known, but it seems possible that it is related in part to the change from the free-and-easy atmosphere at primary school, which accords well with the extraverted, and possibly the anxious, temperament, to the more formal atmosphere at secondary school and university, which agrees better with the introverted temperament (Banks & Finlayson, 1973). In partial support of this suggestion may be cited a study in which children were tested at a school which combined primary and secondary classes under the same roof, and in which both were equally formal; here correlations with personality were similar for both the younger and the older children (Whitlock, 1969).

An interesting alternative theory for the reversal of the extraversion-attainment correlation has been suggested by Anthony (1973). There is good evidence that the time-course of the development of extraversion shows an increase up to the age of thirteen or fourteen years, followed by a decrease into middle age and beyond. Ability, on the other hand (as shown by conventional IQ scores) apparently continues to increase until the twenties (Bayley, 1970). These two different developmental courses would, according to Anthony, produce the observed cross-over relationships. Speaking of the personality development, he says that

a child who is consistently *early* in this development would at first be more extraverted than his age-mates, but he would reach his peak sooner than they, and in later years would be *less* extraverted (more introverted) than his age-mates. Similarly, a consistently late developer would in early years be more introverted than his age-mates, but in descending, late, from the peak, he would in these later years be more extraverted than his age-mates ... The occurrence of early and late peaks in the development of a measured characteristic tends to invert the rank order of individuals in the characteristic, i.e. it tends to reduce the retest reliability over the period where the peaks are occurring. This would account for the low re-test (stability) correlations in Eysenckian extraversion mentioned by Entwistle (1972, p. 146).

Anthony then invites us to suppose that, at any given time, a person who is ahead of his age-mates in the development of extraversion is also likely to be ahead in the development of ability, and that, similarly, a person who is behind in the development of extraversion is also likely to be behind in the development of ability. This is purely a supposition, though a natural one, which will enable us to make sense of the correlations between extraversion and ability. It follows, then, that in early childhood the child who is ahead in these developments will be high in ability and high in extraversion, whereas the child who

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is behind will be low on both, and therefore there will be a positive correlation between extraversion and ability. But as a group of children approach the age of thirteen, some among them who are ahead reach their peak extraversion early and start 'downhill' towards introversion, while they are still increasing in ability, for the peak of ability is still many years ahead. Since those ahead are still the most able but *not* now the most extraverted, the correlation is weakened. As the average children pass over their extraversion peaks, the correlation becomes zero; and when, after fourteen, most of the group is decreasing in extraversion, the children who are ahead are the least extraverted but the most able, while the children behind are the most extraverted but the least able; that is to say, the correlation between extraversion and ability in these (hypothetical) children is now negative.

Anthony goes on to review the literature in order to support the hypothesis just outlined; he shows that there is indeed considerable empirical support, but we shall not here discuss the details of this support. Of more interest is a later analysis carried out by Anthony (1977) in an attempt to come to even closer grips with the factors determining the interaction between personality and achievement/ability as a function of age. He used data from a longitudinal study of 266 children tested at 10-11 and again at 15-16 years of age.

The crude idea that the more able children become introverted while less able children become extraverted, may be reformulated as the idea that ability is correlated with decrease in extraversion. A second alternative . . . may similarly be reformulated in terms of extraversion being correlated with decrease in ability . . . Is it . . . that the more able children become introverted while the less able children become extraverted . . . or, alternatively, is it that the extraverts fall behind in the development of ability while the introverts make faster progress?

These alternative hyptheses become testable, using an ingenious formula devised by Anthony, and this he applies to the data, separating out scores on intelligence and on school attainment tests. Two conclusions emerge from his analyses.

(1) The more intelligent children, and those able in English, tended to become relatively more introverted than the less intelligent and the less able in English. (2) The more extraverted children tended to become less able in English and mathematics than the introverted children. Previously the change in extraversion-ability correlations could be hypthetically attributed to *either* of the two kinds of transformation envisaged in the introduction, whereas it is concluded here that *both* kinds of transformation are significantly involved.' The results suggest that the prevalence of one or other kind of transformation depends on the kind of ability which is tested. The correlation between introversion and the increasing relative success is presumably facilitated by private study which is an introverted type of behaviour (Banks & Finlayson, 1973). The correlation between intelligence and decreasing extraversion, on the one hand, may be attributed to the earliness versus lateness of development in the 10–16 year age group.

There are thus good hypotheses to account for the cross-over effect as far as extraversion is concerned; why do we find the same sort of thing for neuroticism? The answer is probably connected with the well-established finding that anxiety acts as a drive, the Yerkes-Dodson Law, according to which the relationship between drive and performance is curvilinear (inverted-U shaped), and the amount of anxiety generated by formal and informal teaching methods respectively. These points will be discussed in detail when we turn to the theories and experiments of Spence and his associates; here we may note simply that an explanation of the cross-over effects for anxiety-neuroticism can be found along these lines.

The correlations between personality and scholastic achievement are more marked in the higher reaches of secondary education, and at university, than in the lower reaches of secondary education; the reason probably is simply that differences in IQ, which would obscure the effects of personality, are less marked there. At university personality may give better predictions of scholastic achievement than does IQ-simply because selection has reduced the range of IQ among students (Wankowski, 1973). Correlations in different studies differ quite markedly; this is expected in view of different parameters obtaining in different studies (IQ range, mode of teaching, motivation, social class, etc.). Nevertheless, N is nearly always a disadvantage, and introversion an advantage, as far as scholastic achievement is concerned. This seems obvious on commonsense grounds; the high N scorer worries about his work, suffers from examination anxiety, and lets his 'nerves' interfere with his studies. The



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Fig. 2. Preferences for different types of university courses by students of different personality. From Wankowski, 1973.

extravert socializes, instead of concentrating on his work, seeks non-academic outlets (sport, sex) for his energies, and has difficulty in concentrating (extraverts score poorly on tests of vigilance in the laboratory). We shall look more closely into these suggested reasons for poor performance of high N and E scorers later.

Personality not only determines in part how well a student will do in his academic work; it also determines in part what particular subject he will study. Wankowski (1973) has shown that 'personality traits of neuroticism and extraversion are related to the students' choices of subjects of study.' Generally, stable people tend to congregate in the 'practically' biased courses and subjects of study, whilst those with neurotic tendencies predominate in 'people-oriented' areas of study. Introverts prefer theoretical and extraverts practical or 'peopleoriented' areas. Fig. 2 shows the trend among the 1965–66 and the 1966–67 student intakes of the University of Birmingham. The trends are very pronounced, and suggest major determinants in this largely unexplored field; personality clearly plays an important part in what a student studies, as well as in how well he does.

The Wankowski study is only one which indicates such relationships; the recent paper by Witkin *et al.* (1977) indicates similar relationships, although he used a test of field-dependence rather than a personality questionnaire in his work. Field-dependence is known to correlate with extraverted behaviour patterns, field-independence with introverted behaviour patterns, so that the agreement is not entirely surprising. What is interesting is that the Witkin study was carried out in a different country, and in a different educational system.

#### The Personality-Teaching Method Interaction

The findings so far considered are, as it were, macroscopic wholesale generalizations which are intuitively intelligible, and which make sense, but which lack the fine grain of causal scientific theories. In turning to the more microscopic experimental work, we pass through an intermediate zone, in which relatively specific predictions are made as to the respective reaction to certain educational methods of extraverts and introverts, stable and unstable students and pupils. The predictions are mediated through theoretical conceptions of these personality factors, and verification of the prediction helps to establish

the truth of these theories, just as falsification would serve to disprove them. In this sense we reach here a half-way house in the quest for strictly scientific study of educational issues related to learning, not quite microscopic enough to satisfy the experimentalist (there is too little control over many relevant variables), but sufficiently so to be acceptable to the theoretician. The work of G. O. Leith will be used to exemplify the power and relevance of this type of research.

We may start our consideration by asking a searching question about the usefulness and relevance of the information so far acquired. It is clearly true that extraverts and introverts, or anxious and stable children, differ in the degree to which they succeed at school and university, and that these relationships depend in part at least on age. How does this information help the teacher? Personality differences are largely innate, and even in so far as they are produced by environmental factors these are clearly almost entirely outside the range of effectiveness of the teacher (Eaves & Eysenck, 1975). Does this argue the case for therapeutic (or educational) nihilism? The answer is that while personality must be accepted as largely given by the teacher, he or she should be in a position to capitalize on the particular personality factors and aspects which enable children to succeed in given tasks. In other words, extraverted and introverted children differ profoundly in the ways that learning tasks can be presented to them optimally, and it is the task of the research worker to disentagle the optimal ways of teaching disparate groups of children, differing in personality as well as in ability.

