

SODIUM AMYTAL AND EXTRAVERSION

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“Extraversion” and “introversion” are descriptive terms denoting two types of behavioural reaction and personality organization widely recognized and described in psychological literature (Guilford, 1934; Eysenck, 1953). “Extraverted behaviour” is characterized clinically by the outward expression of feelings and attitudes, in words, gestures, and acts, in a spontaneous and direct manner, little impeded by reflection, indecision, or reserve. The contrary, “introverted behaviour”, comprises a tendency to limit or moderate spontaneous outward expression, reflection, preoccupation, and rumination rather predominating. A reserved or even withdrawn attitude may be maintained. While individual people may be predominantly introverted or extraverted in their behaviour, fluctuation normally occurs from one form to the other. Introducing these types Jung (1923) writes:

“But every individual possesses both mechanisms—extraversion as well as introversion—and only the relative predominance of the one or the other determines the type.” (p. 10)

And again:

“A rhythmical alternation of both forms of psychic activity may correspond with the normal course of life”

“Outer circumstances and inner disposition frequently favour the one mechanism or hinder the other; whereby a predominance of one mechanism naturally arises. If this condition becomes in any way chronic a type is produced, namely an habitual attitude, in which the one mechanism permanently dominates; not of course that the other can ever be completely suppressed in as much as it also is an integral factor in psychic activity.” (p. 13)

Persistently introverted or extraverted attitudes and behaviour patterns are frequently seen in neurotic subjects; marked fluctuations occur here also.

In the course of intoxication with alcohol or a sedative drug, such as barbiturate, a shift is often seen from introverted towards extraverted behaviour. Verbal and motor expression, both spontaneous and responsive, become conspicuous in behaviour, reflection and passive experiencing minimal. A particular pattern of “uninhibited”

behaviour, often at variance with the normal and conventional practice of the subject, may be a constant or recurrent response to alcohol or sedation. Attitudes may appear which are never or seldom expressed in the normal state. Strong affective expression may appear (“be released”) such as euphoria, expansiveness, resentment, anger, or depression.

During the initial stages of anaesthesia, with say ether or “pentothal”, patterns of motor activity or excitement may appear, similar to those extraverted patterns described, but usually short-lived and associated with a more definite clouding of consciousness. This activity is not constant; the majority of subjects become progressively sedated and do not show it. My own observation of many patients receiving pentothal before E.C.T. showed such initial excitement regularly in the same subjects suggesting that it may be a constant response for certain individuals.

Introverted behaviour may lessen and extraverted behaviour emerge under the influence of many other factors; each is appropriate to certain situations. However, a shift towards extraversion appears to be facilitated in certain people by drugs with a particular type of depressant action on the central nervous system.

An objective measure of extraversion (the “rathymia” or R scale; Guilford, 1940) was given to a group of introverted neurotic (dysthymic) subjects after injections of placebo and sodium amytal (Laverty and Franks, 1956). The R score was significantly higher after sodium amytal, confirming the extraverting effects of the drug. These subjects also answered the questionnaire more often in the affirmative after injections of “amytal”.

Shagass (1954) and Shagass and Naiman (1955, 1956) used sodium amytal to establish an objective measurement of sedation, “the sedation threshold”. This measure, the quantity of drug (mg./kg. body weight) required to produce inflection in the amplitude of the “barbiturate-fast” activity of the electroencephalogram (a point usually concurrent with the onset of slurred speech) was found to be high for

introverted neurotics, low for extraverted and normal subjects, and intermediate for "mixed neurotics".

"A high sedation threshold seems to be associated with obsessional personality traits, introversion, and a predisposition to anxiety, tension, and depressive symptoms; a low threshold . . . with hysterical personality traits, extraversion, and a predisposition to conversion symptoms" (Shagass, Naiman, and Mihalik, 1956).

