PERSONALITY AND PSYCHOPATHOLOGY

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The hypothesis that the phenomena of mental disease are the outward manifestations of impaired brain function suggests a systematic exploration of the various dimensions of behavior to reveal the extent and the depth of defect. It rests with biometrics, the science which applies quantitative analysis to the structure and function of living organisms, to provide a map for such a survey by pointing out the main avenues along which progress may be expected, to integrate observations obtained at different levels of function, and to devise new tools for the extraction of significant information.

BIOMETRIC MODEL FOR ANALYSIS OF BEHAVIOR

An analysis of individual behavior can be organized by allocating observations among five major levels of activity: (a) physiological, (b) sensory, (c) perceptual, (d) psychomotor, and (e) conceptual.

Observations of such autonomic functions as heart rate, blood pressure, rate of respiration, production of sweat or saliva, etc., tap an area of behavior which can be measured without the overt cooperation of the subject (S) and even without his attention. In particular, while such measures are noticeably sensitive to external stimulation, they can nevertheless be obtained when the S is at rest, in what might be called the "idling" state, so that it would be possible to establish base lines of psychophysiological activity against which the influence of extrinsic stimuli could be more accurately assayed than at present.

Sensory activity refers to the modality-specific component of the complex of behavior involved in the functioning of a receptor organ. The immediate experience correlate of sensory activity in the human sensorium is a sensation, e.g., the mere awareness of light when the retina is illuminated. The neural conditions for a sensation are as follows:

1. Electromagnetic or gravitational energy impinging on a sense organ or free nerve ending.
2. Conduction of a nerve impulse by the specific afferent system from the receptor.
3. Collateral nonspecific afferent conduction in the reticular activating system (3, 31).
4. Efferent feedback regulation of the sensitivity level of the receptor (9, 11, 22).
5. Integration of peripheral, central, and autonomic neural activity at the level of the diencephalon (26).

The absence of the first condition, external energy, distinguishes a hallucination from a true sensation. One test that has been suggested for this distinction is the occurrence of after-images (41, pp. 6–9); but there is evidence that both eidetic images (17) and visual hallucinations (40) may be followed by after-images. Pure sensation is probably infrequent. Seeing light, feeling pain, hearing sound, etc., with no further qualification approximate the experience, but probably involve some conceptual abstraction on the part of the S.

In contrast to sensation, which is concerned with the unique quale of a sense modality, perception is an activity of the organism which superposes on the sensory function, scanning, focusing, and following mechanisms that are experienced as discrimination and that are oriented to reaction. In addition to the neural events involved in sensation, perceptual behavior incorporates primary afferent pathways into the circuit. Perception is thus the experience correlate of the integration of the primary afferent and efferent systems (30).

When overt movements accompany the perceptual act, the behavior is psychomotor. It is likely that some psychomotor activity accompanies most perceptual behavior.

The expression, conceptual behavior, is best reserved for those obscure components of the cortical network which mediate linguistic and metalinguistic activity.

Elsewhere (4) it has been pointed out that these five categories comprise an ascending hierarchy with physiological behavior providing the vegetative substrate and with conceptual behavior involving at least the first three

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levels as precursors or concomitants. A comprehensive account of an individual's mental functioning ought to include representative samples from each distinguishable level of behavior.

It is just as inadequate to evaluate psychopathology solely in terms of conceptual functioning as it would be in physical science to account for the phenomena of solar radiation only in terms of terrestrial combustion and without regard to the behavior of nuclear plasmas at extreme elevations of temperature. Indeed, the enormous energy expended by the sun without appreciable loss of mass remained a mystery until the submolecular aspects of the system were brought into meaningful relation with the molar observations by Bethe's hypothesis of the carbon cycle.

For psychopathology, biometrics has the responsibility of searching through the whole range of human behavior for the critical relations between different levels of function which will throw light on the mystery of mental disease. It is already abundantly clear from the history of psychopathology that those investigators who confine their attention to a single level of behavior cannot hope to account for the problem in all its complexity.