Such an argument is often countered by the assertion that the literature shows pretty conclusively that different methods of teaching (unless quite extreme and eccentric) give pretty much the same result in follow-up, so that little credence can be given to suggestions of relying on such outmoded ideas. The criticism is based on fact; there are indeed relatively few studies demonstrating departure from the null hypothesis. The point here made is simply that this general finding is an artefact; methods A and B give similar results, not because they are equally good and useful, but because the effects are averaged over disparate groups, such as extraverted and introverted children. If method A favours extraverted children, and succeeds much better with them than does method B, while method B succeeds equally much better with introverted children, then the only statistic which enables us to discover this fact is an analysis of interaction effects—main effects will give the erroneous impression that there are no effects at all (Leith, 1974)! This fundamental point deserves illustration, and several examples are given below to demonstrate that this argument is not speculative, but factually based.<sup>2</sup>

Consider the differences between the so-called 'discovery' method and that of traditional direct instruction. Such comparisons as have been carried out to study the relative superiority of the one or the other have usually failed to disclose any marked differences. Leith (1974) proceeded to examine the possibility 'that the greater readiness of extraverts to become bored by routines but likely to respond to stimulus variation, and of introverts to be disturbed by changes of set but able to maintain attentiveness to a highly-prompted task, would result in a methods by personality interaction.' Teaching materials for a course in genetics (for naïve students) were carefully prepared to give equal amounts of learning and transfer in randomly chosen groups of students; 'the materials were so chosen as to cover a range of personal discovery, tolerance for uncertainty and error-making as well as a difference which may be described as plunging into the deep end or stepping into the shallow end of the pool.' Two hundred students took part in the experiment, and were tested one week, and again five weeks after the end of the course, with a series of largely transfer items. Non-anxious subjects were better learners than anxious subjects, but the major finding was a highly significant interaction effect between personality and method; this is illustrated in Fig. 3. On both testing occasions introverts and extraverts learned equally well on the average; thus there is no overall superiority of one method over the other. But extraverts learn much better than introverts with the discovery method, while introverts learn much better

<sup>2</sup> Such interactions appear to be much easier to discover in relation to personality than to ability. Bracht (1970), Cronbach & Snow (1969) and Gage & Unruh (1967) have commented on the absence of such interactions in the ability field. The studies reviewed below indicate that not only is it relatively easy to discover interaction effects in the personality field, but equally important such interactions can usually be predicted on the basis of theoretical considerations deriving from the theory of personality. The guess may be hazarded that ability-treatment interactions might be observed more frequently if personality were introduced as another variable, thus giving rise to ability  $\times$  treatment  $\times$  personality interactions. Obviously such triple interactions require complex experimental designs, and are only likely to be meaningful if the whole experiment is based on proper theoretical analysis of the problem.

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Fig. 3. Interaction of strategies of instruction (direct vs. discovery) with extraversion on two occasions of testing achievement and problem solving. From Leith, 1974.

than extraverts with the direct teaching ('reception') method. For the second test the difference in score between extraverts and introverts is 30 vs. 18, i.e. extraverts do almost twice as well as introverts! This is a tremendous difference; that for reception learning is greater for the one week period, but even there it is still only 4 points, rather than 12. This experiment illustrates very clearly the danger of comparing different methods of teaching without measuring personality at the same time, and looking for different reactions of different personality types to the methods of teaching under examination.

As another example of the interaction between personality, achievement, and conditions of learning and testing, consider an experiment performed by Leith (1972a) on 106 children who were given an intelligence test, tests of extraversion and neuroticism, and three verbal creativity tests.<sup>3</sup> Half the children

<sup>3</sup> Divergent thinking, while a cognitive ability, is related to personality through the extraverted temperament, just as Spearman (1927) hypothesized. Leith (1972b) and others have found evidence in favour of this view, and have also supported Hudson's (1966) finding linking divergent thinking with preference for arts subjects, convergent thinking with preterence tor science subjects. were given the creativity tests in a relaxed atmosphere, the other half were given the creativity tests in a moderately stressful manner (induced by instructions to 'do their best', to avoid delays, and by statements about the relation of the tests to academic ability). Extraverts and non-anxious children did better under reduced stress, introverts and anxious children under stress. The actual results are shown in Fig. 4; it will be seen that personality interacts significantly with conditions, in a manner predicted by Leith from the arousal theory of personality (Eysenck, 1967).

Yet another example is provided by a study in which Leith & Trown (1970) studied the optimal placing of rules in school learning tasks. The learning task was a programme on vectors from which rules were abstracted and given either before or after sections of the programme containing practice examples.



Fig. 4. Interaction of treatment (stress vs. non-stress) and personality; effects are shown separately for anxiety and introversion-extraversion. From Leith, 1972a.

In general, the evidence favoured superiority of rules following practice, but there was also a significant interaction with personality. Both post- and transfer tests showed that this occurred because the 'rules before' was significantly poorer than the 'rules after' condition for extraverts of both above and below average ability, while there was no significant difference between the treatments for introverts. The results are shown in tables 1 and 2; it will be seen that the treatment affects the extraverts, but not the introverts.

#### TABLE 1

Mean post-test scores of introverts and extraverts under two conditions of learning\*

Personality	Position of rules Before practice After practice Overall				
Introverts	54.75	52.56	53.66		
Extraverts	42.72	55.06	48.88		
Overall	48.74	53.81	51.27		
	$\sigma x_1 - x_2$	= 5.02; df = :	108		

\* From Leith, 1974.

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TABLE	2	
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Mean	transfer	test	scores	of	introverts	and	extraverts
	unde	r tw	o cond	itic	ns of learr	ung*	t i i i i i i i i i i i i i i i i i i i

D	Position of rules				
rersonanty	Before practice	After practice	Overall		
Introverts	39.75	36.88	38.31		
Extraverts	25.16	42.88	34.02		
Overall	32.45	39.88	36.17		
	σ x <sub>1</sub> — x <sub>2</sub>	= 6.33; df =	108		

\* From Leith, 1974.

Teacher training is another area in which the introduction of personality concepts can make important contributions. Consider an unpublished study by Leith and Britton, in which they experimented with the newly-developed technique of 'microteaching'. This is a system of teacher training by means of which individual skills of teaching are identified and particular

skills are practised by students who receive feedback about their performance. The complexity and stress of fully-fledged teaching situations are further reduced by employing small classes (e.g. five pupils) and brief practice-sessions (e.g. five to ten minutes). Thus the trainee is able to focus on one aspect of teaching at a time in order to gain mastery, defects in teaching performance are revealed in feedback sessions (usually by means of videotape playback), and errors can be overcome through further practice with different microclasses. In the experiment to be discussed, seminars were held with students of education, emphasizing two particular teaching skills-set induction and reinforcement. In addition to these seminars, students participated as pupils in microclasses of four students. They received instruction and, at the end of the 'lesson', completed a schedule which evaluated the teacher's performance. Half of the students, as well as their microclass participation, also had experience of microteaching. They prepared miniature lessons, delivered them in the television-studio classroom, and then, with the help of the teaching supervisor, analysed the videotape recording of their performance. Following this the 'teachers' taught their lesson again with a new group of students. A control group not receiving experience of microteaching completed the design of the experiment, which thus has three randomly selected groups of students: (a) controls, (b) students receiving microteaching only (microclass), and (c) students receiving microteaching and also practising microteaching with feedback (microteaching). Complex evaluation methods were used, separating out intellectual (A) and performance (B) aspects of teaching.

On the scales used, extraverts and introverts showed quite different results. Both did poorly in the control group, given conventional instruction, and both did well in the microteaching condition. The results for extraverts and introverts respectively are 17.83 and 19.38 for the controls, and 23.23 and 26.16 for the microteaching group; the two evaluation indices gave similar results, and are therefore not given in detail. For participation in the microclass, however, extraverts showed a powerful positive effect (26.00), while the introverts showed no effect at all (score 18.78). Thus the most effective way of employing this very expensive method of teacher training would seem to be one in which introverts are used as microteachers, and extraverts as microstudents only; this would optimize results, and, if the results of this study can be generalized, improve efficiency for both groups by something like 40 per cent. Obviously replication is required, and extension to other areas of instruction can at the moment only be based on extrapolation without a firm basis; nevertheless the main point remains that personality interacts with teaching method to a very significant extent.

Another area which shows marked personality interaction phenomena is that of paired learning, i.e. learning in a situation where two learners are paired with each other. Consider first a study by Leith (1974) in which pairing was on the basis of anxiety/neuroticism, pairs being either similar in score on this variable, or opposite, i.e. one anxious, the other stable. Table 3 shows the main results; it will be seen that quite etxraordinary improvements over the 'same' pairings are shown by the 'unlike' pairings. Opposite anxiety pairs showed something like a 100 per cent superiority over same anxiety pairs on the transfer test! (The pairs were also subdivided according to heterogeneity or homogeneity in ability; the figures in brackets refer to the

#### TABLE 3

## Comparisons of achievements and behaviour of same and different anxiety level pairs\*

(Heterogeneous ability pairs in brackets, homogeneous ability pairs without brackets)

Achieved	74%	more on the post-test
	(32%)	than same anxiety pairs
Achieved	98% (113%)	more on the transfer-test than same anxiety pairs
Spent	59% (36%)	more time in showing solidarity, raising other's status, giving help and rewarding than same anxiety pairs
Spent	121% (132%)	more time asking for orientation, informa- tion, confirmation, than same anxiety pairs
Spent	11% (20%)	less time in disagreeing, passively rejecting, withholding help than same anxiety pairs
Spent	49% (25%)	less time in showing antagonism, deflating other, asserting self than same anxiety pairs
	Achieved Spent Spent Spent Spent	Achieved  98%    Spent  (113%)    Spent  (36%)    Spent  121%    (132%)  (132%)    Spent  11%    Spent  49%    (25%)

\* From Leith, 1974.