It may be argued from this that introversion depends on a cerebral activity which is opposed by sodium amytal (before full sedation), in the course of which opposition a shift from introversion towards extraversion takes place; the overcoming of this activity may be presumed to require a certain quantity of the drug and this could account for the higher doses necessary to produce the sedation threshold in introverted subjects. If introversion is the factor in question both neurotic and normal introverted subjects should behave in the same way, becoming more extraverted after amytal and showing a high sedation threshold. Extraverted subjects, on the other hand, should show little or no increase in extraversion and have a low threshold.

The present investigation was carried out to test these expectations.

Method

Forty subjects were tested as to their degree of "extraversion" using Guilford's R scale. Each subject was tested on two occasions, once after amytal and once after injection of a placebo. Four groups of 10 subjects tested in this way were made up as follows:

- Group I. Introverted neurotic subjects
- Group II. Introverted normal subjects
- Group III. Extraverted neurotic subjects
- Group IV. Extraverted normal subjects

The neurotic subjects were in-patients or out-patients of the Maudsley Hospital and were all complaining of current neurotic symptoms or showed neurotic disturbances of behaviour. They were selected as "introverted" or "extraverted" on the basis of their behaviour and history taken during a preliminary interview. The normal subjects were psychiatrically unsophisticated acquaintances of my own, selected as being "extraverts" or "introverts" according to their known personalities and free from a history of mental illness or neurotic symptoms. The proportion of men to women in each group (I to IV) was 6 : 4, 6 : 4, 5 : 5, 6 : 4. Ages were between 18 and 37.

The subjects were asked to participate in an experiment in which their experience of the passage of time would be tested after the injection of a drug: such a test was given after each injection but does not form a part of the investigation reported here.

Amytal injections were given in the manner described by Shagass *et al.* (1956). Sodium amytal solution, freshly prepared, in a dose of 0.5 mg./kg. body weight/ml. sterile water, was injected at a rate of 1 ml. in 40 seconds. At 40-second intervals the subject was requested to read a

sentence on a card held before him and from this response the onset of slurring of speech was assessed. At this point the injection was stopped.

Placebo injections of sterile water were given in the same way.

After the patient was able to sit up and walk about comfortably, and did not appear to be drowsy, the Guilford R scale was presented in the form of cards. The subject was requested to sort the questionnaire cards into boxes labelled "Yes", "?", and "No", answering them according to the way he felt at the time.*

A random order for the administration of placebo or amytal at the first or second session was prepared and followed for each group. The subject's behaviour and mental state before and after injection was assessed and recorded. No positive suggestions with regard to symptoms were given. All the verbal comments made by the subject during the card-sorting tests were recorded as giving an indication of the presence and quantity of spontaneous talk.

Results

These are reported as follows: (1) Questionnaire scores; (2) spontaneous talk; (3) symptoms reported; (4) behaviour observed; (5) sedation threshold.

(1) **Questionnaire Scores (R Score, "Yes" Score, "?" Score).**—The mean scores for each group after injection of a placebo may be assumed to be little different to what they would be without injection since placebo injection and "no treatment" scores were not significantly different in the former investigations (Laverty and Franks, 1956).

Mean R scores for the introverted groups (I and II) were: after placebo 22.8 (S.D. 3.3)† and 24.8 (S.D. 4.5); after amytal these groups showed higher R scores than after placebo, the means being 29.6 (S.D. 3.4) and 26.3 (S.D. 7.9). The extraverted groups (III and IV) showed higher R score means than the introverted groups as follows: after placebo 46.1 (S.D. 5.3) and 46 (S.D. 8.3); after amytal 48.9 (S.D. 5.8) and 48.1 (S.D. 4.5).

There is a consistent increase in the R score after amytal, being for each group (I to IV) 6.8 (S.D. 3.3), 1.5 (S.D. 3.4), 2.8 (S.D. 4.8), and 2.1 (S.D. 4.5). The difference is highly significant for the introverted neurotic group (I) at the 0.1 level of confidence. For the other groups (II to IV) the differences are not significant, but if the scores are combined, significance at the 2.5% level is obtained.

