

Reminiscence, Drive and Personality—Revision and Extension of a Theory

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Some twenty studies have been examined which have purported to test the hypothesis that reminiscence effects are stronger in extraverts than in introverts, or related hypotheses involving the postulation of greater inhibition effects in certain criterion groups. It has been demonstrated that the results on the whole lend support to the original hypothesis. Little support is forthcoming for the additional hypothesis that neuroticism or emotionality, having drive properties, should also correlate positively with reminiscence.

The original theory linking reminiscence with extraversion was based on three hypotheses, according to which extraverts (1) generate reactive inhibition more quickly, (2) dissipate it more slowly, and (3) develop greater amounts of reactive inhibition. The third hypothesis has been found to run foul of work done on the relation of drive to reminiscence, according to which the amount of reminiscence developed is a direct function of drive. A reformulation of the theory is therefore offered, using only differences in rates of development and dissipation of I_R to account for the observed differences between extraverts and introverts in reminiscence.

1. INHIBITION AND PERSONALITY

In recent years the author has attempted to link up descriptive and dimensional studies in the field of personality with the findings and theories of experimental psychology, particularly Hullian learning theory (Eysenck, 1957*a*; 1960*a*; 1960*b*). Of particular importance in this connection has been the concept of *inhibition*, because it has been postulated that extraverts are characterized by strong, quickly developing and slowly dissipating inhibitions, while introverts are characterized by weak, slowly developing and quickly dissipating inhibitions (Eysenck, 1957*a*). In modern learning theory, the reminiscence phenomenon provides a relatively direct measure of reactive inhibitions (McGeoch & Irion, 1952), and accordingly several attempts have been made to use experimental set-ups involving this measure in the experimental analysis of personality, beginning with an experiment by Eysenck (1956*a*) in which 50 students were given the Maudsley Personality Inventory (Eysenck, 1959*a*) and tested on the pursuit rotor; significant correlations were reported between reminiscence and extraversion, as predicted, and also between reminiscence and neuroticism. This latter finding was explained in terms of Kimble's (1950) extension of Hull's theory as being possibly due to the greater drive of more neurotic Ss, a hypothesis obviously related to those espoused by Spence (1956) and Taylor (1951). According to Kimble (1949), reactive inhibition grows until it equals the positive drive under which the *S* is working; the greater *D*, the greater the amount of I_R which can be tolerated. Neuroticism ('anxiety' in the Spence-Taylor hypothesis) may be considered as a drive which thus increases the tolerance of Ss to the presence of I_R .

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Table 1

Author	N	Type of S	Type of test	Criterion	Result: E	Result: N	Remarks
Eysenck (1956)	50	Students	Pursuit Rotor	MPI	++	++ +	Criterion questionable; cf. Gwynne Jones, 1960.
Treadwell (1956)	40	Students	Stylus tracking	Minnesota T Scale	++	(not included)	
Star (1957); 1	100	Apprentices	Pursuit Rotor	MPI	++	--	Sixteen 90-sec. trials; 5-min. rests. One 90-sec. session.
Star (1957); 2	79	Students	Pursuit Rotor	MPI	-	+	
Das (1957)	68	Students	Pursuit Rotor	MPI	++	(not included)	Extraverts have significantly lower performance scores. Extraverts have significantly lower performance scores.
Das (1957)	68	Students	Pursuit Rotor	Nuffern test	++	(not included)	
Rechtschaffen (1958)	47	Students	Inverted Alphabet	Guilford R Scale	+		Several reminiscence scores used, of which only one correlates significantly with E. Significant Rest-Extraversion interaction. Eleven 1-min. trials. One correlation with E significant.
Ray (1959)	240	Students	Pursuit Rotor	MPI	=	=	
Claridge (1960)	48	Soldiers	Pursuit Rotor	Factor loading	++ +	=	Extraverts have significantly lower performance scores.
Becker (1960)	62	Students	Pursuit Rotor	MPI	+	=	
Eysenck (1960c)	240	Apprentices	Pursuit Rotor	MPI	+	=	Personality \times length of rest pause interaction significant at 1% level. Factor analytic study.
Eysenck (1960d)	45	Apprentices	Pursuit Rotor	MPI	+	+	
Eysenck & Eysenck (1960)	62	Apprentices	Rotating Spiral	MPI	+	=	Hypothesis erroneously stated by author. Unpublished data.
Lynn (1960)	40	Students	Inverted Alphabet	MPI	++	+	
Lynn (1960)	40	Students	Inverted Alphabet	Spiral after-effect	++	++ +	Personality \times length of rest pause interaction significant at 1% level. Factor analytic study.
Lynn (1961)	82	Children	Inverted Alphabet	Factor loading	++	+	
Pimillos (1962)	300	Drivers	Pursuit Rotor	MPI	++	+	Hypothesis erroneously stated by author. Unpublished data.
Bendig & Eigenbrode (1961)	160	Students	Pursuit Rotor	Guilford-Zimmerman Temperament Survey	++	=	
Meier (1961)	128	V.A. patients	Inverted Alphabet	MMPI	++ +	+	Unpublished data.
Costello & Feldman (1962)	120	School children	Pursuit Rotor	Junior MPI	++	=	

