EXTRAVERSION AND THE ACQUISITION OF EYEBLINK AND GSR CONDITIONED RESPONSES¹

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A summary is given of studies relating eyeblink and GSR conditioning to the personality dimension of extraversion (E). It is found that extraverts are poorer in eyeblink conditioning when conditions favor the development of inhibition, as by the use of partial reinforcement; they do not differ from introverts when conditions are such as to preclude the development of inhibition. Extraverts are poorer in GSR conditioning when relatively mild stimuli are used, but do not differ from introverts when very strong stimuli are used, making impossible the development of cortical inhibition. They are also poorer than introverts when discrimination learning is involved, facilitating the growth of inhibition. Correlations between conditioning and personality appear to be dependent on the suitability of experimental conditions. These findings have implications for the problem of the generality of the hypothetical factor of "conditionability."

There are two main theories linking classical conditioning with personality. Spence and Taylor (1951) and Spence and Spence (1964) have argued for a positive association between conditionability and anxiety (Nneuroticism); the experimental work relating to this hypothesis has been reviewed quite recently by Spence (1964). Eysenck (1957) has put forward the hypothesis that conditioning would correlate with introversion (I). This hypothesis is based on two major theoretical assumptions: (a) Extraversion (E) is a phenotypic set of behavior patterns which is related to genotypic differences in the relative ease of arousal of cortical excitation and inhibition, extraverts showing greater inhibition, introverts greater excitation ² (Claridge & Herrington, 1963; Eysenck, 1963a, 1963b; Savage, 1964; Shagass & Schwartz, 1963). (b) Cortical inhibition depresses conditioning and facilitates extinction; this assumption follows directly from Paylov's theoretical concepts and experimental demonstrations. It would also be expected that cortical excitation would facili-

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² The terms "excitation" and "inhibition" are used in a sense very similar to that described by Diamond, Balvin, and Diamond (1963). tate conditioning, provided that the optimum degree of excitation had not yet been reached. As this provision is unlikely to be fulfilled in normal, rested subjects more stress has been laid on the inhibitory postulate.

The considerations mentioned above suggest immediately the experimental parameters which would produce the predicted correlations between E and eyeblink conditioning. Conditions productive of inhibition are (a) partial as compared with complete reinforcement, (b) weak as opposed to strong CS and UCS, (c) discrimination learning as opposed to single stimulus conditioning.

The general point was made by Eysenck (1957): "Inhibitory potential is expected to be generated during the unreinforced trials interspersed with reinforced trials [p. 125]."

These predictions follow directly from a consideration of Pavlov's theory, but they also have good experimental backing. Thus Ross and Spence (1960) compared 50% partial and continuous reinforcement under different strengths of the UCS, and concluded that

inhibition of performance is more readily accomplished under conditions of low puff strengths. . . . The large differences between the 100% and 50% reinforcement groups at high levels of puff strength require that considerable "inhibition" still be present with such puffs [p. 381]. In addition there is evidence to link partial reinforcement with cortical inhibition directly; thus Magoun (1963) points out that:

in each of the several categories of conditional reflex performance in which Pavlov found internal inhibition to occur . . . recent electrophysiological studies have revealed features of hypersynchronisation and/or spindle bursting in the EEG [p. 180].

The distribution variable is easier to control and compare in published studies than is the strength of puff variable. While usually a statement is given of the pressure used to produce the puff, the effective strength of the impact of the air on the cornea depends on many variables usually not measured or stated, such as the opening of the nozzle, the angle to the corneal surface, the exact distance from the cornea, the enclosed (goggles) or unenclosed nature of the surrounding air space, and even the humidity of the air is involved. The complex configuration of the human face makes real accuracy in these measurements very difficult, and comparisons of doubtful value.

As regards GSR conditioning, partial reinforcement is unusual, and the main method for obtaining an adequate degree of inhibition would appear to be the employment of differentiation (discrimination learning). In the quotation from Magoun, partly given in a preceding paragraph, this is explicitly mentioned as one of the conditions for which electrophysiological evidence is available, and we may surmise that in terms of Eysenck's theory studies using differentiation, such as those of Lykken (1957), Vogel (1961), and Halberstam (1961), would give significant relationships with E, while those using a single UCS not differentiated from other stimuli, such as those by Martin (1960) and Davidson, Payne, and Sloane (1964), would not.