A map of the world of psychopathology needs meridians to distinguish the experimental techniques that can be applied across the latitudes of behavior. In studying the behavior of an individual, the experimenter may adopt one of three methods: First, he may merely observe the S without intruding in any way into the natural flow of behavior; second, he may seek to engage the S in some specific activity; or third, he may modify or distort the intrinsic functioning of the S and then proceed to examine the residue of behavior by one of the above two methods. The first procedure, naturalistic observation, is propaedeutic to experimentation. Observation and description provide a context from which hypotheses can emerge for testing under controlled conditions. Even the ethologists (27), who rightly insist on the importance of studying animal behavior in naturalistic settings, nevertheless do not hesitate to manipulate the environment so as to determine the limits within which a particular act, such as a duck's retrieving an egg, will be evoked.

The second method, the controlled experi-
the sense organ is particularly responsive, as light to the eye, sound to the ear; or it may be inappropriate, i.e., outside the energy range for which the organ is specially adapted, as electrical stimulation above the retina to produce phosphene, or caloric stimulation of the vestibular apparatus.

Signal variables, on the other hand, provide a relatively insignificant fraction of the energy released in the response. They are triggering devices which vary in spatial or temporal organization. Correspondingly, the response, deriving its motive power from energy intrinsic to the organism, can no longer be represented as a function of input energy.

The simplest kind of signal variable is the configuration in which the stimuli consist of spatio-temporal patterns or arrangements. Variations of juxtaposition or of time interval produce corresponding changes in behavior, as in the visual discrimination of shape or the auditory discrimination of timbre.

A more complex kind of signal variable is the sign. A sign is any event which implies some other event. More generally, a sign places a probability valuation on the event it designates. Thus, smoke is a sign of fire; a footprint in the sand signifies that someone has stepped there; a certain residue of C14 in a fossil plant is a sign of its age. Natural signs are either precursors or consequences of the events they designate. It is, however, a universal characteristic of human behavior to employ sets of arbitrary conventional signs for cultural purposes. For example, an arrow indicates direction; a red light warns of danger; a shrill tone on a siren gives the all clear. A set of signs may be said to comprise a code when arranged in some lexical order over against a corresponding set of designated events. The process of transmitting and receiving such encoded signs is the signal engineer’s definition of communication. In the psychological laboratory, if the experimenter places an arbitrary sign (CS) in temporal or spatial contiguity with a reinforcing event (US), the sign by its presence or absence establishes a pattern, or configuration, which may be varied according to a predetermined sequence. Classical Pavlovian conditioning, animal experiments in visual or tactile discrimination, and delayed reward experiments employ this technique.

A symbol is a sign which designates an aggregate or class of events. Symbols are by their very definition abstract, removed from direct reference to particular events. Language, i.e., the systematic designation of classes of objects, attributes, or events by accidental patterns of acoustic energy, is in essence a complex communication code composed of symbols. In all likelihood, linguistic behavior is the prototype from which symbolism in art and music is derived. In art, all music is “program music,” i.e., has content reference, and all art is representative. The complex experience evoked by a work of art through the interplay of elements of pure design with subtly suggestive allusions to persons and events is probably prepotent in such devices as the Rorschach and the TAT. These techniques should therefore be viewed as presentations of symbol variables, and the corresponding behavior should be designated conceptual rather than perceptual. Other instances of behavior evoked by symbols are found in the interview and in the questionnaire. Table 1 shows examples of measurable activities as functions of stimulus variables.

The Modified Organism

On the premise that the whole is the sum of its parts, physiologists have long had the practice of studying isolated systems, e.g., the nerve-muscle preparation, the perfused liver, etc. Taking a leaf from this common physiological procedure, experimental psychologists and psychiatrists have in recent years begun to study the organism’s behavior after first introducing certain modifications or distortions of intrinsic functioning. This has been done in three ways: imposition of a load, intervention in the internal neurohumoral environment, and ablation or destruction of part of the organism.