"Yes" scores (the number of cards placed in the "Yes" box) after placebo showed lower means for introverted subjects: group I, 44.2 (S.D. 13.4),

*In the former investigation (Laverty and Franks, 1956) the number of "Yes" answers was significantly increased after amytal. In the present investigation questions 8, 16, 18, 19, 57, 106, 110, 118, and 119 were put in their negative form, bringing the possible number of "Yes" responses to 43 and the "No" responses to 42.

†Standard deviations for means given in brackets.

group II, 47.9 (S.D. 10.9) than for extraverted subjects, group III, 57.0 (S.D. 12.5), group IV, 54.0 (S.D. 7.7). An increase in the "Yes" score after amytal occurred in each group, being for group I, 7.1 (S.D. 9.4), group II, 3.6 (S.D. 10.0), group III, 4.0 (S.D. 3.0), and group IV, 2.4 (S.D. 3.3). The difference is significant for the introverted neurotic group at 2.5% level, but not for the other groups. Similarly " ? " scores (number of cards placed in the " ? " box) showed a tendency to decrease after amytal as compared with placebo, but the scores being small and frequently zero the differences are insignificant. However, the number of subjects in each group showing a decrease is high for the introverted groups (10 in group I, eight in group II), and lower for the extraverted groups (five in group III, five in group IV).

(2) **Spontaneous Talk.**—Spontaneous talk during the card-sorting test was greater (number of words recorded) for extraverted groups both after a placebo and amytal. After amytal an increase in spontaneous talk was recorded for all groups, particularly for groups I and III, the mean increase being for each group I to IV 65.5 (S.D. 56), 14.9 (S.D. 126), 46.0 (S.D. 115), 17 (S.D. 47). Introverted subjects showing a restriction in speech became noticeably more talkative after amytal, often showing a sudden flow of spontaneous talk during injection.

During the card sorting subjects who had received amytal tended to read the questions aloud or to themselves, moving their lips. After a placebo this was noted only in four subjects, two in each extraverted group. After amytal it was more common for subjects to break off from the card sorting to speak directly to the investigator.

(3) **Current Symptoms Reported.**—Symptoms were reported spontaneously or elicited by questioning at each interview. Thirteen of the neurotic subjects (eight in the introverted group, five in the extraverted group) described symptoms as troublesome most or all of the time; the other seven described definite fluctuations in degree and persistence. Two subjects in the introverted normal groups and one in the extraverted normal group described feelings of anxiety.

Relief from symptoms was frequently reported after amytal. This was most evident in the introverted neurotic group; placebo injection seldom afforded relief. The neurotic introverted group reported relief after amytal from pain and somatic discomfort (7), anxiety or depression (4), recurrent or obsessional thoughts (4), depersonalization (1), and other symptoms (3). The neurotic extraverted group reported relief from pain and somatic discomfort (4), anxiety (3), and other symptoms (3).

Introverted subjects described relief more often than extraverted subjects; extraverted subjects described exacerbation more often than introverts. Exacerbation of previously reported symptoms was more common after placebo than after amytal; after amytal drowsiness and dizziness were more commonly complained of, but this was transient except in two subjects who both belonged to the extraverted neurotic group.

The only introverted neurotic subject who failed to report relief from at least one symptom experienced a compulsive fear that he would commit some indiscretion under the influence of the drug. He remained anxious about this after both injections.

Attitudes.—Besides differences in reported symptoms certain alterations in attitudes were observed after amytal. These were not consistently enquired for, but in five subjects were sufficiently striking to record. A dysthymic patient who had consistently expressed anxious solicitude for a married woman with whom he was involved, after amytal abused her for compromising him. A second dysthymic subject went to a dance on the evening after injection of amytal and surprised those who knew him by his sociable attitude; formerly in hospital he had been persistently shy. A third dysthymic patient went out with her friends the day after injection of amytal; one reported "she was brighter than she ever was before, she read our fortunes out of cups—I never knew her to do that before." A fourth dysthymic subject after injection of amytal displayed for the first time in hospital a markedly paranoid attitude. A tense, extraverted patient with an hysterical weakness of the arm became excited and aggressive towards the doctor after amytal and the weakness was no longer apparent; he was previously over-talkative but polite.