It will be seen that both the Spence and Eysenck theories are in a rather similar position. Both are "process" rather than "status" theories; in other words, while different individuals are hypothesized to have differential potentials for reacting to emotionevoking or inhibition-producing stimuli, these potentials can only be translated into observable behavior under specified conditions, that is, under emotion-producing conditions for Spence, and under inhibition-producing conditions for Eysenck. Unless conditions are such that these processes are in fact evoked, no correlations with N or E will be observed. Spence (1964) has reviewed the evidence as far as work with the Taylor MA scale is concerned; we will, in this article, be concerned with a review of experiments attempting to relate E and conditioning.

REVIEW OF CONDITIONING STUDIES

The studies to be reviewed below have been segregated into three groups. The first group consists of eyeblink conditioning experiments using partial reinforcement; the second group consists of eyeblink conditioning experiments using 100% reinforcement; the third group consists of GSR conditioning experiments. The experiments are in each case given in date order, and each experiment is described only very briefly; sufficient data are given, however, to enable the reader to follow the discussion. The data relating to studies in the first group are suitable for tabular summary, and are accordingly presented in Table 1.

Tests of the Eysenck Inhibition Theory Using Partial Reinforcement

1. In his original study, Franks (1956) used clinical diagnosis (dysthymic versus hysteric, and normal), as well as questionnaire replies (seven Guilford scales, Taylor MA scale, and the Maudsley Medical Questionnaire). He found highly significant relations between eyeblink conditioning and clinical diagnosis, and between conditioning and E as measured by the Guilford R scale (r = -.48); for the three groups mentioned correlations were -.15, -.40, and -.05.

2. In Franks' (1957b) second study, 55 normal university students were subjected to the same conditioning procedure; E and N were measured with the Maudsley Personality Inventory (MPI). A correlation of -.46 was obtained with E. Groups high and low on E were very significantly differentiated. These two studies are only mentioned very briefly as they are readily available in published form; the next two studies are quoted

Author	Correlation with:		
	Ss	Е	Criterior
Franks (1956)	60 normals & neurotics	48	R
Franks (1957)	55 students	46	E
Brebner (1957)	8 E vs. 8 I students	(61)ª	\mathbf{E}
Symon (1958)	8 E vs. 8 I students	(48) ^a	\mathbf{E}
Shagass & Kerenyi (1958)	30 neurotics	38	R & S
Franks & Leigh (1959)	80 neurotics & normals	26	\mathbf{E}
Franks (1963)	21 alcoholic patients	10	E
Franks (1963)	28 normal volunteers	01	\mathbf{E}
Field & Brengelmann (1961)	33 criminals	17	Е
Das (1957)	63 students	08	E
Willett (1960)	80 youths	08	E
Sweetbaum (1963)	56 patients		Rb

TABLE 1 EYEBLINK CONDITIONING: PARTIAL REINFORCEMENT

Coefficients are not comparable with rest of table as calculations are based on extreme groups only.
Clinical diagnosis.

in more detail as they are not likely to be accessible to many readers.

3. Following Franks' paper, two replications were carried out at the University of Aberdeen by Brebner (1957) and by Symon (1958). Brebner used a 60% partial reinforcement situation, with a CS of 70 decibels and a UCS of .068 lb/in²; mean intertrial interval was 25.4 seconds. The subjects (Ss) with MPI scores between 2 and 6 were chosen as representative of the introverted group; Ss with scores between 33 and 46 as representative of the extraverted group. Pseudo-conditioners were eliminated, and the remaining Ss were divided into sensitized and nonsensitized, according to the number of responses to tone-alone trials prior to the beginning of the experiment proper. There were 8 sensitized Ss in all and 16 nonsensitized Ss, equally divided in each case between E and I. The nonsensitized Ss practiced to a criterion of number of trials to first four CRs on successive test trials. The criterion was reached by introverts in 28 trials, by extraverts in 70 trials; p < .01. There was a significant interaction with sex, male introverts conditioning relatively quicker than female introverts, and male extraverts less quickly than female extraverts. As regards the sensitized Ss, the acquisition score was nearly always zero, and extinction scores were therefore used to compare the

groups. Introverts extinguished after 28 trials, extraverts after 10; p < .05.

4. Symon (1958) used conditions similar to those described above, but limited herself to 18 test trials and 30 reinforcement trials very much as Franks had done. She selected eight extraverts (MPI scores between 36 and 43) and eight introverts (MPI scores between 4 and 13), and used as her score the total number of CRs performed by members of the two groups. Scores were 20 for extraverts and 58 for introverts, p < .05. She also combined her results with those of Brebner (1957) to discover the earliest trial on which a CR occurred. Means for introverts converged on the fourth trial, for extraverts on the eighth trial; p < .05. The influences of sex and of experimenter were found to be insignificant. All these four investigations, insofar as they are scored for extreme E and I scores (i.e., scores just over 1 SD above and below the mean), agree in finding the introverts as being approximately twice as easy to condition as the extraverts.