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heterogeneous pairs.) Table 4 shows the results of a similar experiment, using extraversion-introversion instead of anxiety/ neuroticism. It will be seen that when working individually, introverts were significantly superior; this superiority vanished when the students worked in pairs. Homogeneous pairs here worked better than heterogeneous pairs, regardless of whether the pair was made up of two extraverts or two introverts. These results open up fascinating vistas of both research and educational practice.

#### TABLE 4

Achievements of students learning in homogeneous or heterogeneous personality pairs or as individuals<sup>®</sup>

Personality	Homo	Individuals					
Introverts		32.2	27.3	30.0			
Extraverts		30.6	27.7	25.4			
	Significance of difference (l-tailed)	N.S. s	N.S.	p<.01			
	Homogeneous Homogeneous	Homogeneous vs. heterogeneous pairs: p<.01 Homogeneous pairs vs. individuals: p<.025					

\* From Leith, 1974.

Pairing of heterogeneous children, one of them anxious, the other not, would be one way of actually combating the negative effects of anxiety; another way is suggested in an experiment by Trown & Leith (1975). Almost 500 boys and girls took part in the experiment which contrasted the effects of 'supportive' and of 'explorative' strategies in mathematics teaching in four junior schools, the mean age of the children being 10 years and 6 months.

In the case of the supportive strategy, the sequence employed, over each of the 12 sections of learning material, was that of teacher-provided statement of organizing principle, followed by related pupil activity with mathematical models, and subsequent restatement of principle by the teacher. Such statements were both spoken and written on the blackboard. The same activities with models were used in the exploratory strategy, but this time at the beginning of each section of the learning sequence. Each statement of principle by the teacher

was now delayed until pupils had been given the opportunity to perceive the relationship themselves and had been encouraged to attempt an appropriate generalization.

Results are shown in Table 5. 'Anxiety level distinguished between those who were able to profit greatly from the learnercentred exploratory approach and those whom it clearly handicapped . . . The teacher-centred supportive strategy, on the other hand, was almost equally effective at each level of anxiety.' Overall differences (i.e. neglecting the personality interaction) between strategies were minimal; thus neglect of the personality dimension would have led to the quite erroneous conclusion that strategies were identical in their effects. It may be noted that in this experiment there was an ability effect (in the expected direction) but no ability-treatment interaction. The results of the experiment, as the authors emphasize, are very germane to an evaluation of the Nuffield mathematics scheme, suggesting that this may improve the performance of some (non-anxious) children, and make worse the performance of other (anxious) children. Such a conclusion cannot of course be based on the results of a single experiment, and cannot be extrapolated to other subjects, but it does suggest the importance of proper experimental investigation of interaction effects.

TABLE 5 Strategy-anxiety interaction (by sex). Mean scores for retained learning\*

	Boys		Girls		All pupils	
	(N per cell = $40$ )		(N per cell $= 40$ )		(N per cell $= 80$ )	
•	Low anx.	High anx.	Low anx.	High anx.	Low anx.	High anx.
Supportive strategy	15.98	15.26	16.63	17.73	16.30	16.49
Exploratory strategy	20,30	12.33	18.30	14.25	19.30	13.29

\* From Trown & Leith, 1975.

#### Educational Consequences of Personality–Teaching Method Interaction

Some of these are discussed by Leith (1968, 1974), and his discussion is well worth taking seriously, although not all educationists would wish to follow him in one of his conclusions, namely that 'To go into possible differentiation features of subject matter organization by method by mode by personality by teacher interactions, of course, will require not specially trained, sharply sensitive, highly adaptable teachers but appropriately programmed computers—in addition to the best teachers we have.' Even if none of his conclusions and recommendations appeal, nevertheless he does at least succeed in pointing out the problems which are raised for education by the complex interactions between method of teaching and pupil personality interactions to which the best teachers have of course always been sensitive, but with which they have hitherto been able to deal only on an intuitive rather than a rational, experimentally supported basis. Here is what Leith has to say:

The evidence presented above does not lead to definitive conclusions which can be applied immediately with confidence in classrooms. It can be claimed, however, that the repeated findings of interactions between personality (as measured by neuroticism and extraversion scales) and instructional methods (defined in terms of both global differences and experimentally manipulable variations) require that educationists pay serious attention to the need for adapting learning situations to learners. It is probably a reflection on our teaching methods in schools, colleges and universities that general surveys of what characterizes good students have brought out that introverts are frequently higher in academic achievement. Lavin's (1967) and Eysenck's suggestion that it may have to do with extroverts' greater likelihood of engaging in social activities will not account e.g. for findings of the writer and his associates with programmed or quasi-programmed instruction tasks . . .

An examination of methods by personality interactions shows that extraverts are not intrinsically poorer students but students frequently taught by methods whose design favours introverts. To take one of Bloom's (1972) arguments further, in an age of educational innocence this may be tolerable. Beyond the stage of ignorance it becomes neglect or discrimination.

Besides a call for more intensive, ramified and rigorous research, however, what should and can be done? The answer is certainly not to stream by personality rather than, or in addition to, ability. The type of teaching system which uses class units as relatively homogeneous blocks is administratively convenient rather than educationally enlightened. The strategy implied by the recognition of these differences suggests, rather, an extension of the methods used in many infant schools—in other words 154

the provision of a variety of approaches, e.g. reading schemes and interactive situations, adapting methods to suit individuals by close monitoring of pupils' progress. The investigations of co-operative learning were a step towards finding tactics for individualizing instruction in destreamed, comprehensive school classes, providing not only learner-centred activities but continuous feedback, progress checks and optimization of the social environment of school learning. It may be noted that some of the learning tasks were undertaken by up to three classes in a single space and with a minimum of teacher supervision.

Indeed, if streaming by personality were carried out, the protocols from the interaction analyses of pairs, as well as the findings of Joyce and Hudson (1968) and Zussman and Pascal (1973), show that there would be a need to match teachers with classes having differing profiles. We have not yet, incidentally, acted on the finding that different types of teachers obtain better achievement in their pupils when teaching different types of instructional tasks (e.g. factual information, discursive ideas).

Especially but not exclusively, at university level, adaptive methods, or systems close to them, are becoming more widespread. Though they do not yet vary instructional provision to suit particular personality differences, such systems as Mastery Learning do maintain progress checks and, in some cases, switch students from e.g. verbal instruction to audio-visual. Clearly, too, it is possible to incorporate co-operative learning, small group activities or alternatively individual study in Mastery Learning. Again, the development of 'modular' instruction makes individual adaption feasible. Though there are other interpretations of 'module' in education one of them is the idea of a set of learning stimuli, activities and evaluations which is relatively self-contained. A course is made up of a collection of modules perhaps with additional, intervening activities. The point is that a module on say, osmosis can have alternative versions organized to induce personal discovery (if you shake the divided tray will the different-sized ball-bearings on either side of the narrow hole get evenly mixed up? and so on) or to give explanatory instruction. Pupils or groups of pupils would move from one module to another, revealing a need to take a different mode, to regroup, to change the sequence-pattern, and so on. Indeed. there is evidence that the differences in sequence of a modularized course give different results for pupils with different levels of N and E, one of the possibilities being to make one's own sequence given a flow chart, one a random arrangement and one a prestructured 'critical path'. A variable of importance was being told, or not being told, that a sequence was 'out of order'.

In brief, the answer proposed is that there should be redundancy of methods, monitoring of individual progress and, over a period of continuous evaluation (which could in some circumstances be self or peer evaluation), a choice of optimal strategy. This might imply forced-pace or competitive learning for some (to maintain a sufficiently high arousal potential), group cooperation, or self-paced learning for others, and the setting of appropriate levels of aspiration and difficulty as well as patterns of feedback and reinforcement which are appropriate.

#### Experimental Studies of Learning and Personality: Anxiety

We have now taken a cursory and even dogmatic look at two of the major sets of facts and theories which link personality study and education. We have seen that school and university achievement is strongly linked with such personality factors as introversion and stability, although such links are dependent in part on age, and we have seen that personality also determines preference for different types of subject matter, from the arts-sciences dichotomy to more detailed break downs of academic disciplines. That constitutes the most global account of the observed relationships. We have next looked at some of the various treatment-personality interactions which have been found in the educational field; it will have become clear that in many cases the main effects of different methods of teaching are much less important than are interaction effects with extraversion-introversion and neuroticism-stability. We shall now turn to a third, even more narrowly circumscribed set of facts, dealing with the strictly experimental study of learning, using laboratory methods and detailed academic theories to predict findings and account for them. Our presentation will commence with a theory which historically started much of this work, although as we shall see the theory is in part misleading, and has been replaced by a more convincing one. A more complete account of this theory, and its replacement, has been given elsewhere (Eysenck, 1973c; M. W. Eysenck, 1977); our account here must of necessity be brief.

