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EXTRAVERSION, NEUROTICISM, AND VERBAL REASONING ABILITY AS DETERMINANTS OF PAIRED-ASSOCIATES LEARNING

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Predictions based on theories of verbal learning proposed by Spence and Eysenck were compared by using a non-competitive list of paired-associates formed from seven synonym pairs, and a competitive list formed by pairing each of the seven S words with a R word with which it was not synonymous. Each list was presented in a $2 \times 2 \times 2$ design to groups of primary school children differing in extraversion, neuroticism, and verbal reasoning ability. Performance on both lists was related to ability level and extraversion, and these relationships did not interact with the stage of learning. It is concluded in support of Eysenck's theory that differences in extraversion are of importance in determining performance on such tasks.

Eysenck (1973) has reviewed the mass of verbal learning studies designed to test aspects of Spence's theory (Spence, 1956, 1958; Spence & Spence, 1966; Taylor, 1956) that performance is related to differences in drive level as measured by the Manifest Anxiety Scale (MAS) (Taylor, 1953). He concluded that an interpretation of these studies is extremely difficult because the MAS is a factorially complex measure correlating with two major orthogonal factors of personality, $-0{\cdot}3$ to $-0{\cdot}4$ with extraversion, and 0·6 to 0·7 with neuroticism. In his own theory (Eysenck, 1965, 1967, 1973), Eysenck separates MAS-type 'anxiety' into two components: cortical arousal, measured by personality differences in extraversion, and autonomic activation, measured by personality differences in neuroticism. It is hypothesized in a similar manner to Walker's theory of action decrement (Walker, 1968), that the greater cortical arousal of introverts than of extraverts will cause a stronger and more prolonged consolidation process resulting in better ultimate memory but a temporary interference with performance.

Jensen (1964) carried out a complex factor analytic study of various serial learning and short-term memory tasks which showed clearly that extraversion played a more prominent role than neuroticism. Extraversion was positively correlated with superior performance on most of the tasks in the battery, and had a loading of 0·41 on the general factor running through various short-term learning tasks. Jensen concluded that there is some common genotype underlying extraversion and learning ability, and suggested that extraversion is related to resistance to interference due to response competition.

Support for the hypotheses of Eysenck and Jensen has been obtained from a number of paired-associates learning experiments. Howarth & Eysenck (1968) used a paired-associates task of seven CVCs of medium association value, and found that extraverts learnt the list better and showed superior recall after intervals of up to 5 min., but that introverts were superior at longer intervals of 30 min. and 24 hr. McLaughlin (1968) used a list of 12 paired associates with three-letter words as stimuli and 40 per cent association value nonsense syllables as responses. He also found that extraverts performed better in learning the list, although he failed to

find support for the predicted interaction effect when comparing varying recall intervals of up to seven days. In a study comparing the effect of recall intervals of 2 min. and 24 hr. on paired-associates learning of single digits paired with nonsense syllables, McLean (1968) obtained psychophysiological measures of within-subject arousal, and imposed conditions of high or low arousal through the use of white noise in order to induce high arousal in the experimental group. The expected cross-over effect occurred when both methods of comparing arousal were considered, the high arousal group recalling more at the longer interval and the low arousal group more at the shorter interval. McLean compared the within-subject arousal measures with differences in arousal hypothetically measured by extraversion–introversion, in terms of the inverse-U curve relating arousal to performance. With increasing arousal, as measured psychophysiologically, performance decreased when the recall interval was 2 min. For the delayed recall interval, the optimal arousal category was the high arousal associates of the control group, while the same associates for the experimental group remained postoptimal for that recall period. On the other side of the inverted-U, low arousal associates for both noise conditions were suboptimal for the 24 hr. recall interval. The comparison between extraverts and introverts produced a remarkably similar pattern to this arousal–recall relationship found as a function of time. Introverts recalled fewer correct associates than extraverts when tested 2 min. after paired-associates presentation but recalled more a day later. From his extensive experiment, McLean concluded that the consistency and similarity with which personality derived arousal influences the magnitude of paired-associates recall as a function of time, compared to physiologically recorded arousal changes, adds considerable weight to the notion that introverts function at a higher state of cortical arousal than extraverts.

