SCHIZOPHRENIC THINKING IN A PROBLEM-SOLVING SITUATION.

By NORMAN CAMERON, M.D., Ph.D.

(From the New York Hospital and the Department of Psychiatry, Cornell University Medical College, New York, U.S.A.)

INTRODUCTION.

THE difficulties inherent in reducing schizophrenic thinking to the conditions of an experiment have led to a variety of attacks upon the problem. Of these, the attempts to subject thinking disorders to methods of quantification have so far yielded little of value. That this has been the case can be readily understood when one considers what heterogeneity of psychopathology is included under the term " schizophrenia ". Moreover, the thought of schizophrenics is apparently of the same order of complexity as the thought of normal persons, and its qualitative characteristics are even less well known. Under present conditions the qualitative approach seems to promise a greater and more useful field. Where tests have been employed with advantage in studying schizophrenia it has been chiefly their by-products that have deserved attention.

Rawlings (13), using the Yerkes-Bridges point scale and tests of association and imagination on schizophrenic patients, noted a decrease in linguistic fluency, marked impairment of the ability to compare, abstract and generalize, and a loss in apperceptive activity. There was also present a tendency " to deal with the concrete rather than the abstract when the abstract was indicated ". Rawlings attempted to relate these reductions in capacity to cellular changes found post mortem in the cerebral cortex. Wentworth (17), making use of the Stanford-Binet test, found schizophrenic patients defective in generalization.

Babcock (1) attempted to work out on a quantitative basis what she called an " efficiency index ", using oligophrenic and schizophrenic patients. This " index " represented the difference between the mental age, as determined by the vocabulary rating, and the level of achievement reached in a battery of tests, which depended largely upon the acquisition of new learning and the speed of reaction. She drew certain conclusions regarding deterioration on the basis of the " efficiency index ", in terms of how well the patients performed

https://doi.org/10.1192/bjp.85.358.1012 Published online by Cambridge University Press

but she did not throw much additional light upon the characteristics of schizophrenic thinking responsible for their relatively poor performance.

Bender (2) had schizophrenic patients copy simple Gestalt figures, taken from Wertheimer's patterns. In comparing their copies with those of normal and of feeble-minded persons, she felt that the schizophrenics tended to revert to childish characteristics, among which she lists perseveration and fragmentation in the copied forms, the changing of dots to loops and dotted lines to wavy lines, an avoidance of crossed lines and angulated lines, and micropsia. This reversion she found occurring irregularly, and frequently in only a part of the total pattern while the internal organization of the pattern as a whole might remain undisturbed.

Muncie (12) has analysed the schizophrenics' use of metaphorical expressions. He calls attention to their use of metaphors in the original " concrete sense " which is no longer current, and sees in this an expression of a " loss of social value and the resort to autistic gratification ".

Bolles (3), following Goldstein's approach to the study of organic cases, used the coloured skeins of the Holmgren test, the Weigl form-colour sorting test, two object-sorting tests (one involving the grouping of objects varying in colour, form, material and dimension, and one made up of miscellaneous objects which the subject was to group on the basis of their seeming to him to belong together), the Kohs block test, the feature profile test from the Pintner-Patterson performance scale, and several verbal tests from the Stanford-Binet. She found that neither oligophrenics nor schizophrenics showed the highest levels of abstraction achieved by normal children ; they characteristically responded in a concrete way on tests in which either concrete or abstract ways of behaving were possible, while normal children were able to respond in either way. *Concrete behaviour* Bolles defined as that " primarily determined by sensory impressions ", and *abstract behaviour* as the " response to objects as representative of a class or category ". She emphasized the inability of the schizophrenic patients to shift from one aspect of the situation to another when instructed to do so by the experimenter.

Bolles and Goldstein (4) gave in more detail results they obtained by using similar methods. They were struck by the difficulty their patients found in stating why objects they had placed together seemed to belong together. They felt that the ability to shift one's attitude from one aspect of the problem to another " is lost if the abstract attitude is impaired ". They also pointed to similarities between their results and those obtained in the study of organic cases by Gelb and Goldstein, adding by way of caution, however, that they did not mean " that schizophrenia is the same as an organic lesion of the brain. We mean that the effects of the disorders which might be signs of a very different origin and kind, in these tests show the same characteristics ".