The theory in question is Spence's adaptation of Hull's general learning theory: a good statement of the theory, together with a survey of the evidence, is given in a recent paper by Spence

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and Spence (1966). Taking into account only the most relevant concepts, we might simplify this theory by saying that  $D \times H =$ P, i.e. performance on a given task is a product of motivation (drive, D) and learning (habit, H). All these constructs are of course carefully defined in the Hullian system, and many others are introduced to take into account such factors as behavioural oscillation, reactive inhibition, and threshold levels; nevertheless, for our present purpose these must be neglected.

It may also be noted that theoreticians of widely different plumage have adopted rather similar formulae; Tolman, it many ways an outspoken critic of Hull's system, nevertheless comes to much the same conclusion (McCorquodale and Meehl, 1954). Spence now proposes to use this theory in order to bring personality into the Hullian formulation; his suggestion is that *anxiety acts like a drive*, so that persons who are characterized by strong anxiety are in fact in a state of high drive. (In Hull's system all drives summate to bring about the final drive state, D; this enables Spence to add anxiety to whatever other drives may be active in a given situation.) For the measurement of anxiety Spence habitually uses the Manifest Anxiety Scale (MAS), a conglomerate of anxiety-related statements from the Minnesota Multiphasic Personality Inventory (MMPI).

In his earliest work, Spence made predictions from his theory in relation to eyeblink conditioning; his argument was that in this situation, where a tone constituted the conditioned stimulus (CS) and a puff of air to the cornea the unconditioned stimulus (UCS), there would be no pre-existing habits to interfere with the simple establishment of a connection, through experimental pairing of the CS and the UCS, resulting in eye-blink when the tone was sounded. This being so, and all subjects starting out from a habit strength of zero, subjects with higher drive (high anxiety) should develop the conditioned response (closure of the eye) more rapidly than subjects with lower drive (little anxiety). The experimental literature supports this prediction with some regularity, although results may be negative when the conditions of the experiments are not made anxiety-provoking enough, e.g. through the provision of visual stimuli, such as electric apparatus, which may suggest shock and other fear- producing effects.

When we come to the learning of verbal material, or other complex matter, Spence comes into conflict with the Yerkes-Dodson Law. This states two things: (a) The relation between drive and performance is curvilinear, with optimal drive level being intermediate between very low and very high, and (b) the optimal drive level is lower, the lower the complexity of the material learned. There is much evidence for this law (also known as the inverted-U relation between drive and performance), but Spence approaches it from a novel point of view. According to him, the important variable is not complexity, but the actual verbal and other habits existing at the time of learning, and their relation to the material to be learned.

Suppose the subject of our experiment is required to learn the paired-associate item: Table-Fish. Clearly there are already in existence many other associations, such as Table-Chair, which have a fair degree of habit strength; the to-be-acquired association has to compete with these older ones. Drive multiplies impartially with existing habits, and if the to-be-learned habit has to compete with older established ones, then it will be the more difficult to learn, the higher the drive-for the simple reason that the high drive multiplies with the existing habit (which has high habit strength) and thus produces a strong performance potential. Unfortunately for the learner, of course, this performance potential is for the wrong (old-established) association; consequently he will find it all the more difficult to learn the new association, the higher his drive! Thus in complex learning, Spence makes predictions which depend on the strength of existing habits, as well as on the degree of drive; these existing habits may either be learned during the experimental session, which brings them under proper experimental control, or else they may have been acquired during the subject's past life, like the association between Table and Chair.

Spence would thus predict that new associations competing with older ones would be established more quickly in low anxiety subjects, because in these the older associations would have little performance potential because of the low drive. Gradually, however, this position would change as the new associations were in fact learned, and once their habit strength surpassed that of the older associations, they would be learned better by the high drive subjects. These predictions, and this analysis, are both clearly relevant to school learning, and it should be added that they may also be relevant to educational practices in other ways than simply in relation to personality differences; highanxiety drive can be induced even in low-anxiety subjects by threats, by punishment, or by other manipulations of the situa-

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tion in which the child finds himself. Thus a low-anxiety boy or girl in a high-anxiety situation may behave like a high-anxiety child in a situation not itself highly productive of anxiety; in this way the educationist can manipulate the environment to produce complex interactions with personality and performance.

Spence's theoretical account has been firmly related to the empirical side by a lengthy series of experimental studies. One of his first attempts to provide empirical content for his theories was in relation to serial maze learning; he assumed that at many choice points anticipatory or perseverative tendencies would be present to such a degree that the incorrect choice would be stronger than the correct one. It was therefore predicted that high-anxiety subjects would show a greater number of errors on the learning trials than low-anxiety subjects; he also expected to find a correlation between the rank order of the 'difficulty' of the choice points (as indexed by the total number of errors made on each) and the magnitude of the difference between the errors made by high-anxiety and low-anxiety groups. Most of the empirical studies have borne out Spence's predictions. Spence next turned to serial learning tasks, where again his predictions were largely borne out by the findings.

For various theoretical reasons, Spence gave up work on serial learning and concentrated rather on paired-associate learning, using non-competitive lists, i.e. lists containing a minimum of previously established associations. Here, predictions of quicker progress of high-anxiety groups were verified by several workers. Equally successful were other studies using to-be-learned associations which were already present in the minds of the subjects (e.g. Table-Chair); here again high-anxiety subjects did better. The obverse of this prediction, i.e. that when the established associations are different from the to-be-learned ones, then high anxiety subjects would be at a disadvantage, was also verified.

#### Anxiety and Drive Stimuli $(D_s)$

Work with children has been particularly concerned with the interaction between drive level and degree of intra-task competition; using motor learning tasks, Castaneda and his coworkers used a children's version of the Manifest Anxiety Scale (MAS) or manipulated the drive variable by means of time stress. These studies have given predominantly positive results. Altogether, the outcome of the studies surveyed (and many others not cited) has on the whole been favourable to the theory put forward by Spence; however, some results have suggested the need for an extension of the theory, by taking into account the importance of drive stimuli  $(S_D)$ . The inclusion of this concept in the system necessitates a brief theoretical retake.

Hull's system relies very much on primary drives (hunger, thirst, sex) and the reinforcement provided by drive-reduction (eating, drinking, intercourse); he also, however, postulates secondary drives and secondary reinforcements. Anxiety, on this view, is a term denotative of a secondary drive, and also a source of secondary reinforcement. As Hilgard (1956) puts it, 'the primary drive involved in this case is pain; neutral stimuli associated with pain give rise to 'fear' responses, very similar to responses to pain, and the proprioceptive consequences of these learned responses produce the drive stimulus ( $S_D$ ) that serves the secondary drive.'

This conditioned fear response is the psychologist's conception of 'anxiety'; the diminution of anxiety has the properties of reinforcement, and hence can serve to cause learning. Anxiety may be unique in having both these functions; few other examples come to mind of secondary *drives*, although there are many studies using secondary reinforcers (Cravens and Renner, 1970). Tokens which may be exchanged for food will act as secondary reinforcers for a hungry chimp, but they will only cause him to work when hungry (primary drive). Miller (1948, 1951), in a series of classical studies, showed, first, that neutral stimuli became fear arousing after association with noxious stimuli, and could serve as the basis for motivating an animal in a learning situation so that it strove to escape; and second, that reduction of the fear through cessation of the conditioned fear stimulus constituted a reinforcing event in that it led to the learning of the responses which it followed.

Drive stimuli are proprioceptive stimuli produced by the conditioned fear responses; in humans they are capable of being verbalized (introspected), and consist of such reactions as rapid heart beat, rapid breathing, blushing or blanching, muscular innervation, 'feeling sick', and in extreme cases micturition or even defecation. Other drive stimuli are associated with hunger or thirst, or with sexual deprivation; these are too well known to require description. Drive stimuli can become very strong, and may generate task-irrelevant behaviour which may interfere with the behaviour to be learned. 'The extensions of our notions 160

concerning drive and anxiety involved what might be called the "response interference hypothesis", the hypothesis that states that task-irrelevant responses which in some situations may interfere with efficient performance are more easily elicited in high than in low anxiety subjects' (Spence and Spence, 1966).

What Spence is telling us here is (a) that previously existing and competing habits are not the only handicap which retards efficient learning, but that drive stimuli may also be a nuisance by generating task-interfering behaviour—such as worrying about the result of an examination rather than getting on with it, or withdrawing from the anxiety-generating situation, or thinking that one might be suffering from a cardiac dysfunction. He also maintains (b) that high-anxiety subjects are more prone to suffer from these interfering effects of the S<sub>D</sub>, presumably because the D is so much stronger in them. This additional source of interference in high-anxiety subjects did not form part of Spence's original theory; it was incorporated in order to accommodate some criticisms presented by Child (1954), and the results of experimental studies which could not be explained simply in terms of the original theory. It should be noted that like D, so S<sub>D</sub> may help or hinder performance, depending upon whether the response tendencies instigated by  $S_D$  are compatible with the task to be performed, or not (Amsel, 1950; Amsel and Maltzman, 1950).