5. Another replication of Franks' study was reported by Shagass and Kerenyi (1958); additional cases were reported by Kerenyi (1958). Thirty conditioning and 18 test stimuli were employed, and interstimulus intervals varied from 11 to 19 seconds. The Ss were psychoneurotic patients aged from 16 to 71, the ratio of males to females being approximately 1 to 2. The criteria used were the R and S scales of the Guilford inventory (which were also combined to give a C score) and the Taylor MA scale. Thirty Ss in all were submitted to the conditioning test, and the total number of CRs constituted the score. Correlations with the R scale (r = -.359), the S scale (r = .341), and the combined C scale (r = .383) were all significant at the .05 level.

6. Das (1957) has reported an experiment correlating hypnosis and conditioning. in the course of which he also administered the MPI to the 63 paid volunteer Ss who took part in the experiment. He obtained a correlation of -.08 with E, which is quite insignificant. It should be noted that this correlation was only obtained as a by-product of an experiment designed for another purpose, and that some of the conditions militated against the finding of any significant correlations with questionnaire measures of personality. Thus the group of Ss constituted a mixture of white and colored, some born in England and others born and brought up abroad under quite different patterns of social living; it does not seem likely that the MPI scales can be used indiscriminately for such very divergent groups. For this reason it is doubtful if the result as reported is very meaningful. It is interesting to note that Das (1957) used a number of other objective laboratory tests which had in the past been found to correlate with E; he reports that

all the previously established relationships were verified insofar as the direction of these relationships is concerned, but the size of the correlations was too small to reach an accepted level of significance.

This general finding may be held to support an explanation in terms of an experimental group chosen in such a way that the MPI was not unambiguously applicable to its members. None of the other studies surveyed contained ethnically mixed groups of this kind.

7. Franks and Leigh (1959) studied 80 Ss, the group being made up of 20 inpatient neurotics, 20 outpatient neurotics, 20 asthmatics, and 20 normal Ss; personality was measured with the MPI. The conditioning procedure was similar to that previously

used by Franks. The correlation between CR acquisition and E was -.26, which is significant at the .05 (almost the .01) level.

8. Willett (1960) used 80 adolescents in a conditioning experiment modeled after the original Franks study. He found a correlation of -.08 with the E scale of the MPI. A factor analysis conducted by Evsenck (1960a) of 34 tests, including Willett's, gave a loading of -.12 on the \tilde{E} factor. These correlations are all very much smaller than those previously reported, and none of them is significant. It is possible that the composition of the group may not be unconnected with this. The adolescents tested were below the age for which the MPI was designed. and many of the questions may not be properly applicable to them, or else may have been difficult to understand for those with below average intelligence or education. Furthermore, as a group, these boys were rather homogeneous, the majority having quite extraverted scores on the MPI; this restriction in range, excluding very introverted Ss, may have had the effect of reducing the covariance. In none of the other studies surveyed were subjects below the age at which the MPI is properly employed.

9. Field and Brengelmann (1961) have extended the field of investigation to the study of criminals in prison. They replicated the Franks technique, using intertrial intervals between 20 and 30 seconds. They used a different criterion, namely, the sum of the acquisition and extinction scores; it would have been preferable to have given both separately, as results are not comparable with those on acquisition cited from other authors. (Quite generally acquisition scores give higher correlations with E than do extinction scores.) A total of 33 Ss were reported on (the authors also give results for somewhat larger groups, but give good reasons for excluding these additional Ss) and a large battery of tests of N and E was given. The highest correlation (r = -.17)was with the MPI E scale, while in the right direction this was not significant.

This experiment is subject to two criticisms. In the first place, it was carried out in prison, under conditions where it was impossible to reduce the noise level as much

as might have been desirable; even sound deadening was impossible. It is difficult to say what influence this factor may have had. In the second place, the MPI E scale, as well as most other measures of E, places much stress on questions dealing with sociability; these questions are clearly inappropriate in a prison, and may invalidate the scale as a measure of E. F. Warburton has reported that in a recent study of criminals all the subscales of the Cattell Extraversion Battery placed the prisoners as extremely extraverted, with the exception of the sociability score, which did not differentiate them at all. These two points suggest that the true correlation may have been attenuated to an unknown extent by the faulty design of the experiment.

