Contributions of Biometrics to Psychopathology

By JOSEPH ZUBIN

BIOMETRICS IS THE SCIENCE that applies measurement to the structures and functions of living organisms. When applied to psychopathology, its meaning includes, in addition, the assessment of their behavior, as well as of the milieu of the groups of which they are part. Its purpose is to improve classification, diagnosis, prognosis, and the evaluation of treatment and outcome. In trying to provide as wide an avenue as possible for biometric approaches to psychopathology, we have viewed the subject through a wide angle lens that takes in the entire panorama of sciences dealing with psychopathology.

As a result, our group consists of nine sections. This paper can present only a small portion of the contributions of each, and I am very grateful to the following heads of sections for permitting me to present to you this brief selection of their contributions: Dr. Muriel Hammer, Anthropology; Dr. Kurt Salzinger, Behavioral Analysis and Modification; Dr. Joseph Fleiss, Biostatistics; Dr. Barry Gurland, Diagnosis and Psychopathology; Dr. Robert Spitzer, Evaluation; Dr. Denise Kandel, Family Research; Dr. Ruth Bennett, Gerontology; Dr. Samuel Sutton, Psychophysiology; and Dr. David Wilder, Sociology. In contrast with more formally organized departments at universities or in institutes, we have found that by focusing on problem solution rather than specific disciplines, we have been able to discard disciplinary boundaries and permit coalitions of individuals from various disciplines to cooperate freely.

Biometrics, like psychology, has a long past but a short history. The use of counting and quantitative methods in science and in medicine goes back to the early Greeks. In Shakespeare's day we note that there must have been a cross-national study of mental disorders in Denmark and England, leading one of the characters to say of Hamlet's dispatch to England, "T'will (Hamlet's madness) not be seen in him there; there the men are all as mad as he."

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The enumeration of patients in the hospital, required by the exigencies of some institutions, contributed some of the earliest records in statistical annals and the calculation of the percentage of improved patients was one of the first examples of the biometric method in psychopathology.

Richard Hunter and Ida Macalpine trace the development of statistical methods in psychopathology and find that by the middle of the 17th century considerable data were being collected in systematic fashion. These statistical reports have reached their zenith in the reports of the Statistical Bureaus of the Department of Mental Hygiene in New York, the Department of Mental Health in Massachusetts and in the Biometric Branch of the N.I.M.H. But already in 1849, more than 120 years ago, Isaac Ray complained that these statistics depended largely on subjective impressions and there was not even a uniform nomenclature by which clinical information could be communicated.

Culpan is usually regarded as the father of modern biometrics, and the Culpan Laboratory, established by Pearson and directed later by Fisher and Penrose, continues to be a leading center for biometric research. His attack on the impressionistic approaches which were so prevalent in his day is documented in the following quotation:

General impressions are never to be trusted. Unfortunately, when they are of long standing, they become fixed rules of life and assume a prescriptive right not to be questioned. Consequently, those who are not accustomed to original inquiry entertain a hatred and horror of statistics. They cannot endure the idea of submitting their sacred impressions to coldblooded verification. But it is the triumph of scientific men to rise superior to such superstitions, to desire tests by which the value of beliefs may be ascertained, and to feel sufficiently masters of themselves to discard contemptuously whatever may be found to be untrue.

So much for a brief history of biometrics in psychopathology. The purpose of this presentation is not to delve into history, but to present some of the current developments in biometrics research. It was inspired by Dr. Fritz Freyhan's Presidential Address to the 1969 meeting of the American Psychopathological Association, entitled, "The psychopathologist—what man of science?", in which he bemuses the lack of recognition afforded clinical research of the subjective and intuitive, but creative, variety, as opposed to the experimentally controlled and statistically tested approaches. In accepting his invitation to address you I wrote him:

I have just finished reading your chapter for Disorders of Mood and found it interesting and most challenging, as always. In my proposed talk I may point out how the biometric approach emanates from the clinical approach and attempts to provide a public mirror for the private, subjective phenomena with which the clinician is concerned. Like all mirrors, it is not the "real" thing, but it does permit public scrutiny and consensus, or lack of it, in an otherwise highly subjective, intuitive area where one must depend only on his own private world for guidance.