Howarth (1969) compared the susceptibility of extraverts and introverts to response interference by generating response competition within a five-pair word-list by twice changing the S-R combinations after the previous form of the list had been learnt. Extraverts performed slightly better on the first two list combinations, and much better on the third list in which response competition was hypothesized to be at a maximum. McLaughlin & Eysenck (1967) constructed an easy and difficult list of seven CVC pairs with identical stimuli but different responses, so that in the former list the responses were of low similarity to each other, but in the latter were of high similarity to each other. Extraversion was related to good performance on both lists, although the relationship was stronger in the difficult list where response competition was involved.

McLaughlin & Eysenck also showed a complex relationship between performance and extraversion and neuroticism considered in combination. According to Eysenck's physiological theory (Eysenck, 1967), a high level of arousal, in addition to being characteristic of introverts, is also automatically produced on the occurrence of strong emotion in the individual. From this McLaughlin & Eysenck hypothesized, in terms of the well-known inverse-U relationship between arousal and performance, that for the easy task stable extraverts (SEs) would be at suboptimal, and neurotic introverts (NIs) at superoptimal arousal levels, and that both groups would therefore perform less well than the intermediate groups of neurotic extraverts (NEs) and stable introverts (SIs). On the difficult task they predicted that a lower level of

arousal would be optimal, and hence that a relative improvement in performance would be expected for the SEs and a relative decline for the NIs. The predictions concerning both lists were upheld. Very similar results were obtained by Allsopp & Eysenck (1974) who used a non-competitive and competitive list of paired associates taken from a study by Spence *et al.* (1956). On the non-competitive list the SEs and NIs were again inferior in performance to the NEs and SIs, and on the competitive list the hypothesized low arousal group of SEs showed the best performance. However, as was the case in the McLaughlin & Eysenck study, the NIs, who were assumed to be the group with highest arousal, and were predicted to provide the worst performance, did not in fact do so. In both studies the SIs showed the worst performance on the competitive list. Allsopp & Eysenck (1974) also obtained MAS scores for all subjects, and divided them into low, medium and high scorers. No support was obtained for the original findings of Spence *et al.* that high drive subjects, as measured by MAS scores, performed better on the non-competitive list, and worse on the competitive list, than low drive subjects. There was, however, a marked tendency for medium scoring subjects to perform worse on the competitive list than subjects with either high or low MAS scores.

In extending the Spence–Taylor theory of emotionally based drive, Spielberger (1966) has pointed to the importance of considering the interactive effect of anxiety and intelligence on performance. Katahn (1966) replicated the first complex serial learning study in which the differential effects of anxiety as a function of task difficulty were noted (Taylor & Spence, 1952). Katahn found that when subjects with high and low task ability, as measured by a test of mathematical aptitude which correlated with performance, were considered separately, high anxiety was facilitating for high ability subjects, but for those with low ability it made no difference. In Taylor & Spence's original study which had used subjects of still lower ability, the low anxiety subjects had provided the best performance. Katahn argues that there are certain tasks in which high ability may operate to lower the effective difficulty, so that high anxiety may facilitate the learning of an assumed difficult task.

In studies which have considered both extraversion and neuroticism, the former dimension has more consistently been shown to correlate with differences in remembering and learning. A similar finding has been obtained with respect to the effect of personality on the academic achievement of primary schoolchildren (Eysenck & Cookson, 1969). Extraverts were found to do better scholastically and on verbal reasoning tests than introverted children. Further, stable children did better than neurotic ones, but here the relationship was far less strong. These studies, in conjunction with those showing the effect of anxiety to be dependent on ability level (Katahn, 1966; Spielberger, 1966), suggest that future work should consider individual differences on at least three dimensions. Thus the present study was designed to consider simultaneously the effects of extraversion, neuroticism and ability level on non-competitive and competitive paired-associates learning tasks.