Rickers-Ovsiankina (13) has studied the reaction of schizophrenics to

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environmental objects in a free situation, and (14) their reaction to interrupted tasks. She found in the former that, on the whole, schizophrenics responded to environmental objects approximately to the same degree as normals did; but only in the normals did preoccupation with directed activities become predominant. The schizophrenics showed a definitely lower percentage of resumed or completed tasks following interruption—41·8%, as compared with 72·5% for normals.

Hanfmann (8) used the Healy pictorial completion test II. She found that two-thirds of the schizophrenic group, and three-fourths of a group of general paretics and cerebral arteriosclerotics, made incongruous placements that were practically absent from the normal group. She found the schizophrenic patients apparently "unable to keep apart the sphere of personal wishes and fears, the sphere of objective reality, and the system of symbolic representation by picture or by word".

Kasanin translated an article from the Russian by Vigotsky (16), which reported the general results obtained from schizophrenic patients when they were faced with the necessity for making generalizations on a basis unfamiliar to them. Vigotsky distinguishes between "complex associative" types of thinking and "conceptual" types. According to his usage, in the former the union is concrete and mechanical, whereas in the conceptual types there is some general and abstract principle at the basis of the association. He found experimentally that normal pre-adolescent children and adult schizophrenic patients had difficulties in forming concepts. He attributed this in the children to the lack of development of the genetically later conceptual organization, and in the schizophrenics to a regression to the concrete factual forms of thought.

Hanfmann and Kasanin (9) have developed a modification of Vigotsky's method which will be described later in this paper. They stated in a preliminary report that schizophrenics were unable to grasp and apply principles of classification. In a later paper (10), these authors presented results indicating that even schizophrenics of superior education on the average made a poorer showing than normal persons with inferior education.

N. Cameron (5) studied thinking in schizophrenic patients who showed definite scattering by presenting them orally, one by one, with a series of fifteen incompleted sentence-fragments, each ending with the word "because". The patient was required to complete the sentence. The topics covered in this series varied from actual to purely hypothetical situations, from personal and other-personal to impersonal matters, and from those which any normal adult could complete acceptably to those which most normal individuals could not. Analysis of the material thus obtained brought out the following characteristics of schizophrenic thought:

(*a*) A loose organization in which things more or less relevant appeared clustered together, essential links were lacking (*asyndesis*), and fringe-elements were included which are eliminated by the normal adult. The inclusion of

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fringe-elements, i.e., of material belonging to the periphery of a given thought-organization, resulted in a lack of adequate boundaries and a consequent tendency to go over, by way of common material, into other topics. In some cases, when the patient tried to amplify his explanation, his attempt led only to a definite increase in vagueness and disorganization, the so-called *scatter-by-amplification*.

(*b*) A peculiar use of unprecise approximate terms and phrases which was largely responsible for giving to the responses that elusive flavour one so commonly observes in clinical experience. In place of saying that he eats three times a day, for instance, a patient says he "has menu"; another calls a total flat surface on which light falls "full room capacity", and so forth. Woods (18), using protocols from hospital records, was also impressed by the unprecise approximations used by schizophrenic patients.

(*c*) Closely related to the unprecise approximations are the personal idioms which these patients develop. These are habitually used terms and phrases which have a special meaning for the individual patient, and may be compared with colloquialisms and intimate family terms. For instance, the routine of daily work is called "methodical business" by one patient, and he uses "to serve a work" in the sense of "to be of service". Thus when he states that his goal in life is "to serve a work from the standpoint of methodical business", only a knowledge of his habitual private usages makes it possible to share his references, and so understand him.