(4) **Behaviour Observed.**—Abnormal behaviour patterns were noted at each interview.

Repetitive tension movements (tapping, fidgeting, etc.), restlessness or restricted movements with the appearance of tension, were noted, particularly in the introverted neurotic group; these signs were associated with complaints of tension or anxiety, and appeared relieved after injection of amytal in all the dysthymic subjects except one. Anxious behaviour of this type was seen to a lesser extent in the extraverted group of neurotics and was rather less consistently relieved after amytal. Other individual items of symptomatic behaviour in the extraverted group were unrelieved after amytal in five cases (abnormal gait, aphonia, facial tic, weakness of leg, anaesthesia), but relieved in two (retching, weakness of arm). Both these latter patients appeared relieved of anxiety, one after abreaction.

Overtalkativeness after amytal was frequently noted, often with euphoria or other affective display and in one case with motor excitement and aggressiveness. This latter patient had shown similar behaviour after alcohol on at least three occasions.

A tendency to fall asleep after the injection was observed in two subjects in the extraverted neurotic group; in other subjects drowsiness was frequently reported at an early stage in the injection but passed off to reappear transiently at about the onset of slurred speech but not lasting more than a few minutes after the injection and not reappearing after testing had begun. Three subjects felt "more alert," "more wide awake" after amytal (two in group I, one in group II).

Three other minor observations on behaviour in the introverted neurotic group may be mentioned. Three of these subjects showed an incapacity to carry out different actions simultaneously; movements of the hands, breathing, speaking, shifting, and so on were performed separately while other actions were temporarily suspended. This breaking up of the normal rhythm of movements was associated with a general restriction of movements, with feelings of anxiety or tension and was never seen after amytal, when these subjects became relaxed. Subsequent questioning showed these subjects to be very conscious of movements normally carried out unattended.

The same subjects and one other in the introverted neurotic group and one in the introverted normal group were observed to cease breathing during the time that they were reading and considering the questions on the cards; respiration was resumed with a deep inspiration as they placed the card into the appropriate box. This, and other examples of intermittent hyperpnoea were not seen after amytal; even yawning was rarely observed in this group.

Restricted and hesitant talk in three subjects of the introverted neurotic group was associated with prefatory inarticulate sounds ("Er-er") and then failure to talk. It was noted that a remark or even a slight movement on the doctor's part immediately caused the patient to make another verbal response, often with a movement of the subject's hands or body. Following this response the patient became stuck again, unable to utter and restricted in movement. This did not occur after amytal.

No consistent relief from abnormal behaviour was noted after a placebo.

(5) **Sedation Threshold.**—The "sedation threshold", as assessed by the point of onset of slurring of speech, was in some cases difficult to ascertain. Other changes in speech, such as slowing, drawing out of vowels, alteration in pitch, and mumbling,

were noted, sometimes preceding definite slurring. Speech which was not quite clear at one point was sometimes distinct at the next. Certain subjects spoke slowly, carefully endeavouring not to slur when aware of the tendency to do so. However, a decision as to the point at which slurring occurred was made in each case.

Mean sedation thresholds (mg./kg.) for each of the four groups were: Group I, 6.4 mg./kg. (S.D. 4.0), group II, 6.1 (S.D. 3.7), group III, 4.15 (S.D. 3.5), group IV, 5.25 (S.D. 5.1). Differences between means for all groups of 10 (I to IV) are not significant. The combined means for the introverted groups I and II (20 subjects) are 12.5 (S.D. 3.9) and for the extraverted groups III and IV (20 subjects) 9.4 (S.D. 4.4). The standard error of difference for these means, 1.33, is less than half the difference between means (3.1), indicating a significant difference at the 5% level. Combining the means for the neurotic groups (I and III) and the normal groups (II and IV) does not show a significant difference between means, the difference being only 0.8.