Spence and his associates have used three main types of anxiety-provoking situation: (a) ego-involving instructions, i.e. instructions that the task had a bearing on the subject's IQ, his scholastic standing, or his personality; (b) failure experiences as a means of producing stress; and (c) the use of noxious stimulation, e.g. electric shock. With the exception of the work using shock, which is very contradictory, the results are on the whole in line with the hypothesis. The importance of  $S_D$  seems as firmly established as the relevance of D (anxiety) in the pathology of learning.

The potential applications of these theories to educational, clinical and other applied uses are obvious, although, as Spence and Spence (1966) recognize, 'whether these results can be generalized to other measures of manifest anxiety, e.g. clinical judgements, will require empirical demonstration.' However that may be, there can be little doubt that Spence has made a major contribution to this field; nevertheless, there are a number of points on which he may be (and has been) criticized. Thus, use of the MAS has been criticized because it does not correlate at all well with physiological measures of emotional arousal or drive, which are believed to have greater validity and to be more fundamental, and it has been suggested that such physiological measures should be employed by preference instead of the MAS.

Possibly even more important as a source of confusion is Spence's failure to take into account the fact that the MAS is not a univocal measure of a single dimension of personality; it has been shown to be highly correlated with N (Neuroticism) and somewhat less highly with E (Extraversion) (negatively). These correlations are sufficiently high to indicate that all the variance of the MAS is in fact accounted for by these two personality dimensions. High MAS scorers are thus dysthymics, or introverted high-N scorers. In assessing the many studies summarized in the preceding paragraphs it is clearly impossible to answer the important question of whether the differences between high- and low-scoring subjects on the MAS are due to differences in N, differences in E, or both. Thus interpretation is impeded on what is really a crucial point, and further development hindered (Eysenck and Eysenck, 1969). As we shall see, the problems raised are quite important, and the writer's own theory, while using Spence's concept of anxiety as a drive, has developed along somewhat different lines, using both physiological hypotheses and more clearly univocal personality measures, such as the Maudsley Personality Inventory (MPI) and the Eysenck Personality Inventory (EPI).

#### Learning, Arousal and Personality

Essentially, Eysenck's (1967, 1976) theory postulates that neuroticism is mediated by the limbic system (visceral brain), which co-ordinates the activity of the autonomic system and is the physiological substratum for our emotional feelings. Extraversion-introversion differences are caused by the arousal state of the cortex, mediated by the ascending reticular formation in the brain stem, introverts being characterized by high resting arousal, extraverts by low resting arousal levels. Thus high-N scorers are seen as over-reactors to emotional stimuli, whether these are conditioned or unconditioned; introverts are seen as having high cortical levels of arousal. This split in the unitary conception of the 'activating' as opposed to the 'directing' aspect of human behaviour is of considerable importance; correspond-

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ing to it we have a possible association between Hullian 'drive' and cortical arousal (an identification adumbrated by Hebb), and the possibility that  $S_D$  might be more closely associated with the visceral-brain/autonomic-system loop. Eysenck (1967) also points out that these two systems are not independent; high emotional activation produces cortical arousal both through direct connections between hypothalamus and cortex and through interoceptive stimuli activating the reticular formation (see Fig. 5). In this theory, then, we would tentatively identify Spence's D with cortical arousal, and on the personality side with introversion; on this interpretation, then, the causal factor in the relations established by Spence between anxiety and learning would be borne by the introversion component, not the N component.

Some supportive evidence on this point is available from a study by Willoughby (1967), who repeated the Spence, Farber and McFann (1956) study on the relation between anxiety and



Fig. 5. Diagrammatic representation of the interaction between the limbic system (visceral brain) and the reticular-cortical arousal system. From Eysenck, 1967.

performance level in competitive and non-competitive pairedassociate learning; however, instead of using the MAS, with its 'contamination' of introversion, he used a pure measure of N or emotionality. He found the high-N subjects inferior to low-N subjects on the competitive paired-associate list, as expected on Spence's hypothesis; he also found high-N subjects inferior on the non-competitive list, which is clearly contrary to Spence's hypothesis. As he points out, 'one possible basis for the discrepancy is that the "introversion" component is the main factor in the MAS producing a performance differential on the noncompetitive pairs.' It seems likely that the guilty party responsible for this effect was the S<sub>D</sub> produced in susceptible (high-N) subjects by the testing situation. Willoughby also reported similar findings with eye-blink conditioning. It is unfortunate that with this one exception, studies of the Spence type have never used inventories measuring both N and E; our understanding of the dynamics of learning in relation to personality would be further advanced than they are in fact, had they done so.

This general theory mediates many predictions, but these are not at all as simple and straightforward as one might at first sight imagine. For instance, it might seem obvious that introverts, having superior cortical arousal, would therefore be superior to extraverts in learning and remembering. This prediction is indeed correct, but its verification is complicated by certain details of the physiological processes accompanying and underlying learning. According to the latest theory (John, 1967), the process of consolidation of the memory trace is of fundamental importance in all learning, and it in turn is profoundly influenced by the degree of cortical arousal obtaining at the time; the greater the degree of arousal, the stronger and more prolonged the consolidation process, and consequently the greater the permanence and accessibility of the memory traces laid down.

To these postulates, which essentially govern the transformation of short-term memory, conceptualized as a set of reverberating neural circuits, into long-term memory, conceptualized as a permanent chemical transformation of the cell material through some form of protein synthesis, must be added certain others (Walker, 1958; Walker and Tarte, 1963) concerned with what these authors call *action decrement*. As they point out:

during the active period (of consolidation), there is a degree of temporary inhibition to recall, i.e. action decrement (this negative bias against repetition serves to protect the consolidating trace against disruption). High arousal during the associative process will result in a more intensely active trace process. The more intense activity will result in greater ultimate memory but greater temporary inhibition against recall.

According to this theory we would therefore expect that extraverts, having low arousal and weak consolidation, would actually show better recall soon after learning, because in introverts the continuing consolidation process would interfere with recall; it would only be later on, when consolidation had ceased, that introverts would appear superior. What is predicted, therefore, is a cross-over effect, with extraverts demonstrating forgetting, and introverts reminiscence (improvement over time).

Several investigations are available to support the first part of the hypothesis, i.e. that linking extraversion to superior learning and memory ability when the interval between learning and recall is short. Results are remarkably unanimous, and have been reviewed in detail by Eysenck (1973c).

A proper demonstration of the cross-over phenomenon was given by Howarth and Eysenck (1968), in an experiment specially designed to test this hypothesis. From over 600 students, 110 were selected on the basis of their EPI scores as being extraverted or introverted, and having relatively low N scores. Seven pairs of Complex Verbal Coding tasks (CVC)\* of medium association value were used in four orders of presentation; the criterion of learning was that the correct response should be given to each item of the list during one consecutive presentation. The subsequent retention interval (up to 30 minutes) was occupied with the subject making up words out of a longer word. Recall intervals of 0, 1 min., 5 mins, 30 mins, or 24 hours were used with different groups of subjects, and a highly significant interaction between extraversion and recall interval was observed. Results are shown in Fig. 6: as predicted. extraverts have superior recall after short intervals, and inferior recall after long intervals. McLean (1968) and others have replicated this result.

A rather different approach to the study of personality-learning interaction to that described above was undertaken by McLaughlin and Eysenck (1967). This study was based on the hypothesis that the four personality groups (E + N +, E + N -, E - N + and E - N -) can be arranged along a

\* nonsense syllables

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Fig. 6. Recall as a function of extraversion-introversion and duration of learning-recall interval. From Howarth & Eysenck, 1968.

continuum of arousal, from the lowest (E + N-) to the highest (E - N +) with the other two intermediate. On the basis of the Yerkes-Dodson law, performance on a paired-associates nonsense syllable learning task should show the usual inverted-U shape when plotted on this continuum; for a difficult task the optimum point of this inverted-U should be shifted towards the low arousal side.

Two lists were constructed to meet the requirements of having stimulus members of high meaningfulness, low similarity and response members of intermediate meaningfulness and either high similarity or low similarity. Stimulus and response members of low similarity had a minimal number of letters in common, while the responses of high similarity all had the same vowel and one consonant in common. In all pairs similarity between stimuli and responses was minimized as much as possible. Sixty-four subjects were assigned to one of the personality groups; eight members of each group were given the easy list,



Fig. 7. Paired-associate learning for easy and difficult lists of four personality groups. From McLaughlin & Eysenck, 1967.

the other eight the difficult list. Results are shown in Fig. 7; extraverts perform better throughout, which is in line with

expectation, as testing immediately followed learning, and consolidation would thus have the maximal interfering effect on the introverts. Of greater interest is the fact that the second order interaction ( $E \times N \times$  difficulty) is also significant beyond the 1 per cent level; this is direct support for the hypothesis.