(*d*) Among the most seriously disorganized patients an intermingling of themes could be detected on analysis. The compelling theme of the personal preoccupations, which was familiar to the experimenter, could easily be followed; while interspersed through it appeared elements plainly recognizable as belonging to the theme of the problem presented to the patient. There seems to be an *interpenetration* of the themes of preoccupation by that of the problem, and the latter appears here and there through the stream of talk, in the form of isolated words. In the normal adult the problem would ordinarily replace the preoccupation, at least for the moment. These data were brought into relation with the influence in schizophrenia of the disturbance of language function upon the social disarticulation of the patient.

Cameron (6) later investigated thinking of deteriorated senile patients, using the same sentence-fragments, and compared these results with those in the schizophrenic study, and with material also gathered from children (7 years, 2 months to 11 years, 5 months) and from normal adults. He found, in the first place, that neither schizophrenic nor senile material resembled that of the normal adults and the children, and, in the second place, that the characteristic features of schizophrenic thinking described above occurred very rarely among deteriorated seniles. In other words, schizophrenic disorganization of thought was found to be unlike the thinking of children and unlike that of a known organic deterioration. These results were discussed in relation to the more

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general differences between schizophrenia and senility—differences in biographical development, in pre-psychotic personality, in the organic pathology, and in the age-period of onset of the two groups.

Cameron (7), in a preliminary report summarizing some of the results he had obtained with schizophrenic and senile patients, using the Hanfmann-Kasanin blocks, again emphasized the differences in performance between these two groups. The verbal productions of the schizophrenics gave further examples of the characteristics of thinking described above. It was pointed out that, since in these results the thinking of the schizophrenics turned out to be neither childish nor that of a common organic deterioration, the terms " deterioration " and " regression " should not be too uncritically applied to schizophrenia.

The present paper presents a further analysis of the results obtained from schizophrenic patients, making use of the Hanfmann-Kasanin blocks. By substituting in this study, for the purely verbal method used in the earlier ones (5, 6), a situation in which both language behaviour and visible manipulation appear together, one can compare the verbal accounts with the manual movements as these occur, simultaneously or in succession. It is possible also to see to what extent and in what way disorganized schizophrenics are able to make general statements about operations and their results which both patient and experimenter can watch together.

Method.

For this more intensive qualitative study of schizophrenic thinking in a complex problem-solving situation, five patients were selected who showed severe disorganization. The Hanfmann-Kasanin test, which was used in this investigation, requires the subject to group the blocks according to principles of generalization that can be inferred only as the experiment proceeds. At the same time, however, the subject is told plainly what the task is about and what in general he is to do; and he is given help whenever help becomes necessary. Since, in order to be able to evaluate the data we are about to present, a clear understanding of the problem and the procedure is essential, a somewhat full description of the test will be given at this point.

The test material consists of twenty-two wooden blocks varying in colour (red, green, blue, yellow, white), and in shape (squares, triangles, circles, half-circles, hexagons, trapezoids). There are two different heights and two different sizes within each height group. The patient's task is to sort the blocks into four groups; and to do this he must eventually infer the principle underlying such a grouping. Since there are five colours (including white) and six shapes, neither of these simple generalizations solves the problem. Indeed, the ingenious feature of this test is that no single word will suffice to characterize the solution. The four groups which the subject is expected to derive are

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into the large high blocks, the large flat ones, the small high ones, and the small flat ones. Colour and shape have eventually to be ignored in the process of solution.

The problem is somewhat simplified by the fact that on the under side of each block a nonsense syllable is printed—*lag* on all the large high blocks, *bik* on all the large flat ones, *mur* on the small high ones, and *cev* on the small flat ones. The twenty-two blocks are spread before the subject on an experimental board in the central circular area, well distributed as to size and colour, and with the nonsense syllables hidden. The subject is then told that there are four different kinds of blocks and that each kind has a name. The experimenter then picks up as an example the red triangle, which is of the small high type, and shows the subject that it is called *mur*. He is told that his task is to find the four kinds of blocks and to put each kind in one of the four corner areas outside the circle. The experimenter places the red triangle, with the syllable now showing, in one of these areas and suggests that the subject start by picking out all the blocks he thinks might belong with this kind, and putting them in the same space. After the subject has tried this on one basis or another (e.g., similarity in colour or shape), the experimenter turns up one of the incorrect selections, shows the subject that the name is not the same as that on the red triangle, and encourages him to go on trying. After each new attempt at a solution another of the incorrect selections is turned up.