In Table a rough indication of the significance of findings has been given by using an = sign to denote absence of any relationship between personality and reminiscence. A single + or - sign denotes results tending to confirm or infirm the hypothesis, but at levels of $p > 0.05$. A double + + or - - sign has the same import, but at levels of $p < 0.05$, while a triple + + + or - - - denotes levels of $p > 0.01$. Occasionally, as in the case of Becker's (1960) work, several results are reported from one study; in this case a (subjective) overall estimate has been attempted. The inclusion of single + or - signs may be criticized as placing importance on data not fully significant statistically. The fallacy underlying such an objection has been discussed recently by Eysenck (1960g) and Rozeboom (1960); briefly, it consists in using *decision* procedures as methods of scientific *inference*. The fact that this fallacy is widespread among psychologists does not make it logically and mathematically acceptable.

The various attempts to duplicate these findings are listed in Table 1. Before discussing the conclusions to be drawn from this Table, however, it will be necessary to state succinctly the component parts of the theory under investigation.

Stated briefly, the hypothesis runs like this. (1) Massed practice produces a negative drive called reactive inhibition (I_R). (2) I_R grows until it equals D , the drive under which S is working. (3) When this critical point is reached, performance ceases and an involuntary rest pause (IRP) occurs. (4) During this IRP inhibition dissipates, and performance begins again when sufficient I_R has been dissipated. (5) I_R accumulates again until another IRP occurs, and performance continues by fits and starts in this fashion. (6) A programmed rest pause allows I_R to dissipate, so that performance after the rest pause is better than before; the resulting improvement is called reminiscence. (7) If the rest pause is long enough to allow of the complete dissipation of I_R , then reminiscence is an accurate measure of I_R . (8) After the critical point has been reached where $I_R = D$, reminiscence is an accurate measure of D .

There are certain complicating features. (9) IRPs act as reinforcement for the act of resting in the general test situation. (10) Through this reinforcement conditioned inhibition (${}_S I_R$) is set up; this is a habit and does not dissipate. (11) After the programmed rest, IRPs do not occur for some time as I_R has to grow again from its depleted state; this failure of ${}_S I_R$ to be reinforced causes it to *extinguish* (Eysenck, 1956*b*; 1960*e*). (12) This extinction of ${}_S I_R$ is shown in performance as a marked and prolonged post-rest upswing in performance.

It is possible from this set of statements to deduce the optimum conditions for testing the hypothesis linking extraversion and high reminiscence scores. (1) Pre-rest practice should not be too long. This is so because (a) extraverts develop I_R quickly, introverts do so slowly; maximum I_R should be reached earlier by the extraverts than by the introverts, so that an early rest pause would capitalize on this hypothetical difference in rate of development. (b) Long pre-rest practice allows much ${}_S I_R$ to develop; the extinction of this in the post-rest period may interfere with the measurement of reminiscences. (2) The programmed rest period should be long enough to allow all of the accumulated I_R to dissipate. If the rest period is short, then introverts, dissipating I_R more quickly, may erroneously be thought to have more I_R than extraverts who dissipate it more slowly. (3) The reminiscence score is determined by subtracting a pre-rest score from a post-rest score; these scores should be determined by taking periods of practice *as short as possible*. Post-rest scores can be adulterated by (1) extinction of ${}_S I_R$ and (2) possible warm-up effects, and the only way to minimize these effects is to have very short periods of measurement immediately succeeding the rest. (The length of pre-rest practice in this connection is less crucial, provided that a plateau has been reached in S 's performance.) (4) The test should be carried out near the beginning of the learning curve on the particular task chosen; this is predicated on two considerations. (a) At later stages different S s will have different amounts of ${}_S H_R$ and of ${}_S E_R$; this, combined with ceiling effects, obscures the picture. (b) Long previous practice on a task is likely to have led to the accumulation of ${}_S I_R$, the extinction of which interferes with the measurement of reminiscence.