#### Personality and the Retrieval of Information

These lines of research have received an important theoretical impetus by the work of Michael Eysenck (1976) who suggested an even more analytic search for causal connections. In particular, he showed in a number of ingenious experiments that there appeared to be differences in *speed of retrieval* between introverts and extraverts over and above any differences in speed of learning. He provided evidence for a particular hypothesis the general form of which had been originally suggested by Broadbent (1971). According to this well-supported hypothesis, 'high cortical arousal has the effect of biasing the subject's search processes toward readily accessible, or functionally dominant, information more than is the case with lower levels of arousal.' As task difficulty increases, the accessibility of the required information decreases.

This hypothesis differs from others that have been offered previously in that its centres the effects of introversion-extraversion in the retrieval stage. At the experimental level, this hypothesis regards the length of the retrieval period as a variable of importance. With relatively inaccessible information and the short retrieval periods conventionally used in most of the studies, introverts should be at a considerable disadvantage to extraverts, as the results confirm. However, if sufficient time for retrieval is allowed, any advantage of extraverts over introverts should be attenuated.

Much empirical work has indicated that this hypothesis is strongly supported, but the actual experiments involved require too detailed a presentation to make it possible to discuss them here. The theory offers another explanation of the Yerkes-Dodson law, but it should not be assumed that any one of the offered explanations must exclude the others. It would seem that there are several different reasons for the curvilinear 'inverted-U' relations observed so often between drive (arousal) and learning (performance), and that the law itself is purely descriptive; which causal factors may be active in a particular learning situation depends very much on the situation itself.

The work and theory here considered refers to episodic memory; M. Eysenck has also offered an interesting theory relating to semantic memory. The two kinds of memory distinguished by experimental psychologists may be defined and described as follows: Episodic memory refers to memory for personal experiences and their temporal relations, while semantic memory is a system for receiving, retaining, and transmitting information about meanings of words, concepts and classification of concepts' (Tulving, 1972). Learning of serial or paired-associates lists would be examples of episodic learning; verbal or word fluency, or 'divergent thinking' tests, would be examples of semantic learning. We have already mentioned some of the studies using the semantic learning paradigm, showing that extraverts are able to recall more words from semantic memory satisfying various constraints than are introverts. Two hypotheses have been suggested for this fact. Either extraverts may be better at retrieval from semantic memory or, alternatively, they are less susceptible to output interference. (Output interference occurs when recall of items early in the output sequence interferes with recall of additional items in some manner, possibly because of sampling with replacement-Roediger, 1974.) The experimental evidence favours the former explanation, although again there is yet another alternative. It is possible that introverts retrieve information as rapidly as extraverts, but that they take longer to decide whether the retrieved information is appropriate, due to their greater cautiousness (Cameron & Myers, 1966). Here also there is some evidence, although not conclusive, to support the hypothesis that speed of retrieval is the major cause of individual differences in this field rather than cautiousness.

M. Eysenck (1976) concludes his review as follows:

In sum, the evidence indicates that there are substantial differences between introverts and extraverts in their performance on retention tests. Explanations accounting for these differences in terms of arousal have been fairly successful but need considerably more precision. The major obstacle to future progress appears to be a marked reluctance on the part of researchers to use the information processing concepts being developed by memory theorists in the design and interpretation of their experiments.

To which we may add that memory theorists, in turn, have been very slow to make use of personality constructs, such as extraversion, in their work, and that both memory theorists and personality theorists have neglected psychophysiological interpretations of the phenomena which both are investigating; important theoretical contributions such as the Walley and Weiden (1973) theory of lateral inhibition and cognitive masking have not yet found their way into the thinking of either side, although they hold out much promise for a unification of these three almost entirely separate fields of psychology (personality, learning and memory, psychophysiology). What is most needed is greater awareness of what is being done in fields other than one's own, fields which may hold the key to puzzles impossible to solve without such a wider look.

Does this rather technical experimentation, and the theories which direct it, help the educationist? Opinions will almost certainly be divided, but in essence it should be said that the more we learn about the fundamental processes of learning, retrieval, recall and recognition, the better should we be able to help our pupils and students to organize their schedules, provide them with reinforcement and motivation, and assess what they have in fact learned. The obvious and pronounced individual differences found between introverts and extraverts in respect to almost all the details of the learning process should alert the teacher to possible misconceptions and errors. Clearly introverts remember better in the long run, but are disadvantaged in the short run, while consolidation is still proceeding; if quizzed during this time, they may give the impression of not having paid attention. Extraverts may shine in the short period after learning, but will disappoint in the long run; also their retrieval mechanism is clearly superior. Both have strengths and weaknesses which could, with skilful guidance, be used or obviated. The known facts will suggest to the ingenious teacher many ways in which this knowledge can be used; unless we assume that teaching can proceed just as well in the absence of any knowledge about the learning process, or individual differences relating to it, we must conclude that the information contained in this vast mass of experimental material is not only relevant to teaching, but may be vital for any improvement in our techniques.

#### Learning, Socialization and Personality

Before turning to a more extended discussion of the ways in which psychological knowledge of the interaction between

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learning and personality can be useful to the teacher, a few words may be said concerning non-cognitive learning. Schools have always had the dual task of transmitting academic knowledge and teaching skills, on the one hand, and also of training character and transmitting social mores and other rules which society considers important for its preservation. Are individual differences in personality as relevant to the latter process as they are to the former? The answer would seem to be very much in the affirmative, as has been shown in some detail in Eysenck's (1977) book on Crime and Personality, which deals essentially with the relation between personality and antisocial conduct, both in adults and in children and adolescents; a more extensive review of the literature relating to the author's theory is available in Feldman (1977). Eysenck's theory, to put it very briefly and dogmatically, is that socialized behaviour is essentially acquired through a process of Pavlovian conditioning, in which behavioural acts considered 'bad', 'naughty', 'wicked', or 'disobedient' constitute the conditioned stimuli, and social retribution on the part of parents, siblings, peers, teachers and others, in the form of corporal or social punishment, constitutes the unconditioned stimulus producing pain, fear, anxiety and other undesirable unconditioned responses. Through many years of social conditioning the child gradually becomes socially conditioned, so that antisocial acts, or even their very contemplation, leads to the conditioned response of fear and anxiety; as a consequence, such acts are avoided. There are of course many qualifications and additions to this very crude model, but essentially it seems to fit a large number of experimental and observational facts.

It is very clear that individual differences must play a decisive part in this process, because sociological factors often blamed for antisocial conduct have not on the whole helped very much in explaining the known facts. Similar conditions of upbringing, even in the same family, do not produce similarity of outcome, and twin studies and studies of adopted children demonstrate the importance of genetic causes for antisocial and criminal conduct. Identical twins show more than four times as much concordance for criminal activity than do fraternal twins, and adopted children are much closer to their biological than their adoptive parents with respect to criminality. What suggestions does personality theory contain in explanation of these facts?

We have two major terms in our general theory of socialized

conduct as a consequence of early conditioning. These terms are conditioning itself, which as Pavlov already showed can be very fast, middling, or very slow; we would expect children who condition strongly and quickly to learn' socialized behaviour better than children who condition poorly and slowly. (It is of course assumed that a condition of ceteris paribus obtains; where it does not, suitable allowances have to be made.) The other term is the strength of the unconditioned response to the unconditioned stimulus, i.e. the fear/anxiety/pain reaction. This would be very likely to be much stronger in anxious/neurotic than in stable children, again assuming that other things are equal. As a consequence we would predict that antisocial children, adolescents and adults would predominantly come from the high E/high N quadrant, and this prediction has indeed been found to be verified in many studies-more readily with children and adolescents not incarcerated than with adult criminals in prison; it is possible that imprisonment affects personality in ways which reduce the relationship postulated. (There are other difficulties, such as the selective process of discovery,



Fig. 8. Mean scores and antisocial behaviour scale (ASB) and school misbehaviour (naughtiness-NA) scale of children above average on one, two or all three of the E, N, and P personality scales. After Eysenck, 1977.

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apprehension and incarceration.) There are also other factors involved on the personality side; thus the personality dimension of psychoticism (Eysenck & Eysenck, 1976) has been found to be closely related to antisocial conduct and psychopathic/criminal behaviour (Fig. 8). However, there seems to be ample evidence that antisocial behaviour is partly determined by genetic causes, mediated through personality factors such as N and E, and related to low cortical arousal (Hare, 1970).

It might be objected that perhaps the criminal behaviour, and the consequences which it invites, are responsible for the personality scores of the persons involved, rather than the other way around. This is not so. Burt (1965) reported a study in which 763 children were rated for E and N by their teachers at the age of ten; 15 per cent and 18 per cent of these children later became habitual offenders or neurotics, respectively, during a follow-up period of some thirty years. Of those who became habitual offenders, 63 per cent had been rated as high on emotionality/N, 54 per cent had been rated as high on extraversion, with only 3 per cent rated as high on introversion! Of those who became neurotics, 59 per cent had been rated as high on emotionality/N, and 44 per cent as high on introversion, with only 1 per cent rated high on extraversion. These figures agree very well with Eysenck's personality theory, and are free from the objection that personality measurement was post-dictive rather than predictive. Other follow-up studies have given similar results.