With normal persons, "As the number of the turned blocks increases, the subject by degrees obtains a basis for discovering to what characteristics of the blocks the nonsense words refer. He may try to find the difference between the blocks bearing different names, or search for the common quality in the blocks bearing the same name. If he succeeds in finding a common factor, the formerly meaningless words are filled with meaning; they come to stand for definite kinds of objects (e.g., *lag* for large tall blocks, *bik* for large flat ones) and new concepts for which the language provides no names are thus built up. As soon as he has formed these concepts the (normal) subject is able to complete within a few seconds the original task of separating the four kinds of blocks indicated by the nonsense words. The successful evolving of new concepts thus serves as a means for solving the problem quickly and correctly. The subject who cannot use this tool adequately is considerably handicapped: he will work largely by trial-and-error, not utilizing the help offered by the nonsense words to those who anticipate their potential function as designations of concepts. In other words, he will not look for a common logical principle behind the common designation" (10).

The subjects used in this study were seriously disorganized. Accordingly it was necessary to introduce a certain degree of flexibility into the procedure. All patients were started off with the uniform instructions prescribed by Hanfmann and Kasanin (9). From that point on, the supplementary explanations recommended by those authors were employed so far as practicable.

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The difficulties in obtaining co-operation and in encouraging perseverance in such patients necessitate the use of a technique which permits one to follow up an advantage, or to give ground whenever, on the basis of clinical experience, such a move seems indicated. Some schizophrenic patients, for instance, are especially liable to make an arbitrary change in the rules; if this is met by counter-rules that seem just as arbitrary to the patient, an already tenuous thread of rapport may break.

All the manipulations, all the comments and the queries on the part of both experimenter and subject were recorded at the time in shorthand. This record furnishes further examples of characteristics which we have already described in the study of schizophrenic logic (5)—the *asyndetic* organization, i.e., a loose type of organization from which essential dynamic links are missing; the unprecise approximation and the personal asocial idiom; the increase in disorganization of thought with attempts at greater precision, which we have called *scatter-by-amplification*; and finally the interpenetration of themes introduced by the experimental situation with the co-active themes of personal preoccupations. In addition to these characteristics, this study will serve to bring out still other related aspects of thought disorganization, as these appeared in an experimental setting which involved manipulation and concurrent verbalization. For convenience of presentation the results will be grouped under four general headings. These will bring out, respectively, (1) the tendency to an over-inclusion of material, (2) expressions of a need to alter the conditions of the experiment or of the environment, (3) the lack of conformity between action and verbalization, and finally, (4) attempts at generalization made by the patients.

Experimental Results.

1. *Over-inclusion.*

In an earlier study we found that when schizophrenic patients showing definite scattering of thought were obliged to make causal statements they were often strikingly unable to eliminate the *fringe-elements* of conceptual structuring, i.e., the elements belonging to the periphery of a given organization, and to restrict their responses to simple unextended statements (5). This was true in the verbal organization dealing with real situations as well as in those referring to hypothetical situations. These patients, in making causal statements, went on to add terms that were more or less related to some of the elements of the stimulus or of the initial response, but which were also common to other loosely organized clusters or concepts. Both the *cluster-thinking*, which, with its loose organization, takes the place in these patients of well-knit concepts, and the use of unprecise approximations instead of definitive terms are to be understood as in part the result of an incapacity for selecting, restricting and eliminating.