10. Sweetbaum (1963) tested 56 patients in all, divided into an anxious and a nonanxious group, and then subdivided into high extraverts and high introverts on the basis of the Guilford R scale. The reinforcement schedule employed was partial, but only 10% of all trials were not reinforced, so that his procedure deviated in this respect profoundly from that of Franks, and was more akin to the complete reinforcement schedule of Spence. Experimental conditions were arranged in such a way as to exacerbate the anxiety of the anxious groups. Under these circumstances, Sweetbaum found marked differences between the anxious and nonanxious groups, but none between the extraverts and the introverts. On both grounds (failure to use proper partial reinforcement and use of experimental conditions designed to promote extreme anxiety in some Ss), this cannot be regarded as a suitable test of the inhibition hypothesis.

11. Franks (1963) undertook a replication of his earlier studies, using 21 alcoholic patients and 28 normal Ss. He obtained correlations with E of -.10 and -.01, respectively. These values are certainly lower than those he obtained in his previous studies, and the reason for the difference is not very clear. He suggests "that it is perhaps the technique used to measure extraversion which is most suspect [p. 306]." This is not a tenable view, in our opinion; questionnaire measures of E are reliable and valid (Eysenck & Eysenck, 1964), and in the absence of direct evidence invalidating the questionnaire used, speculation of this kind is not helpful. This study illustrates a point made by Spence (1964). Drawing attention to the large number of uncontrolled variables in work on conditioning, he comments "that it is necessary to have reasonably large samples, so that the effect of these confounding variables are more likely to be equalized in the comparison groups [p. 138]." Franks' results do not disprove the null hypothesis; but neither do they disprove the hypothesis under investigation, that is, that E and conditioning correlate -.3 approximately. In other words, the results are not decisive one way or the other, and this might have been predicted on the basis of the small number of subjects. Some form of sequential analysis seems indicated in the design of such studies, or else the use of samples sufficient to give a clearcut answer. Studies such as this are not very informative, leaving the issue quite unresolved (Wilson & Miller, 1964).

Tests of the Eysenck Inhibition Theory Using Complete Reinforcement

1. Barendregt and Ree (1961) used a 100%method of reinforcement, giving 40 combined stimuli in 20 minutes, and using the number of conditioned eyeblink reactions as the S's score. The Heron (1956) two-part personality measure was used as the personality measure, and a correlation of -.29 was obtained on 41 Ss with E: this is significant at the p < .05 level. Berendregt also correlated these and other tests with the nature of the psychosis developed after administration of LSD. "The tests which most accurately predict the nature of the psychosis were found to provide the best measure of introversion-extraversion." He suggests that this differential symptom development may be used as an external criterion of E.

2. Spence and Spence (1964) used their well-known method of conditioning on 160 students who were also administered the MPI. A correlation of -.08 with E was obtained, which is not significant.

3. Farber, Spence, and Bechtoldt (1957), in a paper referred to by Spence and Spence (1964) but not available in the literature, "found no correlation between conditioning and the Guilford R scale. However, the MAscale was significantly related to performance (r = .29), as was the Guilford C scale (r = .37)." Farber³ states that the total number of cases involved was 103 college students, and that the correlation with R was .007.

4. Al-Issa (1961, 1964) used 90 apprentices, divided into three groups. One group (A) was given a simulated reaction-time task to disguise from them the purpose of the experiment; one group (B) was simply asked to keep pressing the reaction-time key, but without instructions to react to anything; and the third group (C) underwent the experiment without the presence of the key. All Ss were given the MPI and the MA scale. All stimuli were reinforced. It was expected that the pseudo-task would serve to eliminate disturbing test-taking attitudes, and thus provide optimal opportunities for the emergence of personality-conditioning correlations. No specific predictions were made for Conditions B and C. Under Condition A a correlation of -.31 with E was found; this is in the expected direction and significant on a onetailed test (p < .05). The corresponding correlations under Condition B were .21 and under Condition C, .01.

Tests of the Eysenck Inhibition Theory Using GSR Conditioning

1. The first study using the GSR was carried out by Franks (1956), using the same conditions and Ss as in his eyeblink conditioning experiment. He found a statistically significant correlation of -.25 with E.

2. Lykken (1957) worked with a group of 19 "sociopaths," 20 "neurotic sociopaths," and 15 "normals"; the MMPI was used to ascertain personality scores. Discriminant conditioning to one of two buzzers was attempted, shock acting as the UCS. The two sociopathic groups, which come out as extraverted on the MMPI, show less conditioning than does the normal group; this agrees with Eysenck's theory. The strength of the shock was described as giving "a decidedly unpleasant stimulus, producing in most cases a

⁸ I. E. Farber, personal communication, 1957.

pronounced startle reaction and in all cases a strong GSR [p. 7]."