The Major Approaches to Psychopathology

Someone has likened psychopathology to a landscape, the clinician to a taxi passenger, the phenomenologist to a tourist, and the biometrician to a surveyor. The clinician is not concerned with the landscape and its beauties as much as
he is with arriving at his destination, which is the diagnosis, and by the shortest route. The phenomenologist takes no short cuts because he is primarily interested in viewing all the sights and in satisfying his curiosity about the nature of the terrain. The biometrician is less concerned with the beauty, than with a scientific survey of the entire landscape. It is quite clear that the three methods—clinical, phenomenological, and biometric—are actually different aspects of the search for knowledge in psychopathology; without the clinician there would be no questions to answer, without the phenomenologist there would be nothing to measure, and without the biometrician there would be no solutions to the questions that arise. While each of these three disciplines can exist in its own right, for experimental investigations and for the comparative evaluation of individuals and groups, the biometric method offers many advantages. One outstanding clinician and phenomenologist, Karl Jaspers, recognized these when he said: 12

The biometric methods give us more than figures and correlations. They foster clarity in all fields in which biometric variations can be established. Moreover, through the application of these methods we have concrete experiences which we would never have had without them . . .

The Application of the Biometric Approach to Descriptive Psychopathology

The descriptive approach was suggested by no less an authority than Kraepelin, who 75 years ago suggested the paradigm for biometric description in the following words: 13

As soon as our methodology has sufficiently proved itself through experience with healthy individuals, it would be possible to approach the actual ultimate goal of these efforts, the investigation of the sick personality, especially of the inborn pathological disposition . . . We, therefore, have first of all to investigate whether it is possible by means of psychological tests to determine individual deviations, which cannot be recognized by ordinary observation. If that succeeds, we would be in the position, through the quantitative determinations at our disposal, to establish the borderline between health and disease much more precisely and more validly than has been possible so far.

Following Kraepelin's lead, in the early 1930s, we used psychological tests to try to measure the effects of treatment for general paresis; later we constructed personality inventories, sorting tests, handwriting analyses, and projective techniques for classification and diagnosis and a whole battery of psychological tests for the evaluation of topectomy operations. The results were equivocal, principally because we had no reliable criterion against which to validate these tests except the interview, and you know what the scientist has said about the unreliability and invalidity of the freewheeling interview. In fact, the Rorschach, on which we spent nearly 15 years, turned out to be completely unreliable and invalid, except when the protocols were treated as interview material. As a consequence, we decided to tackle the interview directly and converted the mental status examination to a systematic structured interview, yielding both high reliability in its scoring of items, as well as considerable validity. There are three types of interviews: (1) a nonprobing approach, SCI; 9 (2) a medium-probing approach, MSS 27 and PSS; 26 and from outside our
laboratory, (3) a deep-probing approach, MRC schedule.\textsuperscript{3,7,28,29} These instruments are now used in some 50 centers and have proved their value in various epidemiological studies and therapeutic trials and succeeded in demonstrating, for example, the superiority of day hospital care to inpatient treatment in several studies.\textsuperscript{10} Our evaluation section has also developed Diagno I and II,\textsuperscript{24,25} programs for arriving at a computer diagnosis based on the systematic structured interview.

The next example of the utilization of the descriptive approach is the Cross-National Study of Mental Disorders in the United States and the United Kingdom. On the basis of a combined schedule comprised of nonprobing, medium-probing, and hard-probing items, our Project on Diagnosis of Mental Disorders was able to demonstrate that the much heralded differences in the prevalence of hospitalized functional mental disorders (schizophrenia versus affective psychosis) in the United States and the United Kingdom were, to a large extent, labeling differences.\textsuperscript{8,7}

An example of the need for better diagnostic instruction in the United States is shown by the following analysis by Dr. Gurland and his colleagues.\textsuperscript{7a} By means of our structured interviews, a group of patients was found in both the United States and the United Kingdom whose profiles of psychopathology indicated that they suffered from morbid depression and very little else. In New York only 21\% of this morbid depression group were given the diagnosis of depression, while 60\% were given the diagnosis of schizophrenia, and 19\% were given the diagnosis of "other." In the United Kingdom the picture is reversed; 60\% were given the diagnosis of morbid depression, while 14\% were given the diagnosis of schizophrenia, and 26\% the diagnosis of "other." In both countries, morbid depressives are apparently mislabeled to some extent, but the proportion mislabeled in the United States is much higher than in the United Kingdom.