In connection with the pursuit rotor, it would appear that pre-rest practice periods of 5 minutes and rest periods of 10 minutes have given good results, provided the reminiscence measure is calculated in terms of 10-second work periods; Eysenck (1960c) has shown that with an identical set of data reminiscence scores calculated over 20-second periods reduce previously significant differences to insignificance. This may account for the fact that Ray (1959), who had observed the predicted inferiority of extraverts to introverts in pre-rest practice over a 5-minute period, failed to discover significant differences in reminiscence; he used 20-second periods for determining reminiscence. (He also failed to follow the author's practice of starting the rotor $2\frac{1}{2}$ seconds before the beginning of the post-rest trial in order to obtain properly comparable sets of scores; when this is not done S on the last pre-rest trial starts with an obvious advantage over his own performance on the first post-rest trial. Cf. Eysenck, 1956b.)

Of the findings in Table 1 which fail to support the theory strongly, those by Rechtschaffen (1958) and Becker (1960) are derived from experiments which do not make use of optimum conditions of testing. Rechtschaffen used 60-second rest pauses; this, as pointed out above, is probably too short to allow all of the accumulated I_R to escape, and thus prejudices the data against the hypothesis under investigation (Eysenck, 1959b). It must be admitted that Rechtschaffen used inverted alphabet printing rather than the pursuit rotor, so that optimum times may very well be different to those quoted; nevertheless it is not likely that those chosen by him are anywhere near the optimum. That this is true is indicated by the fact that his measure of *inhibition* (essentially like Ray's (1959) a measure of performance decrement) is significantly related to extraversion on a one-tail test. Becker's (1960) procedure is very complex, and deviates in several points from that advocated and used by Eysenck. It is, however, of some interest to note that one of his reminiscence scores did in fact correlate significantly with extraversion.

Meier (1961) concludes his discussion of results by saying that 'the MMPI findings imply diagnostic differences in opposite directions from those predicted by Eysenck for them' (p. 92). He finds that hysterics have a significantly higher reminiscence score ($p = 0.01$) than the dysthymics (6.71 vs. 4.64), with character disorders (psychopaths?) also high (6.92). This is exactly in line with the author's predictions and original results, which are not quoted by Meier. His own interpretation of the results, which makes reminiscence scores entirely dependent on speed of dissipation of I_R , is not acceptable; a 5-minute rest pause as used by him is sufficient to allow practically all of the accumulated I_R to dissipate. Lynn (1960) discusses this general problem.

Several attempts have been made to use shorter pre-rest practice periods than 5 minutes, following Eysenck's original suggestion (1956a). Star (1957), Das (1957), and Eysenck (1960c, d) have used periods of 60 seconds to 90 seconds, but the results, while usually in the predicted direction and sometimes significant, have not on the whole reached acceptable levels of statistical significance. This may be due to the lack of reliability of the data at very low levels of performance, or it may be due to the fact that usually the rest pauses have been rather short. Following the reasoning of Bahrig, Fitts & Briggs (1957) it might be surmised that short practice periods at the beginning of the learning curve would give better results if a larger target disc, or a slower rate of rotation were to be employed.

2. EVALUATION OF THE EVIDENCE

We may now summarize the evidence presented in Table 1; this includes all relevant data which have come to our attention, even where the method used has been criticized. Several conclusions are apparent with respect to the data relating to extraversion. (1) Nearly every experiment, regardless of method of measurement or criterion used, gives results which are in line with the prediction that reminiscence

is greater in extraverts than in introverts. The ratio of positive to negative findings leaves very little doubt about the reality of the phenomenon. (2) Experiments fulfilling the conditions demanded by the theory under investigation (Eysenck, 1956a; Star, 1957, 1; Claridge, 1960; Lynn, 1960; 1962) are distinctly more positive than are those reported by investigators who have contravened these rules (Ray, 1959; Rechtschaffen, 1958; Becker, 1960). In support of the writer's belief that failure to find the predicted reminiscence differences was due to faulty design may be quoted the fact that both Ray and Rechtschaffen reported significant pre-rest inferiority of performance in their extraverts. (3) Experiments using very short practice periods (60 seconds or 90 seconds) tend on the whole to give positive results, but to do so at a level which is altogether lower than that reached with longer pre-rest practice (5 minutes). Possible reasons for this have been discussed above, but it is by no means clear yet why this should be so; suggestions have been made for improving the level of differentiation when short pre-rest work periods are used.