Conclusions

Administration of sodium amytal intravenously to the point at which speech becomes slurred was associated with consistent differences in responses to questionnaires and behaviour as compared with the same observations following injection of a placebo. After amytal "R" scores, "Yes" scores (Guilford), and "number of words spoken" were higher than after the placebo; "?" scores were less. These differences were most significant in the introverted neurotic (dysthymic) group of subjects. This group also showed a consistent relief from symptoms and from "introverted behaviour patterns". The neurotic introverted group and the normal introverted group require a larger mean dose of amytal to produce slurred speech (sedation threshold) than the extraverted groups.

Discussion

Brazier (1954) has presented a hypothesis for the mode of action of barbiturates on the central nervous system based on electroencephalographic evidence in animals and human subjects. Brazier describes three phases of barbiturate action: (i) An initial action is exerted on neurones in the cerebral cortex (based on findings with depth electrodes in human subjects). (ii) At a slightly deeper level of narcosis

"barbiturates appear to have a differential depressant action on a subcortical inhibitory system, the result being an augmentation of response in the non-specific sensory system that carries 'Forbes secondary responses'."

Brazier continues:

"the phenomenon suggests a release effect, as though at *this stage* of barbiturate anaesthesia some inhibitory system, possibly in the diffuse ascending system (of the reticular substance) had been put out of action by the drug, thereby releasing from control the responses carried rostrally from this system. Such a concept envisages that there would be in normal circumstances a condition of balance between inhibition and activation and that by increasing very gradually the depth of anaesthesia the action of the one (inhibition) can be depressed before the other."

The augmentation of this cortical response to sensory stimulus is maximal in the pre-motor area. The suggestion that it is analogous to the K-complex (Davis, Davis, Lomis, Harvey, and Hobart, 1939; Gastaut, 1953) is contested (Roth, Shaw, and Green, 1956).

(iii) At a deeper level still the differential action on inhibitory and activating systems is lost and the sole remaining activity is the "barbiturate burst". At this stage the subject is drowsy or asleep.

It is tempting to relate the first two of these three phases to the initial stages of early barbiturate anaesthesia observed here. The first subjective report during amytal injection is usually of dizziness, warmth, or other slight sensation and occurs after 50 to 150 mg. The group of changes that follows appear related to the shift towards extraversion; relief from anxiety experiences and preoccupation, increased talkativeness and readiness of affective motor expression. The change of attitude that occurs at this point appears to be the same as underlies the differences to questionnaire responses; the subject feels less inhibited, more spontaneous, says "Yes" more often and is less indecisive (low "?" score); the observed behaviour gives a similar impression. The terms used by Brazier to describe the altered E.E.G. in the second phase serve to describe the form of altered behaviour response also: "inhibition" is reduced, "activation" is unimpeded. The alteration is smooth in most cases, but when abreaction and abrupt excitement occur the impression of a "release effect" is obtained.

The larger sedation threshold shown by the introverted subjects confirms the findings of Shagass and Naiman (1956). Possibly the extra quantity of the drug is used in overcoming greater inhibitory activity of the kind referred to above. That the

neurotic introverted subjects showed more shift towards extraversion in response to the questionnaires and in behaviour may suggest that in this group the inhibitory mechanism is more labile and associated with and sustained by anxiety.

As portrayed by Jung (1923), introversion and extraversion are two forms of personality organization and expression between which a fluctuating balance or equilibrium is maintained. At a certain stage of amytal sedation shift of this equilibrium appears, in the direction of extraversion. As described by Brazier, barbiturate anaesthesia at a certain point causes a shift in the equilibrium normally maintained between two discharging ascending neuronal systems in the central nervous system. Further study is required to discern how closely these two effects of barbiturate are linked and how far their similarities can be pursued.

Summary

Injections of sodium amytal and placebo were given to 40 subjects divided into four groups of 10 (neurotics, normals, introverts, extraverts): scores on Guilford's R scale (extraversion) were higher after amytal than after the placebo. Changes in reported symptomatology and behaviour were noted. The sedation threshold, as measured by the onset of slurred speech, was highest for neurotic introverts and this group showed the most marked change towards extraversion. A possible physiological basis for the shift towards extraversion after amytal proposed.

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