1. Loads. A load is defined as an externally imposed force which induces a distortion or strain and a counteracting stress. In a physical object, e.g., a wire with a weight attached, the restorative stress is proportional to the distortional strain, in accordance with Hooke’s Law. Similarly, when a psychological load is imposed on an organism, the organism too undergoes a strain which is countered by restorative stress, although it is still moot whether an analogue of Hooke’s Law can be established for psychology. Examples of psychological
<table>
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<th>Signal Variables</th>
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<tr>
<td><strong>Variable</strong></td>
<td><strong>Function</strong></td>
<td><strong>Symbol</strong></td>
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<tr>
<td><strong>Conceptual</strong></td>
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<tr>
<td>Negative</td>
<td>Rerun and fantasy</td>
<td>Uniformly diffused light</td>
</tr>
<tr>
<td>Positive</td>
<td>Spontaneous movement</td>
<td>Painful stimuli</td>
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<tr>
<td><strong>Perceptual</strong></td>
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<tr>
<td>Negative</td>
<td>Spatial and temporal disorientation</td>
<td>White noise</td>
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<tr>
<td>Positive</td>
<td>Background noise; vertical gray</td>
<td>Light of graded intensity</td>
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<tr>
<td><strong>Psychological</strong></td>
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<tr>
<td>Negative</td>
<td>BMG; basal EEG; basal PGR</td>
<td>Increase in carbon dioxide concentration</td>
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<td>Positive</td>
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loads are threat, with consequent strain of anger or fear (5); tissue damage, with the strain reflected in the inflammatory process; deprivation of air, food, water, sensory input, etc. (2, 15); and intense physical effort or prolonged exposure to extremes of temperature. Just as an excessively severe physical load will produce a permanent distortion in a wire, so too can a psychological load strain an organism beyond its elastic limit, so that subsequent strains must be measured from a new baseline. The consequences of psychological loads which are excessively severe or unduly prolonged are seen, for example, in "combat fatigue," in the General Adaptation Syndrome (39), or in the adrenal hypertrophy which follows intense uninterrupted physical exertion (35).

2. Neurohumoral intervention. The application of drugs or brief electrical current to produce activity in the organism has become increasingly popular with experimenters. Drugs like mescaline (18), adrenochrome (14), and LSD (42) have been used to evoke bizarre behavior or to initiate anomalies of subjective experience in the hope of uncovering a biochemical key to psychopathology. Despite many suggestive analogies, however, their effects are obscured by the wealth of interactions which they set up in the organism. The difficulties to be surmounted before a biochemical understanding of psychopathology can be expected may be appreciated when it is realized that the biochemistry of so common an agent as aspirin is still obscure. The initiation of behavior by intracranial electrical stimulation, first used for mapping the brain (3), has recently become a method of choice for the production of activity or affect (6, 32). But here again the relevance of these new techniques for the behavior of the intact organism remains to be demonstrated.

3. Ablation. The method of ablation, by which a part of the brain substance or of the neurohumoral network is excised, has made many substantial contributions to the understanding of the structure and function of the nervous system (1, 19, 38). However, the caution cannot be repeated too often that what is subsequently observed is the residual behavior of all the rest of the animal, including whatever compensatory or suppressed mechanisms may have been released. Inferences as to the role of the excised part in behavior remain at best dubious. This is particularly true because of the difficulty of assessing the side effects of trauma, degenerative changes, bleeding, anesthesia, etc.