(4) When we come to the question of the criterion, we find that on the whole composite criteria derived from factor analyses (Claridge, 1960; Lynn, 1962) are probably superior to criteria derived from single tests. Criteria from objective performance tests (vigilance, spiral after-effect, etc.) are probably slightly superior to questionnaire criteria, such as the MPI or Guilford R scale. These conclusions are not rigorously supported by the evidence because criteria and designs of experiment interact in ways which cannot be disentangled at the moment; it would be possible to argue that the better criteria have usually been found conjointly with the better designs. (5) The only types of test widely used have been the pursuit rotor and the inverted alphabet printing task; the data do not permit of any decision between these two, although we may draw attention to the improved method of using the alphabet printing task suggested by Lynn (1960).

In addition to the data summarized in Table 1, in which the criterion has been the extraversion-introversion continuum or factor, there are some other studies which may be considered relevant as they are based on extensions of the writer's theory. Thus Claridge (1960), in a study already noted in Table 1, compared hysterics and dysthymics on two measures of reminiscence; he found that 'dysthymics and hysterics were virtually identical on the RS1 measure, while the difference in RS2, although in the right direction, is not significant'. Numbers in the two groups were rather small ($N = 16$ in each group), and repetition of this work would be of some interest. As it stands it cannot readily be adduced as supporting the hypothesis. A recent study by Claridge & Herrington (1961), using multiple choice reaction time measures, also failed to find differences in reminiscence between hysterics and dysthymics; there were, however, significant differences in pre-rest performance in the predicted direction.

Claridge (1960) himself has been led by his results, both published and unpublished, to extend the original theory linking extraversion and inhibition by positing that the sympathetic arousal which is so characteristic of neurotic reactions is itself subject to reactive inhibition, which would tend to damp it down in extraverted (hysteric and psychopathic) Ss. This hypothesis, which follows logically from the general theory, would serve to explain why hysterics on the whole have lower neuroticism scores on such instruments as the MPI (Eysenck, 1959a; Eysenck & Claridge, 1962). If this sympathetic arousal could be regarded as a drive, then neurotic introverts (dysthymics) would have higher drive than neurotic extraverts (hysterics), and the postulated and experimentally verified relationship between reminiscence and drive (Eysenck & Maxwell, 1961; Eysenck & Willett, 1961) would lead to a *positive* correlation between reminiscence and introversion *in neurotics*. This positive correlation

might cancel out the *negative* one postulated to exist in normal *Ss*, thus giving the results reported by Claridge (1960). If this explanation were correct, one might expect dysthymics and hysterics to differ with respect to such indices of arousal as skin conduction (Kling, Williams & Schlosberg, 1959) and muscle tension (Eason & White, 1960) during performance on the pursuit rotor. Differences between normal introverts and extraverts on these measures should be much smaller, or even non-existent. Partialling out this 'arousal' factor should restore the positive correlation between reminiscence and extraversion.

Brain-damage and old age have been suggested by the writer as likely to increase inhibition and decrease excitation (Eysenck, 1957*a*; 1960*h*). No evidence is available regarding reminiscence in brain-damaged groups, but in relation to old age Griev & Lynn (1962), in their review of the evidence regarding this hypothesis, cite one unpublished study giving experimental support to the prediction that a relation would exist between age and reminiscence. (It is not posited that such a correlation would be found over the whole age range, of course, but only after the age of sixty or so, when degenerative processes have set in impeding cortical functioning, and producing some form of 'brain damage'.) The evidence is clearly insufficient, but as far as it goes it supports the theory.