Table 1. *S-R pairs of non-competitive and competitive word lists*

Non-competitive list		Competitive list	
S	R	S	R
Broad	Wide	Broad	Hard
Difficult	Hard	Difficult	Strong
Powerful	Strong	Powerful	Quick
Mad	Insane	Mad	Old
Ancient	Old	Ancient	Wide
Rapid	Quick	Rapid	Gigantic
Enormous	Gigantic	Enormous	Insane

METHOD

Subjects

The subjects were third- and fourth-year primary school children aged 9 to 11 years, who were selected following preliminary testing on a new personality questionnaire for children, the JPQ (Eysenck & Eysenck, 1973) from which scores for E and N were obtained, and on Verbal Test D, a verbal reasoning test produced by the National Foundation for Educational Research. The latter test was chosen as probably the most suitable of the commonly used mental ability tests to predict performance on the lists of paired associates. Different schools were used to select subjects for the two word lists. Subjects with scores of 18 on E or 10 or 11 on N were not selected for testing. According to whether they scored above or below these cut-off points on E and N, the remaining subjects were categorized as stable extraverts (SEs), neurotic extraverts (NEs), stable introverts (SIs) or neurotic introverts (NIs). Each personality group was further divided into high and low ability levels, so that each paired-associates list was presented to eight groups of subjects in a $2 \times 2 \times 2$ design (two levels of extraversion, two levels of neuroticism and two levels of ability, eight subjects per group). For the non-competitive list, subjects were categorized to be of high ability if their verbal reasoning score was 35 or above, but for the competitive list were so categorized if their score was 25 or above. While this difference in cut-off point, which approximately reflects the difference in the mean verbal reasoning scores of the samples from which subjects for the two lists were selected, probably indicates an overall difference in ability, it is also partly due to the children in the school from which the first sample was drawn having had regular experience on similar tests.

Word-lists

Seven pairs of synonyms were chosen as being of suitable difficulty for children of the age range under consideration. The non-competitive list was formed from the synonym pairs, and the competitive list by pairing each S word with a R word from one of the other synonym pairs. These lists, which were presented in three different random orders to prevent serial learning, are shown in Table 1.

The lists were set up in block capitals on 16 mm. film and presented on a screen by back projection from a 'Specto' projector. A digit timer was used to control the rate of presentation, each S word being presented for a 1·67 sec. anticipation interval, and each R word for 2·33 sec. There was a 4 sec. inter-trial interval.

Testing

The subjects were tested individually in a small, semi-darkened room. The children were told that there would be a prize for the child in each class who made the most successful anticipations of the R word. They were encouraged to guess if they were not sure as no credit would be lost for incorrect responses. The subjects were first tested on a practice list consisting of three orders of the pairs cat–dog, table–chair and salt–pepper, until they were performing perfectly and it was clear to the experimenter that they fully understood what was required of them. The subjects were then given either 10 trials on the non-competitive, or 19 trials on the

Table 2. *Analysis of variance on total error scores in the non-competitive list*

Source	D.F.	M.S.	*F*
Ability	1	2704·00	24·87***
E	1	1660·56	15·27***
N	1	52·56	< 1
Ability × E	1	52·56	< 1
Ability × N	1	855·56	7·87**
E × N	1	6·25	< 1
Ability × E × N	1	729·01	6·70*
Residual	56	108·74	

* $P < 0{\cdot}05$. ** $P < 0{\cdot}01$. *** $P < 0{\cdot}001$.

Table 3. *Analysis of variance on total error scores in the competitive list*

Source	D.F.	M.S.	*F*
Ability	1	1580·06	3·50
E	1	2025·00	4·49*
N	1	132·25	< 1
Ability × E	1	68·07	< 1
Ability × N	1	689·07	1·53
E × N	1	1369·00	3·04
Ability × E × N	1	95·05	< 1
Residual	56	451·02	

* $P < 0{\cdot}05$.

competitive list. At the completion of testing each child was told that he had done well, and was encouraged not to talk about the experiment to his classmates as this would spoil his own chance of winning the prize.

Results

The first trial was not scored as any success on this was due to guessing. Hence error scores were obtained for nine trials on the non-competitive and 18 trials on the competitive list. For each list a 2 × 2 × 2 analysis of variance was undertaken on the total error scores to compare the eight groups formed from the two levels each of ability, E and N. These analyses are presented in Tables 2 and 3. To help interpret the results of the analyses, the performance on both lists of the four personality groups at each level of ability is shown in Fig. 1.