3. Vogel (1960) tested 18 alcoholics on GSR conditioning, using nonsense syllables as the CS and loud noise as the UCS; she also administered the MPI. The Ss were dichotomized at the mean, giving 11 introverts and 8 extraverts; the former required 5.18 trials to a criterion of conditioning, the latter 12.25 on the average (p < .005). It is noteworthy that Vogel used a 50% partial reinforcement schedule in this work.

4. Vogel (1961) more recently reported another study of 40 alcoholic and 40 nonalcoholic control Ss, using the same method as before, and again employing a partial reinforcement schedule. The MPI served as the measure of personality. Vogel found that

alcoholic and non-alcoholic groups do not appear to differ in the number of acquisition trials, but a significant effect for personality is obtained (p < .01). Introversive subjects in alcoholic and non-alcoholic groups displayed the conditioned response in an average of 6.12 trials, whereas extraversive subjects averaged 13.05 trials before the CR was displayed [p. 420].

The personality groups were again formed by dichotomizing at the mean. Nine Ss had failed to condition and had not been included in the analysis; all of these were above the dichotomizing score, that is, would have been classed as extraverts.

5. Becker (1960) has reported an experiment on 62 students in which GSR conditioning to shock and buzzer was used, while the MPI E scale, the Guilford R scale, and a combination of four Cattell scales were used for the measurement of E. Conditioning failed to correlate significantly with E. The arrangement of the experimental procedure was quite a complicated one, but reinforce ment was partial.

6. Martin (1960) used 23 Ss in a program of conditioning using a 110-decibel tone as the UCS, and an intertrial interval of 90 seconds on the average; she failed to obtain significant associations with either E or N. The CS was a dim light.

7. Halberstam (1961) tested 18 dysthymic, 18 hysteric, and 18 control (normal) Ss of similar age and intelligence; this classification constitutes the personality criterion. (On Eysenck's, 1957, theory the hysterics would correspond to the extraverted group, the dysthymics to the introverted group, with the control Ss intermediate.) Patients were assigned to the neurotic criterion groups on the basis of their scores on four MMPI scales. Electric shock was the UCS, and a special word repeatedly exposed among other words was the CS. The number of conditioning trials to criterion was 19.61 for the dysthymics, 23.33 for the controls, and 40.94 for the hysterics; the overall significance level by chi square was better than .005.

8. Becker and Matteson (1961) selected four groups of high and low scorers, respectively, on the Guilford R and the Cattell A (anxiety) scale from 273 male college students. Shock was used as the UCS, and the word "repeat" as the CS: partial reinforcement was employed. It should be noted that the strength of the shock was increased during the course of the experiment when GSR to shock decreased noticeably. No significant differences were observed for the high and low R groups. It is also of interest that the shock levels of the Ss were adjusted to be as high as could be tolerated; this resulted, as might have been predicted from Eysenck's theory (Lynn & Eysenck, 1961), in a situation where "the mean shock level for the high R groups is still considerably higher than that for low R groups (246 volts versus 218)." The outcome of the experiment is not really unexpected. The authors have used a UCS of such severity as to produce considerable anxiety, very much as did Sweetbaum (1963) in his eyeblink experiment; under these conditions the higher drive of the high-N group is relevant to the experimental proceedings, and on both Spence's and Eysenck's theories one would expect greater conditioning for the more anxious groups. By failing to give both high and low R groups identical UCSs, and by failing to keep these constant, Becker and Matteson have effectively produced an experimental situation almost designed to militate against the occurrence of any significant relationship between conditioning and E.

9. Davidson, Payne, and Sloane (1964) report a study of 73 students who were subjected to a hand-withdrawal conditioning

procedure; conditioned GSRs were recorded simultaneously. MMPI scores and MA-scale scores were available on all Ss. None of the correlations was significant. It should be noted that Figure 1 in their article, which gives the percentage of CRs for all Ss during acquisition trials, fails to indicate any systematic change in GSR scores; this makes it unlikely that any form of orthodox conditioning had in fact taken place. The electric shock which served as the UCS was presumably extremely strong, as it had to cause hand withdrawal; for reasons already given strong stimuli of this kind are not in our theory expected to produce conditions favorable to the emergence of a correlation between E and conditioning, even where a proper growth of CRs can be demonstrated.