A last source of evidence is the work on drugs reported by Eysenck, Casey & Trouton (1957), Willett (1960), Treadwell (1960), and Eysenck (1960*f*). These reports are based on the drug postulate (Eysenck 1957*b*), according to which depressant drugs increase inhibition and decrease excitation, while stimulant drugs have opposite effects. On this basis one might have expected depressant drugs to increase reminiscence; such a prediction would be disconfirmed by all the studies mentioned. A decrement in performance, also predicted on this basis, is indeed quite generally found, as is an increase in differentiation between drug and placebo groups with increase in practice; these results seem to support the theory in general. No obvious reason suggests itself for the failure of reminiscence to occur to any greater extent after depressant drugs, but the position is rather complex, and the reader may be referred to Treadwell's (1960) excellent discussion. The writer has suggested that the drug postulate, which has received a considerable amount of support (Eysenck, 1960*f*), may be reversed and used to design experiments which would disclose the precise effect of the drug on sH_R and I_R respectively; two preliminary experiments, published in the above-mentioned review, have suggested that the effect is on sH_R rather than on I_R , but the data are not sufficiently extensive to allow of any definitive conclusions. As far as they go, the data on drugs do not support the general theory, but the position is too complex to make possible any clear-cut conclusion. The possibility exists that drugs affect excitation rather than inhibition; this would adequately explain the differences in performance as well as the lack of difference in reminiscence found in the experimental studies. It is in line with this hypothesis that the depressant and stimulant drugs mostly used in our experiments (Eysenck, 1960*f*) have some parasympatheticomimetic and sympatheticomimetic effects respectively, although of a central rather than of a peripheral nature; the brain-stem and the reticular activating system seem clearly implicated.

Compared with the positive and fairly uniform results obtained with extraversion, the results with neuroticism are much less impressive; the slight support given to the original findings by the studies of Lynn (1961), Star (1957) 2, and Lynn (1960) is almost counterbalanced by the studies of Star (1957) 1, and Eysenck (1960*d*). In addition, Claridge (1960) compared normal and neurotic *Ss* on the pursuit rotor and found the normals considerably higher than the neurotics on both the first and also the second reminiscence score. (He followed Eysenck (1956*a*) in having three 5-minute periods separated by two 10-minute rest pauses, thus obtaining two reminiscence scores). These data do not suggest that the null hypothesis has been disproven, but on the other hand it seems that neuroticism as a personality variable presents some special complexities and difficulties to the investigator attempting to link it with personality measures of an objective kind. As the originators of the Yerkes-Dodson Law (Broadhurst, 1959) were the first to point out, the relationship

between drive and performance is curvilinear, and also dependent on the difficulty level of the task; if we conceive of neuroticism-anxiety as a drive variable, than contradictory data from measures of performance obtained on groups of *Ss* differing in their position on the neuroticism continuum cannot come as a surprise. Our argument is of course concerned with reminiscence rather than with performance as such, but as I_R is produced in the course of massed practice, interference in performance by drive-produced stimuli, as posited by Mandler & Sarason (1952) and Child (1954) must also affect reminiscence. Thus it is not impossible that in groups of individuals low in neuroticism a positive correlation of neuroticism with reminiscence may be observed, while in groups of individuals high in neuroticism a negative correlation may be found. The available data are not extensive enough to permit of any definite comment, particularly in view of the fact that different tests and experimental designs have been used. None of the investigators appears to have tested his data for curvilinearity of regression; it is not impossible that the predominantly zero correlations reported may be the result of assuming linearity of regression where in fact none existed.

3. RESTATEMENT OF THE THEORY

In spite of the positive conclusion regarding the relation between reminiscence and extraversion, it is clear that much more work will have to be done on the precise conditions under which this phenomenon emerges most clearly; the optimum combination of length of pre-rest practice, length of rest pause, scoring procedure, level of performance at which the measurement is taken, as well as the most suitable type of performance (pursuit rotor, inverted alphabet printing, etc.) are still to be determined. Only a very rough beginning has been made in this direction. It will, however, have been noted that although most of the results reported have been favourable to the theory, nevertheless the correlations have nearly always been rather low, centering around the 0.2 to 0.3 level, with an occasional one above 0.4, and equally occasional ones around 0.0. This may be due to failure to have conducted experiments under optimum conditions, or it may reflect the failure of the MPI scale to be a perfectly valid criterion of extraversion (Eysenck, 1959a); in any case we may with advantage have another look at the theory itself to see whether some revision may not be necessary. And indeed, there is one obvious discrepancy there which has been pointed out by Gwynne Jones (1960), and which has become more crucial since the successful attempts by Eysenck & Maxwell (1961) and Eysenck & Willett (1961) to demonstrate a monotonic relation between drive and reminiscence. (This work is based on previous studies by Kimble (1950) and Wasserman (1951), but is more directly relevant to our present problem as well as being better controlled from the point of view of motivating conditions.)