Table 2 shows that on the non-competitive list both verbal reasoning ability and extraversion are strongly related to good performance. The analysis of variance term for the interaction between ability level and neuroticism shows that for high ability subjects a high level of neuroticism improves performance, but that for low ability subjects it worsens performance. However, the significance of the ability × E × N interaction term, and the differences between the personality groups shown in Fig. 1, show that more complex relationships held in the present experiment. The superiority of high N over low N scorers in the high ability group was due to the markedly poor performance of the SIs, while the inferiority of high N scorers in the low ability group was due to the exceptionally poor performance of the NIs. Table 3 shows that for the competitive list extraversion is the only factor to reach significance. The variability in performance between subjects was so high

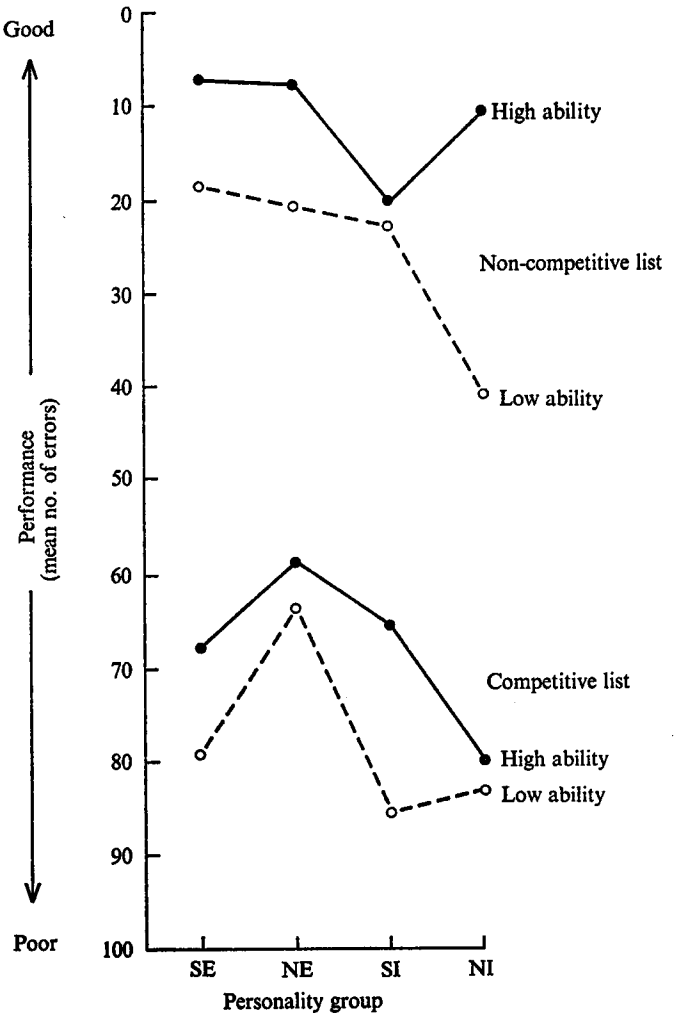

Fig. 1. Performance on paired-associates lists of four personality groups at two levels of ability.

that the two levels of ability, the differences between which are certainly not due to chance, are not shown to be significantly different by the analysis of variance.

As the subjects were selected for testing merely according to their scores in relationship to the cut-off points, the groups were not perfectly matched on the independent variables used in the analyses of variance. It is debatable whether any further matching is required to accurately interpret the results, for any differences between the groups on the independent variables will reflect differences holding in the population; however, it could be questioned whether the significant personality effects are artifacts due to group differences in ability level. For each list a 2 × 2 analysis of covariance was undertaken to compare the four EN groups (16 subjects per group) taking verbal reasoning score as the covariate. Significant effects were found for E ($P < 0{\cdot}005$) on the non-competitive list, and borderline significant effects for E ($P < 0{\cdot}1$) and for the E × N interaction ($P < 0{\cdot}1$) on the competitive