What effect does this mislabeling have on treatment and outcome? In New York only 50\% of this essentially depressed group were treated for depression (drugs or ECT), while in London more than 84\% were thus treated. In other words, of the morbid depressives, many more in New York missed out on the treatment of choice than in London. There is other evidence that the New York psychiatrists were sensitive to the presence of depression in this patient group, but their failure to make a diagnosis of depression rather than schizophrenia produced a situation which may have denied the best treatment to at least one group of patients.

The provision of reliable and valid data by means of the systematic interviews has enabled us to develop a better anatomy of psychopathology through the use of factor analysis. One of the outstanding accomplishments was the separation of anxiety from depression which heretofore had usually been found to coalesce in one factorial dimension.\textsuperscript{30} Armed with these new separate measures of anxiety and depression we were able to demonstrate that (1) depressive neurotics differ from anxiety neurotics on the anxiety factor, but not on the depression factor; (2) schizoaffective psychoses differ from other schizophrenics on the depression factor but not on the anxiety factor; and (3) neurotic de-
pressives do not differ from psychotic depressives on the anxiety nor on the depression factor but do differ on some other factors.

The Application of the Biometric Approach to Etiology in Psychopathology

As long as we are satisfied with phenomenology alone and are not seeking causes, descriptive psychopathology can serve us well. But description alone never cured a patient and never brought full understanding of a disorder. For thorough understanding we need to know etiology. But as far as etiology is concerned, we are currently rather ignorant and therefore we must resort to our imagination and invent "as if" causes or scientific models. The scientific models that now exist in our field are: ecological, developmental, learning, genetic, internal environment, and neurophysiological.

The ecological approach searches for etiology in the ecological niche which the patient occupies and this model indicates the following factors as possible etiological agents: socioeconomic status, educational level, ethnic origin, physical surroundings, and so forth. We are still lacking a taxonomy of environmental forces which may be the culprits in the development of psychopathology.

The developmental model searches for cause in the transitional stages which man goes through in passing from fetus to neonate to childhood, adolescence, adulthood, and the senium. Disturbances at these various levels of development or in the interfaces between these levels are postulated as the sources of the disorder.

The learning theory model stipulates that psychopathology, like normality, is learned behavior. A functional analysis of behavior is necessary to determine what were the contingencies in which the behavior in question developed and what are the contingencies which maintain it now. Once we understand the sources of this behavior and/or the reinforcement which maintains it, we are well on the way to its elimination.

The genetic model needs little explanation. Its main tenet is that, unless you inherit the propensity for psychopathology, you can never develop it.

The internal environment model has been with us since before the days of Kraepelin, and the biological basis of mental disorder is one of the most active research areas of today.

The neurophysiological model suggests that brain function and information processing in the mentally disordered are different from that in normals.

What tools do we have for testing the hypotheses emanating from these various models? The models fall into three clusters with regard to techniques for testing hypotheses. The ecological model depends primarily on culture-dependent techniques such as the interview for its data and hypothesis-testing. The genetic, internal environment, and neurophysiological models can be relatively free of culture-dependent techniques and adopt culture-free techniques—chromosome counts, biochemical tests, electrophysiological measures, and so forth. The developmental and learning theory models utilize culture-fair techniques in which the tools, though reflecting the local coloration of the culture, can nevertheless be translated across cultures. For example, greeting behavior and mourning behavior, though dependent on local culture, have a counterpart in mourning behavior among the elderly. The same disorder was observed peacefully in the 20th century as a degree of proctor domestic illness. Prospective studies of various adjustment needs.

We have considered a patient's problems are not in individuals who are considered when the cases that are the closest ties are one that elapsed patient to the point to hospitalization and performance of

Studies of social networks. The social networks central to acquaintance and the relationship between (3) a tendency observed under-report more skewed

With regard to patterns in friendship patterns. Following the differences between the peer group contact with orientation, the measure of intimacy, reciprocity of intimacy, and so forth.

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counterpart in every culture, and deviations or abnormalities in greeting or mourning behavior can be detected cross-culturally. Similarly, incommunica-
bility of patient speech can be detected cross-culturally by culture-reflecting
techniques.