It will be remembered that the growth of I_R is limited by the quantity of D under which S is working; it would seem to follow *that extraverts cannot accumulate a greater quantity of inhibition than introverts unless their drive is greater*. As there is no reason to believe that there are any differences in drive between the groups, the prediction that 'extraverts should show a higher degree of reminiscence than introverts' (Eysenck, 1956, p. 328) would seem to fall to the ground. It is the purpose of

this paper to suggest that this is not necessarily so, and that the original prediction may be derived from the two hypotheses that (a) inhibition develops more quickly and (b) dissipates less quickly in extraverts than in introverts. Consider Fig. 1,

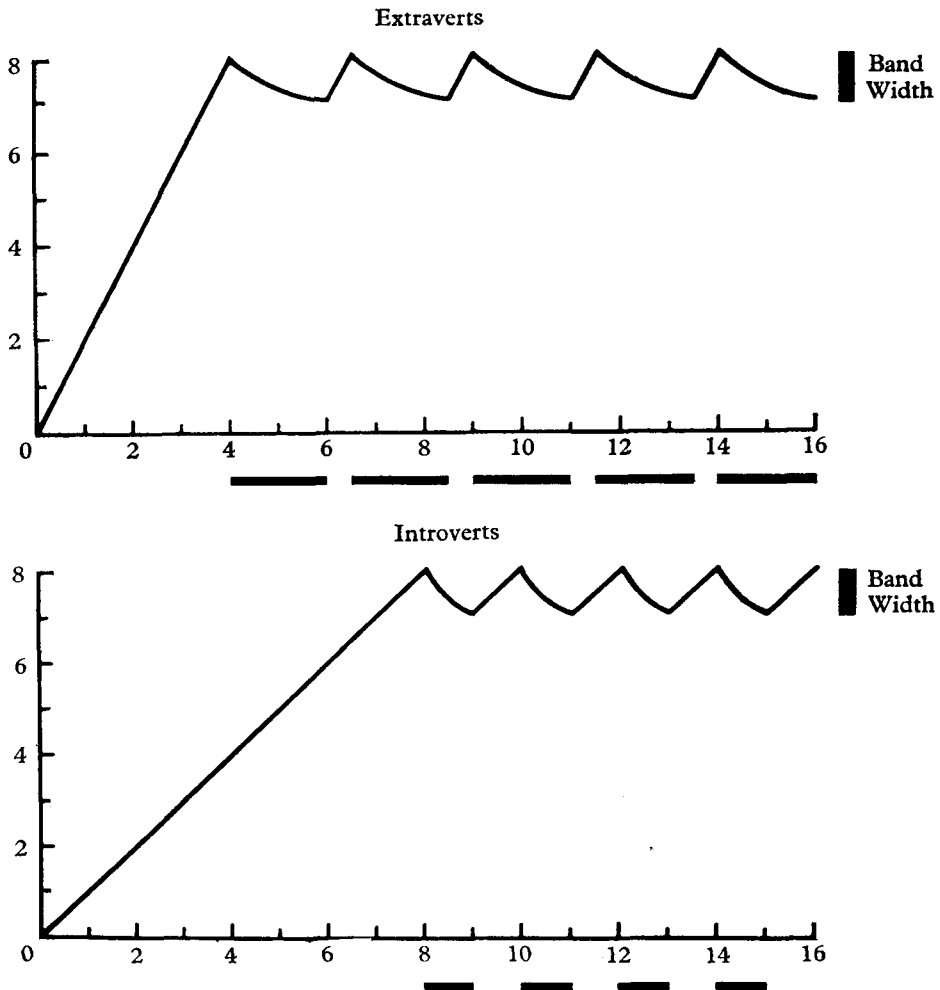


Fig. 1. Diagram illustrating hypothetical growth of reactive inhibition leading to involuntary rest pauses in introverts and extraverts. For purposes of demonstration the rate of acquisition of inhibition for extraverts has been set at twice that shown by introverts, while the rate of dissipation of inhibition in introverts has been set at twice that shown by extraverts. Under these conditions, and assuming equal band-width (for explanation see text), the resulting length of involuntary rest pauses for extraverts and introverts respectively is shown by means of the solid lines underneath the abscissae.

which has been drawn to illustrate the effect these two rate differences would have on the IRPs of extraverts and introverts respectively. To make the illustration more graphic, it has been assumed that extraverts accumulate I_R twice as fast as do introverts, and dissipate it at half the rate. This would lead to three consequences: (1) IRPs are twice as long for extraverts; (2) work intervals between IRPs are half as

long as for extraverts; (3) IRPs begin after half the length of practice for extraverts as they do for introverts. On all these scores it is apparent that the average performance level of extraverts is below that of introverts during most of the course of practice, and it will be remembered that even authors such as Ray (1959) and Rechtschaffen (1958), who fail to find differences in reminiscence, agree in finding performance of extraverts inferior. (Cf. also Bakan (1959), Broadbent (1958), and Claridge (1960).)