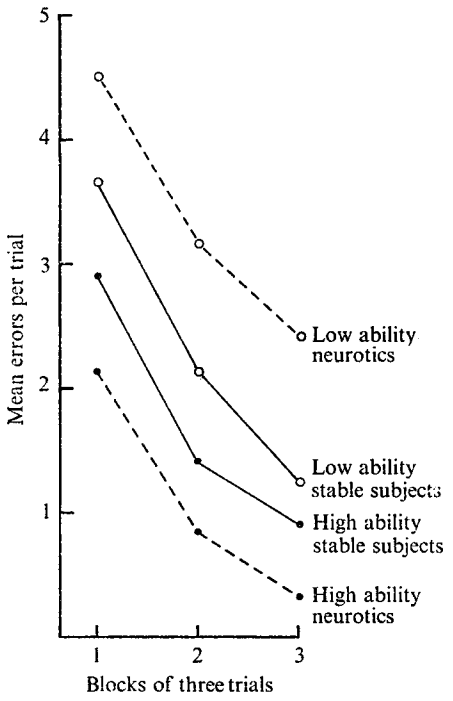

Fig. 2

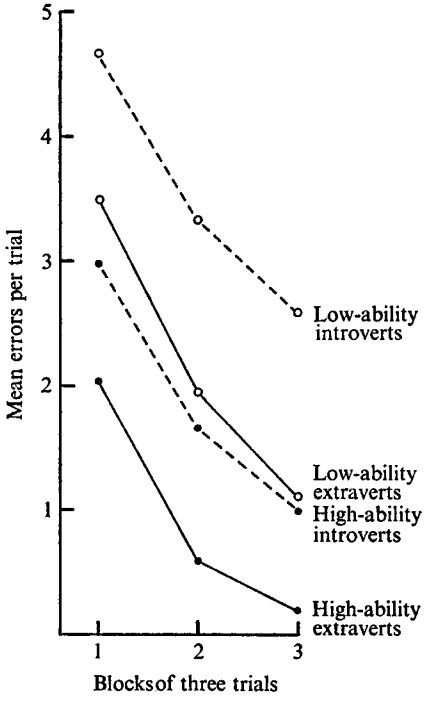

Fig. 3

Fig. 2. Non-competitive list: performance over blocks of three trials for high and low ability stable and neurotic subjects.

Fig. 3. Non-competitive list: performance over blocks of three trials for high and low ability extraverts and introverts.

list. A comparison of these results with those shown in Tables 2 and 3 suggests that partialing out ability level slightly reduces the strength of the extraversion effect. This would be expected on the basis of the established relationship between extraversion and verbal reasoning (Eysenck & Cookson, 1969).

To check for possible interaction effects between individual differences and the stage of learning, error scores for each task were calculated separately for three successive blocks of trials. Fig. 2 shows changes in performance over blocks of three trials for high and low ability stable and neurotic subjects on the non-competitive list, and Fig. 3 shows the changes for high and low ability extraverts and introverts. Figs. 2 and 3 show that the effects found in the analysis on the overall performance (see Table 2) do not vary with the stage of learning. This was confirmed by an analysis of variance in which the total error score was subdivided into the errors made on each block of three trials. None of the terms for interactions with the Trials effect reached significance. Figs. 4 and 5 show the changes in performance on the competitive list over blocks of six trials for high and low ability stable and neurotic subjects, and for high and low ability introverts and extraverts. Figs. 4 and 5 show that the only change in relative performance over trials is between ability levels. Again this was confirmed by an analysis of variance in which the total error score was subdivided into the errors made on successive blocks of three trials. The only