In the ecological area several investigations were conducted on the en-
vironmental factors which lead to hospitalization for mental disorders in the
elderly. The residents of old age homes who had to be hospitalized for mental
disorder were compared with well-matched controls who ended their days
peacefully in the home. The single striking differential that has emerged is the
degree of preadmission isolation that characterized those who became mentally
ill. Prospective studies of this factor have verified this finding; the degree of
adjustment made by those who were isolated was poorer.¹

We have also found, in a study that measured the social connections of
a patient prior to admission, that patients whose closest ties are with
individuals who are also close to each other, are less likely to have these ties sev-
ered when they are admitted to the hospital than are the patients whose
closest ties are with individuals who are not close to each other. Further-
more, these social connections were significantly related to the length of time
that elapsed between the appearance of symptoms and the admission of the
patient to the hospital, the likelihood of his being brought into therapy prior
to hospitalization, and the likelihood of his receiving assistance in the per-
formance of his usual tasks.

Studies of small networks of normal individuals are now providing us with
better measures of social connection which will later be applied to patients' networks. These studies have so far shown (1) a high correlation between
social centrality, by which I mean the amount of interaction and the degree of
acquaintanceship between one member and the other members of a group,
and the relative comprehensibility of speech within a group;¹⁹ (2) a relation-
ship between interconnectedness of contacts and style of interaction;⁸ and
(3) a tendency for subjects' reported contacts to be more clustered than their
observed contacts, that is, subjects tend to over-report frequent contacts and
under-report infrequent ones, making the distribution of pair-frequencies seem
more skewed by report than by observation.⁸

With regard to the developmental model, a study of adolescent friendship
patterns in preschizophrenics was conducted to determine whether their
friendship patterns were significantly related to their subsequent disorder.
Following the lead of Harry Stack Sullivan, one might expect to find differ-
ences between preschizophrenics and matched normal controls during adoles-
cence when the focus of social interaction begins to shift from the family to
the peer group. It has been found that measures of social interaction, such as
contact with peers and the best friend, dating, and a peer rather than a family
orientation, did not differentiate the preschizophrenics and the normals, but
the measures of intimacy, such as favoring, confiding, satisfaction with the best
friends, reciprocity in friendship, and the loneliness accompanying the absence
of intimacy, indicated large differences between the two groups; feelings of
intimacy were much less developed in the preschizophrenic.¹⁴

The Behavioral Analysis and Modification Section of Biometrics Research
has worked in the area of the analysis and modification of deviant behavior in children according to the principles of the learning theory model. Operant conditioning techniques were applied directly to the treatment of young hospitalized children in order to deal with severe speech deficiencies, tantrums, and other behavior problems, and most recently, parents of brain-injured children were instructed in the design and application of behavior modification programs to be carried out with their own children at home. In almost all cases, each child had long-standing multiple behavior problems.

First, the behavior in question is specified in objective terms, so that its occurrence may be reliably observed. The discriminative stimuli—the context of the behavior or the events which are its usual immediate antecedents—are determined through careful observation, and the reinforcements—the immediate social or other consequences of the behavior—are observed. Based on this information, a behavior modification program is then constructed. The approach thus provides for a behavioral classification of the problems, a specification of the events which maintain the problem behaviors, and a means of treatment which can be effectively carried out by hospital ward personnel, families, and others—not only by professional therapists.

Another major interest of this section has been the verbal behavior of schizophrenics. Kurt Salzinger has formulated the immediacy hypothesis which states that relative to normal individuals, the schizophrenic’s behavior is more a function of stimuli which are temporally or spatially close. Applying the hypothesis specifically to verbal behavior leads to the prediction that the speech of the schizophrenic at any point in the discourse is more closely related to the immediately surrounding words, whereas for a normal individual the relationship would hold over a longer span of words.

This prediction was tested using a modification of the cloze procedure, in which every fifth word is deleted from a transcript of speech and a group of subjects attempts to supply the words that were deleted by guessing. Using schizophrenic and matched normal controls, it was found that the schizophrenics’ speech was significantly more difficult to predict. Subsequently, excerpts were taken from the same speech samples of normals and schizophrenics and presented to different subjects with varying amounts of context surrounding the blank to be filled in. As predicted, it was found that the schizophrenic speech consists of relatively short strings of words; for the normals, larger amounts of context are helpful, and thus the interrelationships among words in their speech hold over longer spans.