Of the three methods for modifying the organism, the imposition of a load seems at present the most promising for psychopathology because it usually brings about a response that differentiates between mental patients and normals. Neurotics and early psychotics tend to react with excessive strain, while chronic schizophrenics show a deficiency in reactivity. In studying behavior under load, some care must be exercised to avoid confusing the load with the independent variable. A load which causes tissue damage characteristically takes the form of an energy variable. But a psychological threat may present itself as a sign or a symbol. Particularly when one is studying behavior of the "idling" state under load, there is a tendency, because of the absence of an independent variable, to think of the load as the variable. However, if the term load is restricted to those environmental factors which menace the integrity or existence of the organism, the distinction will serve a useful purpose.

Integration of Observations

It has been noted for some time that the usual performance of the mental patient may not differ from the performance of normals, provided attention and motivation are sustained. It is quite possible that in chronic schizophrenics the prolonged strain induced by the load which the disease itself constitutes has brought about a permanent distortion in the patient's adaptive capacity so that he displays reduced sensitivity under any additional load. It is, therefore, important that autonomic base lines be established for patients vis-à-vis normals under the idling state and that other variables be studied both from the point of view of usual functioning and from the point of view of functioning under a load. The hypersensitivity displayed by early schizophrenics under load in contrast to the apathy of the chronics has already been noted. It may very well be that no single aspect of behavior will alone distinguish the patient from the normal, but that the pattern of function will be distinctive (23). An additional point that has been noted (47) is that patients whose conceptual functioning is depressed below their
perceptual function are more likely to improve than those with conceptual behavior elevated above perceptual.

**Tools and Techniques of Research**

A program designed for the intensive exploitation of these new leads in psychopathology is represented in Table 2 in which certain techniques that have shown promise in preliminary undertakings are classified according to the schema previously described. The omission of techniques for the study of sensory activity is justified by the fact that sensory thresholds have not been found to bear any relation to outcome of mental illness. On the other hand, it should be emphasized that techniques which have failed to discriminate patients from normals under ordinary conditions may yield significant differences when the subjects are tested under a load, such as psychological threat, sensory deprivation, or extreme of temperature. The imposition of a load reveals the lowered tolerance and decreased resilience of the patient.

**Physiological Techniques**

The increasing evidence that schizophrenics may differ from normals in essential physiological function makes it urgent that experimental psychopathology give greater attention to the physiological level of behavior. The following two techniques represent efforts to measure autonomic components of physiological activity.

1. **Pupillography.** The method of recording pupillary reflexes developed by Lowenstein (28) presents an unusual opportunity to study the interaction between the sympathetic and parasympathetic divisions of the autonomic system, since presumably both divisions modulate the pupillary mechanisms. In this technique, serial photographs of the eyes are made under infrared illumination after dark adaptation and during controlled exposures to light. The diameter of the pupil is measured from the film and plotted against time. Lowenstein and his co-workers have performed numerous animal experiments and have assembled a large body of clinical data which point to relationships between pupillographic curves and specific lesions or dysfunctions of the central nervous system. This technique was applied to the study of schizophrenia in a pilot investigation by Lowenstein and Westphal in 1933 before the method had been satisfactorily standardized. The curves they obtained for catatonic schizophrenics were strikingly different from those of normals. The diminution of the pupillary reflex on repeated evocation is more pronounced and appears earlier in patients. Moreover, in normals, but not in schizophrenic patients, the initial level of response can be restored by inducing startle, i.e., when a sudden intense sound is introduced as a load, patients react differently from normals. It has also been noted that the pupillograms of schizophrenic patients show striking similarities to those of patients with extrapyramidal lesions.

2. **Pattern of autonomic responsivity.** Many investigators have reported differences between schizophrenics and normals in autonomic responsivity, particularly under conditions of stress-producing load. There is some indication that acute cases tend to overreact, chronic cases to underreact. However, the equivocal results of a substantial number of studies point up the need for further investigation. It is clear that the degree of activation of autonomic mechanisms is correlated with the strength of the stimulus, or load, ranging from simple alerting responses all the way to the severe and prolonged reactions evoked by combat fatigue. Research by Lacey (23) and by others has also shown that an individual's pattern of autonomic responses may be invariant despite great differences among individuals.