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In these earlier studies our method led us to focus chiefly on the internal organization of the language responses alone, and especially on the paucity of causal links in that organization (asyndesis). In the present study, where not only verbalization but also manipulative behaviour can be observed simultaneously, one's attention is shifted to a corollary—perhaps a consequence—of the loose cluster organization. The inability to select and to restrict, and to eliminate the less closely related elements from the conceptual structure, means that the psychological boundaries are functionally insufficient. The result of this situation is *over-inclusion*. The inadequate demarcation of boundaries, which can be observed in schizophrenic thinking, operates so as to include too great a diversity of material in a given situation. The situation thus becomes so cumbersome and complex that it cannot be handled by the patient. In fact, as anyone who has worked clinically with schizophrenic patients knows, the dispersion of thought and the disorganized complexity of the material are usually too much also for the normal person who is listening unless he has the opportunity to sit down, analyse and reshuffle the units until they assume a simpler, more compact, and hence more intelligible structure.

The manner in which the inclusion of too much fringe material succeeds in confusing both the patient and those with whom he comes into contact becomes apparent when one goes to the actual examples. How is it possible to think clearly and definitively about any topic if one cannot keep the environment out ? That is what one of our own patients expressed when he exclaimed spontaneously in the midst of his tangled efforts, " I've got to pick it out of the whole room ; I can't confine it to this game ". The patient may thus be unable to solve the problem largely because his general environment cannot be effectively organized. The influx of all sorts of extraneous material renders the task at hand one of limitless complexity.

These intrusive fragments may be present as direct perceptual functioning, as in the example just given ; or they may be present as insistent preoccupation, as will be illustrated later ; or they may be in the form of what seems to be neutral imagining. In any case, the degrees of relatedness do not follow the usual functional patterns. Elements present themselves to the patient, and cannot be eliminated by him, which the normal person would regard as belonging to another category, i.e., one that would not be treated on the same plane or by the same operations. In persons who have before their illness been considered of average or of superior intelligence, there has developed a loss of the normal capacity to confine a given problem to its conceptual frame ; and the existence of this incapacity is not merely to be inferred from theoretical considerations, but may be recognized and complained of by the schizophrenic patient himself.

Patient A, whose formulation of his own difficulty was quoted in the preceding paragraph, could not in spite of the verbal insight he showed prevent

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the intrusion into the experimental set-up of the present and past environment —the green desk blotter, my wrist-watch and the meal he had just finished. In the course of a trial his attention had been directed to the fact that he had put a green triangle in with three blue blocks of various shapes. He looked at the group, and said slowly and earnestly, " Three blues ! Now how about the green blotter ? Put it in there too. Peas you eat—you can't eat them unless you write on it (indicating the blotter). You've got to turn that blotter into peas before you can prove you can't eat them. Like that wrist-watch (on my wrist, beyond the blotter)—I don't see any three meals coming off that watch ". Here it was obvious that he included material which, although it lay outside the problem at hand, was at the same time not entirely unrelated to it.

At another point, when this patient's attention was drawn to a white cylinder standing next to a blue one, he brought into the situation the contents of his pockets, the topic of clothes, and the dress of a man visible through the office window. " White and blue is Duke's Mixture. This (cigarette paper he took from his shirt pocket) is white. All this wood (box of matches) and Japan. There's a man out there with a white tie ; that's got something to do with white suits." As in the preceding illustration, the material brought in was not entirely unrelated to the experimental situation ; it was made up of what we have termed fringe-elements.

In another trial he must include me in the problem. " To do this trick *you'd* have to be made of wood. You've got a white shirt on—and the white blocks. You have to have them cut out of *you !* You've got a white shirt on ; this (white hexagon) will hold you and never let you go. I've got a blue shirt on ; but it can't be a blue shirt and still go together. And the room's got to be the same." This formulation of the situation as it appeared to the patient was given in great earnestness. One can understand why the problem cannot be successfully solved when it carries such widespread implications.

In the next example the controversial question of race equality seems to enter the arena. The patient had placed two small yellow blocks together. He was asked by way of prompting, "Are there any others that go with these ? " He looked at some white blocks and then asked in his turn, "Are there any Chinese working here ? " (No.) " Only white ones—then you can't put them together "—and he did not put them together. Here what seems to us a remote relationship between yellow and white determined for him the validity of a move that, had be been able to make it, might have contributed to a solution of the problem. Because no yellow men were working in the hospital with the white men one could not put white beside yellow blocks.