This inferior performance pre-rest should lead to a *permanent* decrement on the part of the extravert, due to the fact that he is in fact practising less than is the introvert, and that more of his time is spent in rest (IRPs). On the other hand, introverts should accumulate more sI_R , due to (a) the larger number of reinforcements (IRPs) during unit time, and (b) the hypothetical greater rate of conditioning of introverts (Eysenck, 1957). It is impossible without further experimentation to say whether one or the other of these factors is the stronger, or whether in fact they may balance out; this is an empirical matter urgently requiring attention. The experiments required would necessitate the direct measurement of IRPs possibly using such methods as those used by Bills (cf. review in Eysenck, 1957a), Bjerner (1949), Geldreich (1953) and Williams *et al.* (1959). Whatever the final verdict, however, it would seem that extraverts should show a higher degree of reminiscence, not because, as in the original version of the theory, they had accumulated more I_R than introverts, but because they were *on the average* more likely to be in a state of not working (IRP) during the pre-rest period, which in the determination of reminiscence is subtracted from the post-rest period; during this post-rest period, of course, both groups are free from IRPs due to the complete dissipation of I_R during the rest. (This statement would require modification for experiments such as those of Becker where the periods used for calculating reminiscence extended to 60 seconds, thus possibly bringing them into the region where IRPs might be starting again.)

On this revised hypothesis we would still expect over-all differences between extraverts and introverts on reminiscence scores, but we would not expect these to be very large. Furthermore, in view of the chance character of the probability of finding any particular person in a state of not working (IRP) during the pre-rest period we would expect rather low reliabilities (retest) for measures of reminiscence; the facts seem to bear out this deduction (Eysenck, 1956a; Star, 1957). It would seem that this new version of the hypothesis linking personality and learning theory is more in line with the facts of the situation than is the original one; it is also less inconsistent internally.

We have made one assumption in this argument regarding which there does not appear to be any evidence. It will have been noted that the mechanism assumed to generate the recurring IRPs is some form of negative feed-back or servo-mechanism, such as may be found in a thermostat, for instance, and it is well known that one important feature in such devices is the tolerance limit or band-width within which the mechanism is inactive. Thus a thermostat set at 75° may cut out at 76° and cut in again at 74° , giving a band-width of 2° , or it may cut out at 80° and cut in again at 70° , giving a band-width of 10° . Similar differences may be operative here, such that different people have differences in tolerances or 'band-widths', and it is not

impossible that these differences themselves may be related to personality. It would be idle speculation to try and trace the effects of such supposititious differences on our hypothesis, in the absence of any direct evidence about their occurrence; nevertheless it does not seem unlikely that something of the kind may be operating. Direct evidence on this point is urgently required.

The assumption has been made throughout that there are no differences in D between extraverts and introverts. It is difficult to verify or disprove this assumption, as in terms of the Hullian system D in human Ss would be indexed normally in terms of performance or reminiscence (Eysenck & Maxwell, 1961), i.e. just in terms of the measures the relation of which to extraversion-introversion was in question. It may be possible to measure D independently in terms of physiological variables (Martin, 1960), but until this has been accomplished in relation to pursuit rotor performance, and validated as a procedure, it must remain possible that differences in reminiscence between groups are (a) produced or (b) attenuated by uncontrolled differences in D . Possibly different instructions to S may differentially motivate extraverts and introverts; thus competitive conditions may motivate extraverts more, while test conditions purporting to measure mental abilities might have greater effects on introverts. Until this problem of motivation is solved results achieved with performance and reminiscence measures in relation to personality must inevitably be assessed with caution. Here again, therefore, we have a large and almost completely unexplored field of experimentation relevant to our major hypothesis. In so far as motivation to perform well on the pursuit rotor is secondary motivation (a point hardly very much in doubt), in so far would it tend to favour the introverted groups by virtue of the writer's general theory according to which conditioned responses (which underly secondary drive) are developed more speedily and strongly in introverts (Eysenck, 1957a). The experimental results of McClelland and his colleagues, in so far as they are relevant, seem to support this general view; high achievement motivation seems to go with introverted personality traits (McClelland *et al.*, 1953). Thus it is likely that this factor has tended to attenuate the results reported in Table 1, and that the actual relation between extraversion and reminiscence under conditions of equal drive may be much closer than it appears. This point has been discussed earlier in this paper together with suggestions regarding possible experimental methods of establishing its truth or falsity.