Taken together, these findings suggest the need to sample patterns of autonomic responsivity at several points along the intensity dimension. It may be that failure to find differences between schizophrenics and normals on a single response variable is caused by individuals with contrasting autonomic patterns who cancel out one another's responses in both groups. A polygraphic study of schizophrenics and normals provides a technique for determining the autonomic pattern as a basis of comparison. Such a study should include techniques from each class of stimulus variables, beginning with the idling state as a baseline and progressing through the energy operators and the signal operators. In particular, it is to be observed that the imposition of the load constituted by sensory deprivation may be expected to magnify the differences to be found between patients and normals.
<table>
<thead>
<tr>
<th>Technique</th>
<th>Variable</th>
<th>Function</th>
<th>Load</th>
<th>Reaction</th>
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<tbody>
<tr>
<td>Pupillography adaptation</td>
<td>appropriate</td>
<td>contraction and</td>
<td>sudden intense</td>
<td>restitution</td>
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<td>and restitution</td>
<td>alternating light</td>
<td>dilation</td>
<td>sound</td>
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<tr>
<td>Pattern of autonomic responsity</td>
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<td>heartbeat, blood</td>
<td>sensory depri-</td>
<td>corresponding</td>
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<td></td>
<td>appropriate</td>
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<td>Weight judgment</td>
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<td>discrimination</td>
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<td>unanchored</td>
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<td>anchored</td>
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<td>discrimination</td>
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<tr>
<td>Flicker-fusion</td>
<td>configural</td>
<td>“steady” from</td>
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<td>Necker cube</td>
<td>configural</td>
<td>“flicker”</td>
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<td>Archimedes spiral rotation</td>
<td>configural</td>
<td>discrimination</td>
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<td>end of rotation</td>
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<td>of alternative</td>
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<td>Digital stimulator</td>
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<td>configural</td>
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<td>ambiguous figure</td>
<td>configural</td>
<td>discrimination</td>
<td>discriminative</td>
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<td>Color-form test</td>
<td>configural</td>
<td>report of direction of apparent movement</td>
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<td>turfboard</td>
<td>configural</td>
<td>movement</td>
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<tr>
<td>Tapping</td>
<td>configural</td>
<td>speed of motion</td>
<td>threat</td>
<td>—</td>
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<td>reaction time</td>
<td>configural</td>
<td>movement</td>
<td>difference in latency</td>
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<td>tapping</td>
<td>configural</td>
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<td>Reaction time shift</td>
<td>configural</td>
<td>movement</td>
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<tr>
<td>Delayed auditory feedback in</td>
<td>symbol</td>
<td>articulation</td>
<td>pin prick</td>
<td>change in rate of articulation</td>
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Because of the critical significance of emotional changes in mental illness, it seems important that base lines of autonomic response patterning should be developed for the various psychiatric groups. Malmo (29) has recently studied pathological anxiety in this way. It may be possible to develop indices which will constitute objective correlates of global clinical concepts such as "flattened affect," "degree of tension," "process and reactive schizophrenia," etc. Such an achievement would be a considerable contribution to the prediction of outcome in schizophrenia and might aid in distinguishing clinical subgroups within the psychosis. By studying indices of autonomic reactivity which reflect the readiness of the organism to adjust to change, one may gain insight into some of the determinants of the duration of illness.

**Perceptual Techniques**

The significance of perceptual behavior for prognosis becomes more apparent when the overlay of conceptual activity is peeled off. Moreover, techniques which minimize the conceptual component, permit a comparison between the patient's perceptual and conceptual function. As intimated above, it may be the difference between these levels rather than their absolute function which distinguishes those who get well from the chronics.