It would be erroneous to assume that because physiological and genetic factors are strongly involved with antisocial conduct, therefore nothing could be done to alter the behaviour of the children involved. This is quite wrong. Pavlov showed that some of his dogs could be conditioned very readily, i.e. in 2 or 3 pairings of the food and the bell; others needed 200 or even 300 pairings. There was therefore a marked genetic difference between individual dogs; indeed, there are genus differences also-Basenjis are natural psychopaths, almost impossible to condition, while German shepherd dogs are stable introverts, very easy to condition. But these differences do not make it impossible to condition even those dogs with the poor heredity; it will take much longer, but it can be accomplished. All that nature tells us is that given identical circumstances (ceteris paribus) different dogs show marked differences in conditionability; if we make circumstances different, e.g. by administering far more conditioning trials to the poor conditioners, then we can equalize things. On this principle Eysenck (1977) has formulated certain suggestions regarding socialization of children difficult to condition, but it would take us too long here to go into details concerning the processes involved. Again, brevity inevitably makes this section too dogmatic, but the major thrust of the argument will be clear.

## Practical Applications of Psychological Theories

We must now turn to a consideration of the general problem of application of such principles, laws, and findings as we have so inadequately summarized in this paper. This must ultimately be a task for educationists, rather than for an experimental psychologist, but a few possibilities may be worthy of discussion.

Selection. In the first place, then, we have the possibility of selection and/or advice. If it is true that personality traits like neuroticism and extraversion strongly contraindicate academic pursuits, particularly in certain areas, then perhaps it might be useful to use personality tests as part of a selection process. Such a suggestion would probably be more acceptable if phrased slightly differently, namely along the lines of advice. Selection by personality should not be mandatory, i.e. leading to enforced exclusion of persons in the high N/high E quadrant; what is envisaged is rather an advisory psychological school or university centre which would test all incoming students and, upon request, give advice on suitability-both as regards higher education generally, and upon concentration of interest on certain subjects or courses. It is our experience that many students welcome such advice, based on good statistical criteria; under such conditions, they will co-operate in the process and not invalidate their forms by faking good, malingering, or in other well-known ways.

Streaming and setting. In the second place, it seems likely that a second selection stage might with advantage be introduced in schools in the form of streaming or, preferably, setting. It does not seem too realistic (except in very large schools) to stream pupils by personality, but it might be useful to use the principle of setting for special assignments and novel teaching practices. Thus one part of the class (extraverts) might be set aside for teaching by discovery methods. Other possibilities will readily come to mind, and some have already been mentioned in the quotation from Leith.



Fig. 9. Two-factor representation of conduct and personality problems in children, showing breakdown into extraverted and introverted groups. From Eysenck, 1970.

Re-education. In the third place, we may have to consider the possibility of active intervention (re-education) when personality features (extreme anxiety, or extreme extraversion) produce difficulties in the school progress of the child, or even the adolescent student. It would be quite wrong to consider such re-education as psychiatric therapy; the methods which have proved most useful are not psychotherapy, or drugs, but behaviour therapy, i.e. a method or set of methods introduced by psychologists, on the basis of psychological principles and laboratory experiments (Eysenck & Rachman, 1964). Examination anxiety and school phobias (predominantly found in introverts); truanting and excessive bad and destructive behaviour (predominantly found in extraverts)-all these and many other undesirable manifestations of personality difficulties have proved readily susceptible to behavioural treatment, and facilities for such treatment should be part of every school and university.

Fig. 9 shows the results of a factor-analytic study of the correlations between different personality problems found in children, to illustrate the introversion-extraversion differences.

Ascertainment. In the fourth place, it seems desirable not to wait until such symptoms as those mentioned in the last paragraph occur, to make it quite obvious to everyone that a breakdown has occurred, but rather to anticipate possible difficulties by monitoring the children's personality development through repeated testing, perhaps once a year. Cost and time involved are minimal, and the accumulating body of information about the child's position and development could be of the utmost use to the teacher. It would enable him or her not only to anticipate possible difficulties and troubles, and take avoiding instead of remedial action; it would also enable him or her to suit more closely the method of instruction to the personality of the child. It would also enable him or her to see precisely what were the difficulties the child had to struggle with (e.g. retrieval in the case of introverted children; long-term memory in the case of extraverted children); and offer suggestions and help. Many a student has failed to do himself justice because no one told him that as an extravert (say) certain methods of study were superior to others, or that he could increase his cortical arousal usefully by nicotine or coffee, but would disastrously lower it by drinking alcohol.

Training. All these suggestions come to nought, of course, if we continue to train our teachers along lines which omit such

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psychological material as would be relevant to an understanding of individual differences, of learning and retention, and of their interaction and physiological basis. Teacher training colleges often pay lip service to the importance of psychology, but introduce their pupils to nothing more solid than ill-digested snippets of psychoanalysis and incorrectly understood principles of psychometric testing. What is lacking are the most up-to-date modern theories of learning and personality which have been alluded to several times in this paper; without proper instruction in these the teacher will not be in a position to make use of such help as knowledge of his or her pupils' personality can bring. Beginning with textbooks of educational psychology, a thorough overhaul of the teaching of psychology to educationists is overdue. When it is said, often despairingly, that psychology has nothing much to contribute to education, then this statement is usually made with reference to the most widely used textbooks and teachings of educational psychology. It may be true of what the student is taught there; it would not be true of more modern findings.

Research. It is well known that fundamental discoveries do not issue in practical applications until after a lapse of something like fifty years, at least in the physical sciences. In the social sciences what is often found is that alleged 'discoveries' are prematurely applied in the practical sphere, without the time-consuming process of applied research to discover the optimal method of application, with results which tend to discredit the fundamental research. It seems necessary to plead here for a much greater body of applied research, carried out by psychological and educational 'technologists' intermediate between fundamental research workers and teachers, and familiar with the theories and facts of the former, and the problems and practices of the latter. It is the absence of such a body of research workers which has delayed the use of such psychological information as we already possess; it would be unrealistic to think that teachers could directly absorb and put to practical use the abstruse knowledge contained in the technical psychological journals. Intermediate, applied forms of research, properly designed and executed (a difficult and complex area of research in itself) are vitally necessary if psychologists and teachers are ever to get on to speaking terms with each other.

In conclusion, then, it may be said that modern psychology

has made considerable strides towards a better understanding of the relationship between personality and learning, as well as in the understanding of both personality and of learning and retention. It is unfortunate that little of this knowledge has penetrated to the teachers training colleges, or the courses on psychology there taught. There is certainly a great need for the class of technologists mentioned at the beginning of this paper, to mediate between the ivory-tower research worker, with his incomprehensible jargon, and the teacher faced with the very real and actual problems of the classroom. Ideally this technologist-mediator should be the person providing the teaching and doing the applied research in the teachers training colleges or in the institutes of education. It is to be hoped that in the future they will see their role in this light, and transmit such knowledge as the psychologist provides to the teacher who may need and use it. In the past this process has certainly not functioned too well; this failure may be responsible for the widespread unfavourable attitude of teachers to academic psychology. The facts suggest that this attitude is only partly justified.

#### References

- Amsel, A. (1950). The effect upon level of consummatory response of the addition of anxiety to a motivational complex. Journal of Experimental Psychology. 40: 109-15.
- Experimental Psychology. 40: 109-15. Amsel, A., and Maltzman, I. (1950). The effect upon generalised drive strength of emotionality as inferred from the level of consummatory response. Journal of Experimental Psychology. 40: 563-9.
- Anthony, W. S. (1973). The development of extraversion, of ability, and of the relation between them. British Journal of Educational Psychology. 43: 223-7.
- Psychology. 43: 223-7. Anthony, W. S. (1977). The development of extraversion and ability: an analysis of Rushton's longitudinal data. British Journal of Educational Psychology. 47: 193-6.
- Banks, O., and Finlayson, D. (1973). Success and Failure in the Secondary School. London: Methuen.
- Bayley, N. (1970). Development of mental abilities, in P. H. Mussen (ed.), Carmichael's Manual of Child Psychology, vol. 1. New York: Wiley.
- Birren, J. E., and Woodruff, D. S. (1973). Human development over the life span, in P. B. Baltes and K. W. Schaie (eds), Life-span Developmental Psychology: Personality and Socialization, pp. 305-37. New York: Academic Press.
- Bloom, B. S. (1972). Innocence in education. School Review. 80: 333-52.

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Bracht, G. H. (1970). Experimental factors related to aptitude-treatment interactions. Review of Educational Research. 40: 627-45.

Broadbent, D. E. (1971). Decision and Stress. London: Academic Press.

Burt, C. (1965). Factorial studies of personality and their bearing on the work of the teacher. British Journal of Educational Psychology. 35: 368-78.

Cameron, B., and Myers, J. L. (1966). Some personality correlates of risk taking. Journal of General Psychology. 74: 51-60.