DISCUSSION

In general, it may perhaps be said that our expectations are borne out by the results reported in the preceding section. As regards the eyeblink conditioning studies with partial reinforcement, we have divided up the whole group into three sets (Table 1). The first group consists of the studies by Franks (1956, 1957, 1963), Brebner (1957), Symon (1958), Shagass and Kerenyi (1958), and Franks and Leigh (1959). All seven studies were carried out on adult normal or neurotic Ss, under conditions which do not present any extraneous stress, and all give results significantly in agreement with the hypothesis, with the single exception of Franks (1963). In addition, none give significant correlations with N, although the direction of the correlations is in the direction expected on the basis of Spence's hypothesis.

Next, we have the three studies of Das (1957), Willett (1960), and Field and Brengelmann (1961). All three use populations to which the MPI is not properly applicable (prisoners, mixed white and colored, and juvenile), and all three give correlations which are insignificant although in the predicted direction. It would seem reasonable to argue that the true relationship has become attenuated because of the choice of Ss. That this may be the correct interpretation is also suggested by the fact that in this group of studies, correlations with N are lower than before, and not all in the same direction.

Last of all, we have Sweetbaum's (1963) study, which can hardly be admitted at all in the group of experiments using partial reinforcement, in view of the fact that he reinforced 90% of all trials. Furthermore, he deliberately manipulated conditions in such a way as to make the task maximally stressful for some of his subgroups. His failure to find any correlation with E, and his demonstration of a significant relationship with N, are not surprising under the circumstances.

When we turn to the eveblink experiments involving 100% reinforcement, we find quite a different picture. Farber et al. (1957) and Spence and Spence (1964) fail to find any correlation with E. Al-Issa (1961) fails to find correlations under two of his three conditions. Barendregt, using a much smaller number of Ss, does indeed succeed in finding a significant correlation, but it is only just significant. The same is true of Al-Issa (1961) when we consider his third condition. Taking all the studies in the partial reinforcement group together, we find a relationship between conditioning and E with a pvalue of less than 1 in 1,000,000, even including all the studies on whose adequacy we have thrown doubt; taking all the studies in the 100% reinforcement group together, we find no significant relationship. It is suggested that these data support the theoretical view stated at the beginning of this paper, namely, that a correlation between conditioning and E can only be demonstrated when care is taken to arrange experimental conditions in such a way that sufficient inhibition is produced during the experiment to bring into action the general law according to which extraverts generate reactive inhibiton more easily.4

⁴ Spence and Spence (1964) have argued that there is "a methodological difference" between the Maudsley and Iowa studies, in that "conditioning studies conducted in the Iowa laboratory have routinely excluded or studied separately the records of subjects who give more than a certain percentage of responses that are of a voluntary form (Spence & Ross, 1959; Spence & Taylor, 1951).... In the Maudsley studies, this problem of voluntaryform responders has not been considered." It is unlikely that difference in results could have been This conclusion is further supported, at least in part, by a comparison of drug studies. Using partial reinforcement, Franks and Laverty (1955), Franks and Trouton (1958), and Franks, Trouton, and Laverty (1958), succeeded in showing that stimulant drugs enhance and depressant drugs inhibit the formation of conditional eyelid responses. Using total reinforcement, Ludvigson (1964) failed to find any effect with the two drugs used by him. This line of investigation is clearly worth following up in more detail.

When we turn to the GSR conditioning studies, we may again divide these experiments into two groups. In the first we have the studies of Franks (1956), Lykken (1957), Halberstam (1961), and Vogel (1960, 1961); all these used relatively weak stimuli and all produced highly significant correlations between conditioning and E. In the second group we have the work of Becker (1960). Becker and Matteson (1961), and Davidson et al. (1964); comment has already been made on the very emotion-producing strength of the UCS used in these studies, and while no information is available on the strength of the shock used in the Becker experiment, it is not unlikely that there too the UCS was stronger than in the first group of studies. It comes as no surprise, therefore, that E did not correlate with conditioning in these experiments.