3. **Weight judgment (method of absolute judgment)**. This is a test of perceptual behavior in response to configural stimulation of varying complexity. The patient is given five weights to judge according to a range of categories from very heavy to very light. After the accuracy of judgment has been determined, a heavy anchor is introduced just before the presentation of each standard weight. The introduction of the heavy anchor tends to make the succeeding standard weight appear lighter. The S is instructed to judge only the second or standard weight. In this way, the directions attempt to offset the influence of the anchor. The effectiveness of the instructions is measured by the amount of shift in the judgment categories following the introduction of the anchor.

In a recent study, Salzinger (36) found that patients did not differ significantly from normals in accuracy of weight judgments, but did tend to shift significantly more than the normals, i.e., the schizophrenics were less successful in resisting the influence of the heavy anchor.
4. Critical flicker frequency. The power of the visual system to resolve stimuli closely spaced in time is a stable measure for the individual under basal conditions but is altered by damage to the central nervous system, by drugs, by illness, and by the normal process of aging (20, 24). There is some preliminary evidence that outcome of illness for schizophrenic patients may be related to level of cff at time of admission. In two studies, patients who were eventually discharged had lower thresholds at admission than those who remained in the hospital. As anxiety serves to reduce cff (21), it is a tenable hypothesis that patients who show greater anxiety, and hence lower cff, at time of admission have a better prognosis.

5. Necker cube. The number of fluctuations in the perception of an ambiguous figure, such as the Necker cube, can be counted by having the S press a switch every time he sees the cube shift. The data may then be analyzed for the number of shifts in each minute as well as for the total number of shifts.

Byseck (7), following the lead of McDougall and of Hunt and Guilford, found that schizophrenics had a lower rate of reversals than normals. It is not surprising, then, as a recent study at Brooklyn State Hospital has disclosed, that first admission mental patients who twelve months later were out of the hospital had a higher rate of shift than those who remained in the hospital. This relationship, however, was reversed in a readmission group—with the “Ins” having a higher number of shifts than the “ Outs.” All together, the first admission Ins had the lowest number of shifts, and the readmission Ins had the highest number of shifts. Moreover, sicker patients reached a maximum rate of reversals earlier in the five minute observation period.

6. Archimedes Spiral. A rotating Archimedes Spiral will be seen as a contracting or expanding configuration, depending on the direction of rotation. When the rotation is stopped, a contrary after-effect is induced in normals, but not in some brain-injured patients (34). This technique is being introduced with the expectation that it may help to detect brain-injured cases among the functionally ill.

7. Digital stimulator. It has been known for some time that perceptual defects may be uncovered by use of simultaneous stimulation methods (13). Although little work has been done on schizophrenic patients, reports thus far available indicate that schizophrenic children show defects in tactile perception with the Face-Hand test. Adult schizophrenics also show perceptual defects when tested by simultaneous stimulation methods. A test apparatus has been designed to permit simultaneous stimulation of one to eight fingers at a constant intensity of stimulation. Preliminary analysis indicates that the amount and pattern of errors made by schizophrenic patients are different from those of matched controls.

8. Color form test. Thurstone’s color-form test was developed for the objective measurement of color versus form preference. It consists of a moving-picture film in which the S indicates the direction of the apparent movement noted in the presented figure. If he sees the movement in one direction, he is color-dominant, if in the other, he is form-dominant. Some preliminary work with this technique indicates that depressed schizophrenics prefer the form responses and the downward-tending direction more often than do nondepressed patients.

Psychomotor Techniques

It has long been noted that mental patients differ from normals in their motor behavior. Indeed, the general apathy and sluggishness of many mental patients is one of their most striking characteristics, while at the other extreme the intense motor activity of the manic is often the first sign of abnormality. Recently, considerable evidence has accumulated (16) that psychomotor behavior may serve to distinguish subgroups among patients. It is in the hope of finding discriminators that will separate those who will eventually get well from the patients who fail to improve, that techniques 9 through 11 have been introduced.