This study not only adds to the support for the immediacy hypothesis but also employs a technique which permits an objective and precise analysis of the commonly cited deficit in schizophrenics’ communication. It should also be mentioned that the cloze technique holds promise for prognostic use as well, since it has been found that schizophrenics whose speech samples were easier to predict spent fewer days in the hospital during a 180-day follow-up period than those whose speech was harder to predict.

All of the studies presented thus far have dealt with culture-dependent and culture-fair techniques. As mental disorders can be occluded as well as elicited by the ecological niche in which the individual finds himself, it is necessary to
use techniques which are less dependent on culture. One approach is afforded by studying responses of the individual that come within the first 1000 msec following stimulation. The response comes so rapidly that it may be relatively unaffected by ecological forces.

An example of such an indicator is afforded by a study conducted by Sutton, Collins, and Kietzman at Biometrics Research (personal communication). They have found differences between schizophrenics and normals in the critical duration of stimulation specified by the Bunsen Roscoe Law or Bloch's Law. According to this law the intensity and temporal duration of stimulation are interchangeable for a brief period of time—the packaging of the energy (high intensity for short duration or low intensity for long duration) does not influence the response, provided that the total energy input (the product of intensity and duration) remains unchanged. This critical period for a reaction time response is about 12 msec in normals, but appears reduced in schizophrenics to less than 6 msec. In other words, even though the total energy input remains unchanged, the integration of energy over time is incomplete earlier in the schizophrenic, as evidenced by an increase in the reaction time at 6 msec compared to that at 4 msec. This increase in reaction time in the schizophrenic may be interpreted as due to a reduction in the effective energy of the stimulus when the duration exceeds 6 msec, indicating partial, rather than full sensory integration over time. It is interesting to note that, in this particular function, depressives differ from schizophrenics and resemble normals.

This is one of several tasks designed by Sutton and his colleagues which shows differences between schizophrenics and normals that cannot be attributed to less motivated or less attentive performance by the patients. Energy packages of these durations, yielding differences in schizophrenic reaction time responses, cannot be discriminated psychophysically by normals. We are in the process of checking this for schizophrenic patients, but we suspect that they also cannot make these discriminations psychophysically. However, the reaction time responses of schizophrenics do "discriminate" these different energy packages. Since the differences do not appear to enter into awareness, and since the schizophrenics are making a "discrimination" which normals cannot make, it would be difficult to attribute these differences between schizophrenics and normals to attitudinal or attentional deficits in schizophrenic performance.

One unanticipated finding in this experiment was that the patients who exhibited a reduction in the critical period for energy integration also showed thought disorder, as measured by the scaled dimension for "speech disorganization," based on the factor analysis of the systematic structured interview. However, those who failed to exhibit the reduction in critical duration also failed to show thought disorder. We are now beginning to investigate further the nature of the thought disorder which characterized these individuals by analyzing the items which show high loadings on the factor of thought disorder. We may also revive the psychological tests for thought disorder, such as sorting tests, in order to further clarify this issue. In this iterative manner, we can go back and forth between the laboratory and the interview to test results and clarify each technique as we progress from the one to the other.
Following Payne's suggestion, we may discover that the thought disorder factor may consist of several components, among which we may be able to distinguish between overinclusive thinking and overinclusive perception.

One might wonder how such miniscule differences in reaction time and in integration of sensory input could play an etiological role in schizophrenia. We have already noted that there seems to be an association between the shorter critical period for energy integration and thought disorder. What could the nexus be? At this point in time, all we can do is guess, but guesses need not be idle; they can lead to investigation. One hypothesis is that these miniscule differences in reaction time, energy integration, and other differences which we have not had time to describe, pupillographic responsiveness and auditory localization, may lie at the bottom of the schizophrenic's reaction pattern. Once these small differences induce in the subject a feeling of being different from his fellows and they in turn begin to regard him as deviant, the rest of schizophrenic behavior can be regarded as epiphenomena, induced by responses of the person to his environment and the responses of his peers to him. These miniscule differences may be likened to the pawns in a chess game, which the preschizophrenic loses in the game of life. This loss is enough to finally produce a checkmate. Whether their source lies in metabolic differences, neural development, or early reinforcement history is at this point not crucial, although their time scale is so brief that their initial development may be independent of learning. After these small deviations appear, learning principles may explain why withdrawal and other schizophrenic symptoms arise.