Another difference already mentioned between the successful and unsuccessful studies lies in the presence or absence of discrimination learning in the experimental paradigm. Lykken (1963), Halberstam (1961), and Vogel (1960, 1961) used discrimination learning; Martin (1960) and Davidson et al. (1964) did not. The available evidence does not allow us to state categorically that the

occasioned by this factor; voluntary-form responders have been carefully looked for in our records, but we have failed to find them. Consequently the question of exclusion or special study does not arise. It is not impossible that the almost complete reliance of the Iowa workers on student Ss pressed into service under conditions of motivation largely unexplored may account for the appearance of such records; in our work we have relied on volunteer Ss paid for their services and unconnected with the school of the University where the work was carried out.

combined action of these two factors (UCS intensity and differentiation) accounts for the observed differences in findings; but as far as they go, the facts as reported tend to support this view. (Stewart, Stern, Winobur, & Freedman, 1961, have thrown doubt on the conditional nature of GSR responses in experiments such as those reviewed here. Kimmel, 1964, and Lockland & Grings, 1963, have also argued the point. Our argument assumes that we are dealing with conditioning proper, not the "adaptation and recovery of unconditioned responses [Stewart et al., 1961, p. 66]." The issue is far from settled, of course, and reconsideration of our position may become necessary.)

We may briefly restate the general argument (Eysenck, 1962a). According to Eysenck's general theory, we must discriminate autonomic arousal from cortical activation (excitation). Individuals high on N are innately predisposed to react strongly and lastingly to certain classes of stimuli with an innervation of their sympathetic nervous system. Individuals high on E are innately predisposed to react strongly and lastingly to certain classes of stimuli with cortical inhibition, while individuals low on E are innately predisposed to react strongly and lastingly to certain classes of stimuli with cortical excitation (activation). (The innate nature of these predispositions is convincingly demonstrated in the recent work of Shields, 1962; however, the theory would still be viable if for "innate" we substituted "acquired through the individual's history of reinforcement.") Under ordinary conditions the eyeblink experiment does not arouse sympathetic innervation to such an extent that task-relevant drive is created, and circumstances ensure that optimal excitation is present. These conditions, exemplified in the work of King, Kimble, Gorman, and King (1961), make it unlikely that correlations with E or N will be observed, although manipulations of S's cortical or visceral state through fatigue, drugs, or other means might alter the situation-so might the influence of brain damage (Franks, 1959) or age (Kimble & Pennypacker, 1963). (Lynn, 1964, has reviewed the literature demonstrating the inhibitory effect of age.)

Task-relevant drive may be created

through change in the experimental conditions, that is, through manipulation of attitudes (Spence, 1964), through threat of surgery (Sweetbaum, 1963), or possibly in other ways (Willett, 1964). Under these conditions, sympathetic innervation will be greater and will last longer in Ss high on N, and consequently correlations will be observed between N and conditioning. Reactive inhibition may be produced through the use of partial reinforcement procedures, through massing of trials, through discriminative learning, or in other ways, and the greater susceptibility of high-E Ss to inhibition will then generate negative correlations between E and conditioning. Attempts to increase excitation (alertness, activation) will not normally result in producing correlations between I and conditioning as Ss are already likely to be in a near-optimal condition as far as this variable is concerned. It seems that Spence and Spence (1964) are in accord with our general point of view, because they write:

The intertrial intervals and the nature of the apparatus employed in the Iowa studies make it extremely unlikely that any substantial amount of I_R is generated by eyeblinks to the CS and UCS [p. 148].

They also refer to the fact that in the initial manifest anxiety study (Taylor, 1951) no reminiscence effect was found, although the conditioning trials were given in two sessions, 24 hours apart.

In applying this theory to GSR conditioning, we must note that inhibition is unlikely to develop under conditions of very strong stimulation; the reticular activating system theoretically underlying the concept of "excitation" is strongly stimulated by electric shock, particularly of the severity employed by Becker and Matteson (1961), and such stimulation of the "activating" part of the formation makes it almost impossible to obtain a simultaneous stimulation of the synchronizing portion. Hence, to obtain correlations between GSR conditioning and E, the strength of the UCS must be restricted to relatively low values.

It will be clear that while these hypotheses derive some support from the literature surveyed, and are in accord with some of the

views published by Eysenck (1957) and Spence (1964), there is no proof of their correctness. The research studies reviewed were not carried out in any attempt to verify or disprove the theory here presented, and consequently more than one variable is usually varied in going from one study to another. Nevertheless, the overall impression left after careful reading of all the available literature on conditioning and personality is one of reasonable congruence between fact and theory. One difficulty may be presented by the fact that differences between introverts and extraverts in eyeblink conditioning tend to appear early in the experiment: this suggests that inhibitory potential is produced very quickly. The rapid descent of extinction curves may seem to lend some plausibility to this idea, but it remains mysterious why later unreinforced trials do not widen the gap more than they seem to do.⁵