9. Purdue pegboard. This is a standard test (44) of finger dexterity with a great deal of data on normals available for comparison. In recent studies, chronic patients performed more poorly than new admissions. Among the new admissions, significant differences were found between patients who were being hospitalized for the first time and those who had records of previous hospital admissions for mental illness.

10. Tapping test. A large number of studies have indicated a general slowing and an increased variability in choice reaction time in schizophrenic patients (16). Recent work has
tended to confirm these results and in addition patients with a good prognosis have been found to improve with successive testing, while those with poor prognosis showed no consistent trend. On the other hand, the trends reversed on this test for first admission patients and readmission patients. First admissions who performed well had a good prognosis, but in the readmission group poor performance was associated with good outcome. In general, the same trends hold for total tapping time as for choice reaction time, although the test seems to be somewhat less sensitive in distinguishing between groups.

11. Reaction time for sensory modality shift. This task requires the S to make a choice reaction to each of four stimuli, two in the visual modality and two in the auditory modality. These four stimuli are presented in a random series and the reaction times are classified into two groups: those for which the stimulus to the previous reaction is in the same sensory modality as the reaction under scrutiny; and those for which the stimulus to the previous reaction is in the other sensory modality. This technique is still in the pilot stage, but it is expected that schizophrenics will have a greater lengthening in reaction time than normals when there has been a shift from one modality of stimulation to the other.

Conceptual Techniques

The domain of conceptual behavior has for so long been the favorite habitat of the clinician that it hardly requires any justification, for it is indeed precisely at this level of functioning that mental disease manifests itself. Perhaps as a natural consequence, a confusion between categorization and description has vitiated much of the research at this level. In order to derive reliable evidence of conceptual functioning both for diagnosis and, more importantly, for prognosis, the psychopathologist must turn from the easy way of global observation up the stony path of rigorous measurement. Techniques numbered 12 through 19 represent some familiar and some new attempts to introduce quantification into the study of conceptual behavior. Here again the imposition of a stress-producing load helps to magnify the differences between patients and normals.

12. Delayed auditory feedback. The alterations in speech resulting from an experimentally induced delay in auditory feedback have been extensively studied. Individual reactions to delayed feedback vary from almost no disturbance to complete blocking of speech. The extent of the interference may represent the degree to which the individual makes use of air-conducted auditory feedback to steer ongoing speech. Experimental variation of the input to this steering mechanism provides a unique opportunity to study such processes in psychiatric populations. In a pilot study, some schizophrenics showed less disturbance than normals under delayed auditory feedback. These results corresponded with a preliminary study by Goldfarb (10) on schizophrenic children. Recently, normative and developmental studies were begun to obtain baselines for studies of abnormal populations. Preliminary results indicate substantial differences between normal children aged 4 to 6 and normal children in the 7- to 9-year age range.

13. Metalog. The Metalog test (46) attempts to tap facility of conceptual shift by requiring the S to produce as many different meanings to a simple stimulus word as he can within one minute. A high score corresponds to a large number of different meanings. This test was first used in connection with the Columbia-Greystone (25) study where a high score was found to be associated with poor prognosis in both the operated and unoperated groups.

14. Analogies test. In this test of conceptual performance, the S is required to complete a series of verbal analogies of the type, "Night is to day as dark is to light." Like the Metalog test, this test too was found to be inversely related to outcome for patients in the Columbia-Greystone study (25).

15. Essential differences test. In this test, the S is presented with successive sets of four words and is required to indicate in each set which word is most different from the other three; for example, apple, pear, carrot, plum. The S thus has to abstract an attribute which is common to three of the four words (25). He is also asked to justify his selection, i.e., to give an account of the ideational process involved. This is one of several tests which seem to be positively related to outcome for first admissions, but negatively related to outcome for readmissions.

16. Porteus maze. A standard test of nonverbal conceptual functioning, the Porteus (33) invokes foresight and planning. This test has shown significant changes after brain surgery.
Chronic schizophrenic patients tend to score quite poorly on this test.