Carroll, J. B. (1975). Fitting a model of school learning to aptitude and achievement data over grade levels, in D. R. Green (ed.), The Aptitude-Achievement Distinction. New York: McGraw-Hill

Child, I. L. (1954). Personality. Annual Review of Psychology. 5: 149-70.

Cravens, R. W., and Renner, K. E. (1970). Conditioned appetitive drive states. Psychological Bulletin. 73: 212-20.

Cronbach, L. J., and Snow, R. E. (1969). Individual differences in learning ability as a function of instructional variables. Research Report, Stanford Univ.

Eaves, L., and Eysenck, H. J. (1975). The nature of extraversion: a genetical analysis. Journal of Personality and Social Psychology. 32: 102-12.

Elliott, C. D. (1972). Personality factors and scholastic attainment. British Journal of Educational Psychology. 42: 23-32.

Entwistle, N. J. (1972). Personality and academic attainment. British

Journal of Éducational Psychology. 42: 137-51. Eysenck, H. J. (1967). The Biological Basis of Personality. Spring-field: C. C. Thomas.

Eysenck, H. J. (1970). The Structure of Human Personality. London: Methuen.

Eysenck, H. J. (1972). Personality and attainment: an application of psychological principles to educational objectives. Higher Education. 1: 39-52.

Eysenck, H. J. (1973a). Handbook of Abnormal Psychology. London: Pitman.

Eysenck, H. J. (1973b). The Measurement of Intelligence. Lancaster: Medical and Technical Publisher.

- Eysenck, H. J. (1973c). Personality, learning and anxiety, in H. J. Eysenck (ed.), Handbook of Abnormal Psychology. London: Pit-
- Eysenck, H. J. (1974). Personality and learning-the experimental approach. Personality and Academic Progress, Conference Proceedings. London: Association of Educational Psychologists.

Eysenck, H. J. (1976). The Measurement of Personality. Lancaster: Medical and Technical Publisher.

- Eysenck, H. J. (1977). Crime and Personality. 3rd edition. London: Routledge & Kegan Paul.
- Eysenck, H. J., and Cookson, D. (1969). Personality in primary school children: I. Ability and achievement. British Journal of Educational Psychology. 39: 109-22.

- Eysenck, H. J., and Eysenck, S. B. C. (1969). Personality Structure and Measurement. London: Routledge & Kegan Paul.
- Eysenck, H. J., and Eysenck, S. B. G. (1976). Psychoticism as a Dimension of Personality. London: Hodder & Stoughton.
- Eysenck, H. J., and Rachman, S. (1964). The Causes and Cures of Neurosis. London: Routledge & Kegan Paul.
- Eysenck, M. W. (1976). Extraversion, verbal learning and memory. Psychological Bulletin. 83: 75-90.
- Eysenck, M. W. (1977). Human Memory. London: Pergamon. Feldman, M. P. (1977). Criminal Behaviour: A Psychological Analysis. London: John Wiley.
- Gage, N. L., and Unruh, W. R. (1967). Theoretical formulations for research on teaching. Review of Educational Research. 37: 358-70.
- Goh, D. S., and Farley, F. H. (1977). Personality effects on cogni-tive test performance. Journal of Personality. 96: 111-22. Hare, R. D. (1970). Psychopathy: Theory and Research. London: John Wiley.
- Hilgard, E. R. (1956). Theories of Learning. New York: Appleton-Century-Crofts.
- Howarth, E. and Eysenck, H. J. (1968). Extraversion, arousal, and paired-associate recall. Journal of Experimental Research in Personality. 3: 114-16. Hudson, L. (1966). Contrary Imaginations. London: Methuen.
- Hundal, P. S., and Horn, J. L. (1977). On the relationship between short-term learning and fluid and crystallized intelligence. Applied Psychological Measurement. 1: 11-21.
- Jessup, G., and Jessup, H. (1971). Validity of the Eysenck Personality Inventory in pilot selection. Occupational Psychology. 45: 111-23.
- John, E. R. (1967). Mechanism of Memory. New York: Academic Press.
- Joyce, C. R. B., and Hudson, L. (1968). Student style and teacher style: an experimental study. British Journal of Medical Education.
- 2: 28-31. Lavin, D. E. (1967). The Prediction of Academic Performance. New York: John Wiley.
- Leith, G. O. (1968). Age, personality and learning aptitudes. Impact of Science on Society. 18: 169-77.
- Leith, G. O. (1972a). The relationships between intelligence, personality and creativity under two conditions of stress. British Journal of Educational Psychology. 42: 240-7.
- Leith, G. O. (1972b). Personality, intellectual style and study background. Afdeling Onderzoek en Ontwikkeling von Wetenschappelijk Onderwijs. Rijksuniversiteit, Utrecht.
- Leith, G. O. (1974). Individual differences in learning: interactions of personality and teaching methods, in Personality and Academic Progress, Conference Proceedings, pp. 14-25. London: Association of Educational Psychologists.
- Leith, G. O., and Davis, T. N. (1972). Age changes in the relationship between neuroticism and achievement. Research in Education. 8: 61-9.
- Leith, G. O., and Trown, E. A. (1970). The influence of personality

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and task conditions on learning and transfer. Programmed Learning. 7: 181-8.

- McCorquodale, K., and Meehl, P. E. (1954). Edward C. Tolman, in W. K. Estes et al. (eds), Modern Learning Theory. New York: Appleton-Century-Crofts.
- McLaughlin, R. J., and Eysenck, H. J. (1967). Extraversion, neuro-ticism and paired-associate learning. Journal of Experimental Research in Personality. 2: 128-32.
- McLean, P. D. (1968). Paired-associate learning as a function of recall interval, personality and arousal. London: unpublished Ph.D. thesis.
- Miller, N. E. (1948). Studies of fear as an acquired drive: 5. Fear as motivation and fear-reduction as reinforcement in the learning of new responses. Journal of Experimental Psychology. 38: 89-101.
- Miller, N. E. (1951). Learnable drives and rewards, in S. S. Stevens (ed.), Handbook of Experimental Psychology. New York: Wiley.
- Mohan, V., and Kumar, D. (1976). Qualitative analysis of the performance of introverts and extraverts on standard Progressive Matrices. British Journal of Psychology. 67: 391-7.
- Roediger, H. L. (1974). Inhibiting effects of recall. Memory and
- Cognition. 2: 261-9. Rushton, J. (1966). The relationship between personality characteris-tics and scholastic success in 11-year-old children. British Journal of Educational Psychology. 36: 178-84.

- Spearman, C. (1927). The Abilities of Man. London: Macmillan. Spence, K., Farber, I. E., and McFann, H. H. (1956). The relation of anxiety (drive) level to performance in competitional and noncompetitional paired-associates learning. Journal of Experimental Psychology. 52: 296-305.
- Spence, J. T., and Spence, K. (1966). The motivational components of manifest anxiety: drive and drive stimuli, in C. D. Spielberger (ed.), Anxiety and Behaviour. London: Academic Press.
- Trown, E. A., and Leith, C. O. M. (1975). Decision rules for teaching strategies in primary schools: Personality-treatment interactions. British Journal of Educational Psychology. 45: 130-40.
- Tulving, E. (1972). Episodic and semantic memory, in E. Tulving and W. Donaldson (eds), Organization of Memory. London: Academic Press.
- Walker, E. L. (1958). Action decrement and its relation to learning. Psychological Review. 65: 129-42.
- Walker, E. L., and Tarte, R. D. (1963). Memory storage as a function of arousal and time with homogeneous and heterogeneous tests. Journal of Verbal Learning and Verbal Behaviour. 2: 113-19.
- Walley, R. E., and Weiden, T. D. (1973). Lateral inhibition and cognitive masking: a neuropsychological theory of attention. Psychological Review. 80: 284-302.
- Willoughby, R. H. (1967). Emotionality and performance in competitional and non-competitional paired-associates learning. Psychological Reports. 20: 659-62.
- Wankowski, J. A. (1973). Temperament, Motivation and Academic

Achievement. Birmingham: University of Birmingham Educational Survey and Counselling Unit.

- Whitlock, R. V. (1969). A further study of the effects of emotional arousal in learning. University of London: Unpublished Ph.D. thesis.
   Witkin, H. S. et. al. (1977). Role of the Field-dependent and Field-
- Witkin, H. S. et. al. (1977). Role of the Field-dependent and Fieldindependent cognitive styles in academic evolution: a longitudinal study. Journal of Educational Psychology. 69: 197-211.
- Wilson, J. A. (1972). Personality and attainment in the primary school. II. Personality structure and attainment of 10-year-olds. Research in Education. 7: 1-10.
- Woodrow, H. (1938). The relation between abilities and improvement with practice. Journal of Educational Psychology. 29: 215-30.
  Ziman, J. (1976). The Force of Knowledge. London: Cambridge
- University Press. Zussman, D. R., and Pascal, C. E. (1973). The interaction of divergence and convergence of students and teachers with personality
- gence and convergence of students and teachers with personality and instructional variables affecting educational outcomes. Paper presented at the A.E.R.A. annual meeting.