Patient B, a college-trained man, gave examples of over-inclusion in his attempts to solve the same manipulative task. With him, however, one must see past an involved personal idiom that often obscured the reference. Once when he had come to a complete standstill after making some partially valid groupings, he was prompted by the question, " What would you like to do

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further to make these groups alike ? " His reply, if one ignore for the moment the idiomatic use of common words, reached out to include other wooden objects. " That substantiates generality from the generality of objects—the substantiation that makes burr boxes be substantial, and book-ends and parts of book-ends." In the general context from which this statement is taken it is evident that he was bringing in other wooden objects, with which he had had recent experience, and adding their vaguely expressed characteristics to help, somehow, to complete the groups of wooden blocks he had put together.

In another trial this patient was shown the nonsense syllables on the blocks, which is done as a part of the routine technique to aid the subject in arriving at a serviceable generalization. When he attempted to interpret the significance of these syllables in the experimental situation the psychological boundaries became blurred and grammatical material, only dimly related, intruded itself, to be in turn followed by one of his characteristic pseudo-definitions. His " explanation " of the part played by the syllables was, " That means the two words are different. An adjective describes a noun ; and an adverb describes a verb ; generality substantiates a work, that is, a routine ". This statement is not meaningless, but for the purpose of the task it was useless. In another connection he gave a different interpretation of the syllables, and went on to include a different type of related material. " The difference (in two syllables) would be meaning that the words were different . . . and the objects have been painted for durability." (What do you mean, " painted for durability " ?) " That means such would endure and have generality for the last of the objects ." He was unable to stop with his statement concerning the syllables on the blocks ; instead he had to bring in the fact that the blocks were also covered with a protective coat of paint.

In the following material it is the personal preoccupations that dominate the scene and cannot be kept outside the boundaries of the experimental problem. Patient C had for a long time been convinced that during the development of her illness she had been given narcotics by the man who was employing her as a domestic at the time ; and she had been greatly concerned over the opinion of her morals that might be held by others. She surveyed the experimental situation, counted, " Five, six, eight colours ", and then pointing to the cylindrical blocks, said not irrelevantly, " Two and four sausages ", which remark brought in irresistibly less related and then more personal material, " two cups of coffee and morphine. I could live without that money, and those people used to annoy us terribly ". Here she has gone on from an attempt at simple enumeration of what she sees to material which had been of great importance to her during the development of her illness.

When after repeated failures, this patient attempted an interpretation of the purpose of the problem, she managed finally to include it as a part of a diffuse philosophy of living in which she located the psychologically more restricted experimental situation. To her the whole experimental problem

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meant that, " You're trying to figure some life out of it in the construction ". (How are we going to do it ?) " We're going to divide it. . . . Aren't you living, dividing before you live in it ? You get a mind there, and you get a life there . . . dividing by feeling your hand," running her fingers around the edge of a block, " and calculating the rim ". The intrusive preoccupations and the objective conditions of the situation were so intermingled that the task became quite insoluble. So much was included in what the patient saw as " the problem " that she could do as little with it as she had been able to do with her life-situations—from which likewise she had been unable to exclude similar preoccupations.

Patient E had similar difficulties. The conditions of the experiment could not shut out her dominant preoccupations concerning marital and maternal responsibilities. Questioned as to one inadequate grouping of the blocks (Do you think these belong together ?), her domestic difficulties came in at once, " When they agree in—agree, in other words, they belong together ". (Do these *blocks* belong together ?) " No, not all the time." (When *do* they ?) " When they're true." (How can blocks be " true " ?) " It has to be in your mind, doesn't it ? " Here the incapacity for restriction and exclusion made of this relatively simple and concrete task a part of a complex life-problem which the patient had already found insoluble for her by ordinary methods. Her failure in dealing with the blocks under these circumstances was inevitable.