One source of heterogeneity, even in patients showing the same psychopathological profile, arises from the fact that measures of psychopathology reveal only one aspect of the patient's personality, his liabilities; his assets remain unknown. Bruce Dohrenwend has shown that a group of community leaders whom he interviewed with our systematic structured interviews revealed considerable psychopathology despite their effectiveness as leaders. Had Dohrenwend utilized a method which also tapped assets as well as liabilities, he would have discovered how the leaders were able to cope with their psychopathology. In order to provide an assessment of assets we are attempting to utilize the method of personality evaluation developed by Sjöbring, the famous Swedish psychiatrist of Lund who evolved a system in which personality is assessed independently of psychopathology. At present it is based on a free wheeling clinical interview, but we have begun to convert it into a systematic structured interview.

**Summary**

I have presented a brief review of the contributions of biometrics to psychopathology. Biometrics takes as its starting point the hunches, beliefs, traditions, and untested practices which have arisen from the clinician's confrontation with the immediate needs of the mentally disturbed. From our analysis of the present state of diagnosis, however, it is quite clear, that for research purposes, any comparison of studies of mental patients based on clinical diagnosis alone is of little value. As the diagnoses among clinicians
and even for the same clinician from one time to another are not comparable, no homogeneous group is described by a given label.

To remedy this situation we have pointed out how these clinically derived conclusions can be subjected to scientific scrutiny by objective measurement with the view of determining their reliability and validity. By subjecting groups of patients possessing similar profiles to certain laboratory tests, we can use an iterative method for relating interview profiles to test results sequentially and improve both the interview and the laboratory test as we move from the one to the other.

In order to contain the entire spectrum of psychopathology, we can not depend on treatment cases alone but must investigate an entire population to find those individuals who may exhibit equal amounts of psychopathology as compared to those who come to treatment, but who themselves never seek help. After assessing assets as well as liabilities, a knowledge of why they fail to seek treatment may unearth some of the hidden factors separating the “ill” from the “well,” as well as discover individuals who need treatment but for some reason do not get it.

But descriptive psychopathology, no matter how precise, never cured a disorder. For deeper understanding, etiology must be sought. The etiology of mental disorders is so poorly understood that we must use scientific models. To test these models we need adequate tools and examples of such tools were described in the studies reported.

One question remains. Has the biometric research program proven its value? If we examine our goals, the unraveling of the causes of the mental disorders through objective approaches, we have made only little progress, but if we look back to where we started, our advances have been considerable. In fact, we may have been too successful! The use of rating scales, systematic structured interviews, and objective instruments and recording forms for evaluating psychiatric status has spread like wild fire because 34 centuries of uncontrolled, subjective observations demanded systematization. This progress, however, has also drawn off the creative energies of many intuitive phenomenologists and turned them in a biometric direction. As a result, we may be running the danger of killing the goose that laid the golden eggs. By siphoning off these creative energies from phenomenology, we may be left with the crystallization of “psychopathology 1970” into a rigid mold and make no further progress. We need the creative, even if unsystematic, curious phenomenologist to examine the psychopathological terrain of his patients so as to provide us with deeper insights and more intuitive understanding which can then be subjected to biometric scrutiny.

Examples of the clinical origin of our research are as follows: the study on adolescent friendships in preschizophrenics grew out of our attempt to find an index of type of onset, as insidious onsets had been regarded by clinicians as having a poor prognosis; our measure of the effect of reinforcement on verbal behavior resulted from the clinical observation that flatness of affect led to poor prognosis; our studies of isolation and network communication arose from the clinical observation of the role of family interaction; and our
psychomotor, sensory, and perceptual studies arose from clinical observations of psychomotor and perceptual dysfunction in schizophrenia.

While the biometrician has his own problems to tackle—reliability, validity, continuity of dimension versus typology—he can not be expected to supply both the universe of discovery as well as the universe of verification. For the universe of discovery, following Reichenbach, there are no rules or regulations, but rather sheer creative moments. If these dry up, neither biometrics nor psychopathology can make further progress.

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REFERENCES


CONTRIBUTIONS OF BIOMETRICS TO PSYCHOPATHOLOGY