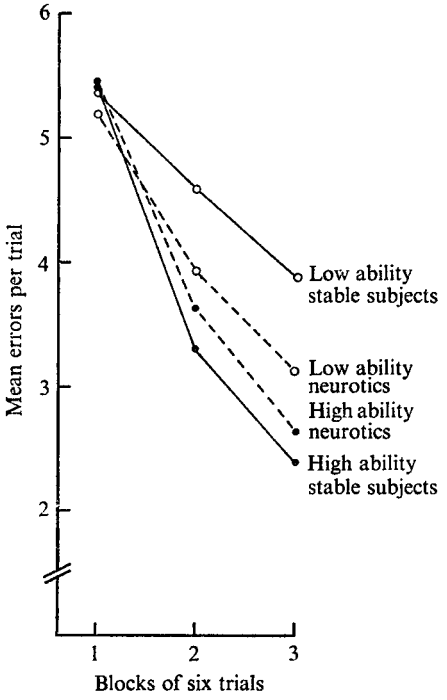

Fig. 4

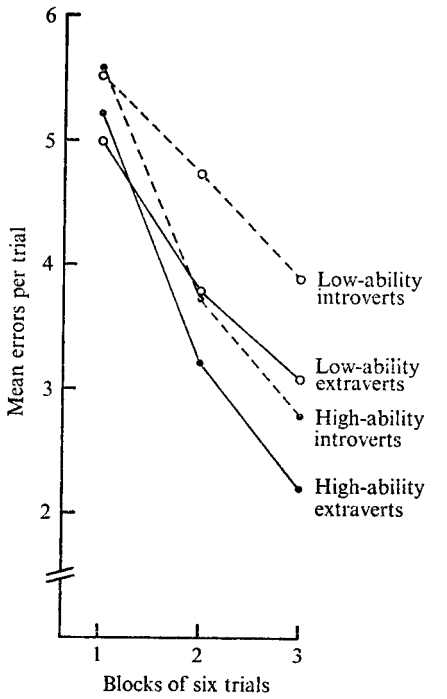

Fig. 5

Fig. 4. Competitive list: performance over blocks of six trials for high and low ability stable and neurotic subjects.

Fig. 5. Competitive list: performance over blocks of six trials for high and low ability extraverts and introverts.

significant interaction with the trials effect was ability × trials ($P < 0{\cdot}05$). The low ability subjects perform as well as those with high ability during the early stages of learning, but this effect is the same for all personality groups.

DISCUSSION

The analyses of variance show that in addition to ability, extraversion is related to good performance on both the non-competitive and competitive lists. The clearer relationship between errors and extraversion for the non-competitive than for the competitive list casts doubt on Jensen's suggestion that extraverts are particularly at an advantage when response competition is involved (Jensen, 1964). On the competitive list, there is no evidence for the effect of neuroticism considered either independently or in interaction with ability level. The results for the non-competitive list provide some support for Spence's theory when Katahn's suggestion is followed and task difficulty is considered as a function of ability (Katahn, 1966). Whereas Katahn's results suggested that in a complex situation high ability lowers the effective difficulty so that high anxiety will facilitate performance, it could be argued on the basis of the present results that low ability increases the effective difficulty of the non-competitive list so that a high level of neuroticism worsens performance.

These findings are difficult to interpret, however, for at both levels of ability three of the personality groups performed about equally as well, the differential effect of neuroticism at the two levels being due to the exceptionally poor performance of the SIs at the high ability level, and of the NIs at the low ability level.

The data provide little support for the suggestion that performance in non-competitive and competitive paired-associates tasks can be explained in terms of the inverse-U relationship between arousal and performance. Fig. 1, and the borderline significant E × N interaction effect, suggests the possibility of such a relationship for the competitive list, with neurotic extraverts being at an optimal level of arousal, and arousal being hypothesized on the basis of Eysenck's theory to increase through the personality groups from SEs to NIs. However, for this to be a compelling explanation it would be necessary to have found an optimum level of performance on the non-competitive list for a personality group hypothesized to be at a higher level of arousal than the NEs, and this is clearly not indicated by the results.

The only evidence for interaction effects between personality types and the stage of learning is the finding that in the early stages of learning the competitive list low ability subjects perform as well as high ability subjects. It is possible that the minor role of neuroticism in determining performance is due to the 4 sec. S-R cycle used in the present testing situation being too long to differentially affect the neurotic and stable subjects. Jensen (1962), with a serial rote learning task presented at either a 2 sec. or a 4 sec. rate, found that low N subjects were not affected by the difference in length of interval but high N subjects did much worse at the shorter interval. Young school children probably do not find such a testing situation, which they tend to view as a competition, as stressful as do students who are usually used as subjects, and who see their performance as reflecting on their intellectual ability. In retrospect, a shorter S-R cycle could usefully have been used with these subjects in order to create additional stress. Thus the failure to replicate with neuroticism earlier findings using the MAS as a measure of anxiety cannot be taken to cast doubt on the replicability of the mass of studies supporting Spence's theory, or some later studies showing the interactive effect of anxiety and intelligence on both overall performance and different stages of learning (Gaudry & Spielberger, 1970; Katahn, 1966; Spielberger, 1966).