17. **Stroop test.** This test (43) compares the ability to perform a conceptual task involving discrimination of four colors with and without distraction. The S is first asked to read a list of color names. His next task is to assign the proper names to a random sequence of colored dots. Then he is presented with a list of color names printed in a conflicting color of ink. He must name as rapidly as possible the color of the ink in which the words are printed. Finally, he is told to ignore the actual colors and to read the color names as fast as he can. The difference between the speed with which colors are named in the conflict situation and the speed when no conflict is present provides a critical score. Ability to resist the distraction of the conflict card appears to be positively related to outcome of schizophrenic illness.

18. **Vocabulary test.** Vocabulary can be considered a good indicator of overlearned conceptual behavior for purposes of comparison with other measures of conceptual functioning. The word list is taken from the Wechsler and Binet tests.

19. **Affect-focused interview.** Distortion of affective experience is one of the major characteristics of mental disorder. In fact, patients seldom appeal for help because of any inadequacy in adjustment to the environment. They usually come to the physician because of the way they feel. Moreover, one of the major findings of a survey of the literature was that patients with flattened affect had poor prognoses. In the affect-focused interview (12, 37, 45), the patient is first engaged in conversation for ten minutes (the operant period). During the second ten-minute interval, every affective utterance is reinforced by expression of assent, such as "um-hum" (conditioning period). In a third ten-minute interval, the reinforcement is withdrawn (extinction period). An analysis of recorded interviews for the number of affective utterances during the operant, conditioning, and extinction periods gives a measure of the ability of the patient to emit affective utterances under reinforcement. The procedure has been refined by controls for reliability, i.e., repeated interviews with different interviewers, and repeated interviews on different occasions with the same interviewer. The interview is conducted in a room provided with a one-way observation screen so that the non-verbal behavior of interviewer and interviewee can be observed.

**Summary**

The aid of biometrics is invoked for the design of a program of experimentation; for the integration of findings at different levels of complexity; and for the development of new research tools.

The behavior of individuals can be analyzed into a set of overlapping domains of ascending psychological complexity: physiological, sensory, perceptual, psychomotor, and conceptual. These areas have not received equal attention from students of psychopathology. In the past, there has been too much preoccupation with the conceptual domain. In fact, a good deal of research labeled as perceptual is actually concerned with conceptual behavior. While sensory psychology has thus far contributed little to our understanding of psychopathology, the neglect of physiology by most psychopathologists is unfortunate. Moreover, the interrelations of these functional levels may prove to be of prognostic value. Thus, there is already some evidence that the ratio of perceptual to conceptual function distinguishes different subcategories of mental patients.

The variety of investigative methods employed in research ranges from naturalistic observation through controlled experiments to modifications of the organism. The first method, observation, is propedusetic to science. The laboratory experiment involves directing energy or signals at the organism and studying that part of the subsequent behavior which can be functionally related to the independent variable. Variables of the energy category may be appropriate (e.g., light for the eye) or inappropriate (e.g., pressure on the eyeball). Signal variables can be: simple configurations (as in studies of perceptual discrimination); signs which represent some event remote in time or space (as in learning experiments); or symbols (as in studies of conceptual function.)

In order to throw additional light on the behavior of the intact organism, it is often useful to study response to controlled stimulation when the subject is under the influence of a stress-producing load. By straining the organism to its limit of resilience, a load may help to reveal differences between normals and
patients which are obscured under everyday conditions.

Radical invasions of the organism's integrity, such as administration of hallucinogenic drugs, implantation of electrodes or ablation of brain tissue, can provide information about limited subsystems of behavior, but raise many problems of relevance with respect to integrated behavior.

A comprehensive program of research is presented, part of it already under way, designed to exploit the possibilities inherent in the interactions between different levels of psychological function.

REFERENCES


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