One further point requires to be considered; this has come to the fore largely as a result of some experiments carried out on psychotic Ss . Broadhurst & Broadhurst (1959) and Claridge (1960) have shown that under the usual conditions of testing, psychotics (mostly schizophrenics, but also endogenous depressives) fail to show the reminiscence phenomenon at all, a finding never before made in extensive tests with normal, neurotic and mental defective groups (cf. also Meier, 1961). Two possible explanations suggest themselves. It has often been postulated that psychotics have low motivation; this would immediately lead to low reminiscence according to the theory outlined above. The alternative hypothesis would posit rather that psychotics dissipate I_R very slowly, so that no reminiscence would be observable after the usual 5-minute or 10-minute rest pause. Ley (unpublished results) tested these two hypotheses by comparing reminiscence scores of psychotics

(schizophrenics) and normals when members of these two groups were given either 10-minute or 24-hour rest pauses. As expected the normal *Ss* gave roughly equal reminiscence scores under these two conditions, but the psychotics, while failing to show reminiscence after the short rest pause, gave reminiscence scores even higher than the normals after the long rest pause. These results, which were fully significant statistically, seem to rule out the first hypothesis (in terms of low drive) and strongly support the second (Eysenck, 1961). (Other workers at the Institute have independently arrived at a similar formulation; cf. Venables, 1959; Venables & Tizard, 1956. Indeed, interpretations of a similar kind go back as far as Kraepelin (1913) and Hoch (1901). The relevance of these facts to the theory of psychoticism, which stresses the general *slowness* of psychotics, (Payne, 1960; Eysenck, 1952) requires no emphasis; it seems possible to account for this slowness in terms of failure to dissipate reactive inhibition speedily enough.)

The main relevance of these data to our discussion lies in this. Optimum rest intervals have usually been determined by averaging reminiscence scores of large groups of *Ss* (mostly university students) and demonstrating that further lengthening of rest intervals did not significantly increase reminiscence. It is quite likely from our hypothesis that there are considerable individual differences with respect to optimal rest intervals, and the studies of psychotics show that these individual differences may be quite extreme. It is possible that very extraverted *Ss* may not dissipate all the I_R they have accumulated in the course of the experiment in rest periods of less than an hour's or even a day's duration; if this were so the usual practice of using rest intervals of 5 or 10 minutes would clearly prejudice results against the hypothesis in question.

All in all, the writer would argue that the proper investigation of the personality-inhibition hypothesis requires a whole series of parametric experiments to investigate the various points raised, most of which refer to quantitative variations in practice and rest times. Other parameters, too, require investigation; indeed, although they are seldom mentioned in experimental reports they may exert a very powerful influence on the measurement of reminiscence. Thus consider as an example the influence of extraneous noise, or other disturbance. According to the theory, this should exert a disinhibiting influence, thus reducing reminiscence if occurring before the rest period. In one experiment Rachman (1962) rang a bell for 2 seconds, 25 seconds before the rest period (i.e. after 4 minutes 35 seconds massed practice on the pursuit rotor) in the experimental group, whilst not ringing the bell for the control group. As predicted, he found that the reminiscence score of the experimental group was very significantly ($p = 0.001$) lowered compared with the control group. Uncontrolled sources of noise, such as occur in most laboratory testing which is performed outside soundproofed accommodation, may thus have a very disturbing effect on the measurement of individual differences in reminiscence.

A last source of confusion, even more difficult to control than those mentioned thus far, is related to the choice of *Ss*. It is not impossible that the meaning of a high extraversion score may be different in England and in the United States, according to the different stress placed on sociability, rathymia, activity, aggressivity, and so forth in the two cultures. If the writer is correct in his hypothesis that

the introvert conditions more readily the social mores and stresses of his early environment, and if this environment stresses extraverted values in the U.S., introverted ones in the U.K., then the behavioural consequences of 'constitutional' introversion may be somewhat dissimilar (Eysenck, 1960i). Similar arguments may apply to subgroups (male vs. female, middle vs. working-class) in the population. Here again much experimentation will be required before this parameter is brought under adequate control.

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