Assuming for the moment that the views here presented do not depart too widely from reality, we may consider another related problem, namely, that of the existence of a general factor of "conditionability." Campbell (1938), Moore and Marcuse (1945), Franks (1956), and Bunt and Barendregt (1961) are among those who have discussed this problem and carried out correlational studies; on the whole, the results suggest that correlations

⁵ This failure of differences in conditioning between introverts and extraverts to increase during the later trials is possibly an artifact of the scoring method employed. Let us examine the combined Franks data as plotted by Eysenck (1963b, p. 15). After a very rapid increase during the first four test trials, introverts show a change from 50% CRs at the fourth trial to 80% CRs at the eighteenth trial; extraverts change on these trials from 25% to 40% CRs. Thus introverts show a 30% increase, extraverts a 15% increase absolutely; relatively both show identical increases, that is, they maintain their relative positions. However, the increment in growth of ${}_{B}H_{R}$ in the introverted group takes place considerably nearer the physiological maximum (M), so that our units of measurement are not properly comparable; some such transformation as that suggested by Hull (1943) in his Figure 25 and the associated formulae would be required. When this is done introverts show a spectacularly more accelerated growth than do extraverts. By plotting the raw scores a quite inaccurate picture may thus be given, and any theoretical discussion must make use of data suitably transformed.

between different types of conditioning are relatively low, or may even be near zero. Moore and Marcuse (1945) argue that "the concept of good or poor conditioners must always be with reference to a specific response," and Eysenck (1960b) has argued that specific peripheral factors (number of sweat glands in the hand; pain sensitivity of the cornea) should be measured separately and their influence partialed out before correlating different types of conditioning. Our argument in this paper makes it clear, however, that even if response specificity were eliminated, correlations would nevertheless depend very much on conditions: Are circumstances anxiety provoking or not? Is the sequence of stimuli massed or spaced? Is reinforcement partial or complete? Are CS and UCS strong or weak? Is the CS-UCS interval long or short, relative to the optimum? These and many other similar factors will interact with the N and E components of S's personality to produce, not only variable correlations of a given task with personality, also with other conditioning tests but (Eysenck, 1962a). There does not seem to exist a single study which attempts to take these and similar considerations into account, and consequently, no conclusion is possible about the existence of a "general factor of conditionability."

One last comment may be appropriate. It is mandatory in science that experimental results should be capable of being confirmed, and that theories should be capable of being submitted to experimental tests. However, replication of experiments must be as exact as is possible from the published description of the experiment, and the testing of theories must be arranged in such a way that the theory in question is truly at issue. When Becker and Matteson (1961) write, in connection with their study of GSR conditioning, that "this report is an addition to that growing list of failures by American psychologists to confirm Eysenck's reactive inhibition theory of extraversion [p. 429]," it must be stated that they, and the writers they quote, did not in fact replicate any of the Maudsley experiments. Whether the particular experiment actually performed did, or did not, test the inhibition theory is of course a moot point; we have argued in this article that conditions were in fact arranged in such a way as to make the appearance of inhibition well nigh impossible. Under the circumstances, therefore, we are very doubtful if any consequences follow from experiments such as these as far as the verification or otherwise of the theory is concerned; if anything, the failure of the authors to report positive correlations, where a closer study of the theory would in fact not have predicted any positive correlations, might be thought to support rather than infirm the theory.

This general line of reasoning does not, of course, rule out the experimental extension of work on the relationship between conditioning and personality to conditions and populations differing in significant ways from those employed in the original studies; replication is not the only approved method of scientific investigation, and parametric studies investigating the influence of systematic changes of important variables are of obvious interest and value. The fact that gross changes in conditions produce results differing from those in the original experiment is of importance, but should not be used to argue against the reproducibility of the original findings, nor should it be used to argue against the underlying theory, unless it can be demonstrated quite clearly that the changes do not contravene the demands of the theory.6 Enough has been said in the main body of the article to demonstrate that the more closely experimenters have copied the methods used in the original Maudsley studies, and the more similar were the experimental groups investigated, the closer were the results to those originally reported.

⁶ One point of difference not commented on in many of the studies mentioned is the use of different criteria of extraversion. The Maudsley studies have concentrated on the MPI (Eysenck, 1962b) and lately the EPI (Eysenck & Eysenck, 1963); other writers have used the Guilford scales, or the MMPI or still other scales like the Heron. While all the scales correlate positively, there is little doubt that only the original Maudsley scales embody the conception of extraversion that underlies Eysenck's inhibition theories; the use of other scales is likely to attenuate to an unknown extent the expected correlations.

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