It can be concluded from the relationships between extraversion and good performance on both word-lists, in conjunction with the absence of any interaction between extraversion and ability level, that extraversion is of importance in determining performance in both non-competitive and competitive learning situations for subjects varying considerably in ability. It is hoped that these results, which extend to subjects of a far wider range of ability than is generally considered, the findings of earlier studies in support of Eysenck's theoretical arguments concerning the effect of extraversion on verbal learning tasks, will encourage experimentalists to take into account this important personality dimension.

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REFERENCES

ALLSOPP, J. F. & EYSENCK, H. J. (1974). Personality as a determinant of paired-associates learning. *Percept. mot. Skills* **39**, 315–324.

EYSENCK, H. J. (1965). A three-factor theory of reminiscence. *Br. J. Psychol.* **56**, 163–181.

EYSENCK, H. J. (1967). *The Biological Basis of Personality*. Springfield, Ill.: Thomas.

EYSENCK, H. J. (1973). Personality, learning and 'anxiety'. In H. J. Eysenck (ed.), *Handbook of Abnormal Psychology*, 2nd ed. London: Pitman.

EYSENCK, H. J. & COOKSON, D. (1969). Personality in primary school children. 1. Ability and achievement. *Br. J. educ. Psychol.* **39**, 109–122.

EYSENCK, S. B. G. & EYSENCK, H. J. (1973). Test–retest reliabilities of a new personality questionnaire for children. *Br. J. educ. Psychol.* **43**, 126–130.

GAUDRY, E. & SPIELBERGER, C. D. (1970). Anxiety and intelligence in paired-associate learning. *J. educ. Psychol.* **61**, 386–391.

HOWARTH, E. (1969). Extraversion and increased interference in paired-associate learning. *Percept. mot. Skills* **29**, 403–406.

HOWARTH, E. & EYSENCK, H. J. (1968). Extraversion, arousal, and paired-associate recall. *J. exp. Res. Person.* **3**, 114–116.

JENSEN, A. (1962). Extraversion, neuroticism and serial learning. *Acta psychol.* **20**, 69–77.

JENSEN, A. (1964). *Individual Differences in Learning: Interference Factor*. Washington: U.S. Department of Health, Education and Welfare, Project Report no. 1867.

KATAHN, M. (1966). Interaction of anxiety and ability in complex learning situations. *J. Person. soc. Psychol.* **3**, 475–479.

MCLAUGHLIN, R. J. (1968). Retention in paired-associate learning related to extraversion and neuroticism. (Paper presented at Midwestern Psychological Association Convention, Chicago.)

MCLAUGHLIN, R. J. & EYSENCK, H. J. (1967). Extraversion, neuroticism and paired-associates learning. *J. exp. Res. Person.* **2**, 128–132.

MCLEAN, P. D. (1968). Paired-associate learning as a function of recall interval, personality and arousal. (Unpublished Ph.D. thesis, University of London.)

SPENCE, J. T. & SPENCE, K. W. (1966). The motivational components of manifest anxiety: drive and drive stimuli. In C. D. Spielberger (ed.), *Anxiety and Behaviour*. London: Academic Press.

SPENCE, K. W. (1956). *Behaviour Theory and Conditioning*. New Haven: Yale University Press.

SPENCE, K. W. (1958). A theory of emotionally based drive (D) and its relation to performance in simple learning situations. *Am. Psychol.* **13**, 131–141.

SPENCE, K. W., FARBER, I. E. & MCFANN, H. H. (1956). The relation of anxiety (drive) level to performance in competitional and non-competitional paired-associates learning. *J. exp. Psychol.* **52**, 296–305.

SPIELBERGER, C. D. (1966). The effects of anxiety on complex learning and academic achievement. In C. D. Spielberger, (ed.), *Anxiety and Behaviour*. London: Academic Press.

TAYLOR, J. A. (1953). A personality scale of manifest anxiety. *J. abnorm. soc. Psychol.* **48**, 285–290.

TAYLOR, J. A. (1956). Drive theory and manifest anxiety. *Psychol. Bull.* **53**, 303–320.

TAYLOR, J. A. & SPENCE, K. W. (1952). The relationship of anxiety level to performance in serial learning. *J. exp. Psychol.* **44**, 61–64.

WALKER, E. L. (1968). Action decrement and its relation to learning. *Psychol. Rev.* **65**, 129–142.

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