This patient had real difficulty in keeping on with the whole problem because she could not exclude other material. When the experimenter encouraged her to go on at one point she became visibly disturbed. " I can't bring myself to divide them " ; for dividing meant to her " not to be with whomever you're supposed to be ; I try to think of those things that will be good for a person living with me and to keep sanity ". The act of dividing could not go on because it involved not only the manipulation of blocks but also a separation in the domestic situation, which had in fact already occurred. Her actual conflict over pregnancy entered the situation when she asked spontaneously whether she ought to divide the blocks up " according to the children already in the world ". When she had finally come to a complete standstill and was asked why she could not go on, she replied earnestly, " I can't ! It won't work ; my children won't like it ".

In the examples that have been given above one can see the complexities brought into a situation when delimitation and exclusion cannot be carried out effectively. However nonsensical the verbalizations may have appeared at first glance, closer examination usually make it clear that the patient was having certain consistent difficulties in organization ; and similar ones appeared in the thinking of other patients also. They can hardly, therefore, be regarded as merely accidental. As in the schizophrenic attempts at handling logical sentences (5, 6), the attempts to solve a manipulative problem bring out the

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same confusing fringe material, the many extensions and ramifications, which do not leave the patient sufficient freedom of action to enable him to work out the limited little problem.

2. *Altering the Conditions of the Problem.*

Proposals to change the conditions of the experimental situation or its setting occurred in three general forms: (1) The blocks ought to be transformed in some way; (2) persons in the environment require changing before the problem-solving can proceed; (3) the equipment is declared simply to be incomplete—a somewhat more passive attitude. These forms occur separately and in combination. Samples of the second type have already appeared incidentally, in the form of steps leading toward the inclusion of extraneous material, in the first and third examples of the preceding section. Others will be presented next.

In the course of his manipulations Patient A added three circular-shaped blocks to a triangle. Then he spontaneously expressed a definite sense of incompleteness and suggested a vague correction of the situation along geometrical lines. "Something's missing in this game; I need something to make this game up." He was asked concerning the group he had made up, "What is your basis, your principle?" Pointing to each of the three round blocks in turn, he answered, "It's circular, curve, and curvature. They're missing from this (the one triangular block); it needs something to make a curve on it—a line for an axis". In other words, if one could just convert the triangle into a circle the group would be acceptable. Later on he tried to meet the problem of what to do with a hexagon, a decision which is often difficult for normal persons, as follows. He insisted upon a similar change in the conditions as they actually existed. Pointing to the circle drawn on the experimental board, he said, "You have to swing a radius here, 3·1416, before you can do something with that" (hexagon). In other words, he did not work with the material *as it actually existed*, but proposed alterations in it to meet his failures, instead of alterations in his own plan of attack.

More drastic and more bizarre is the following verbal attempt to assimilate a yellow triangular form to the circular blocks among which it stands. The patient picked up a flat circular block and held it suspended over the smaller triangle in such a position that the circumference of the superimposed circular block lay outside the three points of the small triangle. "You drop this (circle) down over this (triangle), and that gives you the circle there with the others" (i.e., such a change would make the triangle a circle with the other circles). He went right on then to add a further transformation which is quoted here because it also illustrates a fusion of the task with the surroundings. "You need to melt them off and run them on the paper (i.e., the experimental card) and into that telephone and on to the yellow wall." The triangle, which

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was the source of his present difficulty, was yellow in colour and so were the office walls where we were working. The lack of psychological boundaries, both within the problem itself and as between the problem and the environment, is brought out very clearly in this example.

Patient D was nonplussed by the two hexagonal blocks in the set. Instead of trying to assimilate them to others there, he at first decided that he ought to bring in more of this shape from somewhere else and then make up a group. "You don't have any more of them in the box over there?" On receiving a negative reply, he brought in some vague principle of perspective, or of mere proximity, by placing the hexagon next to a cylinder of the same colour and general size. "I put that in a position to get a different shape of the other one." It was evident from the context that he was trying to avoid the difficulty by bringing about some change in the character of the blocks themselves.

Patient C by a somewhat similar method resorted to colour blending to account for a grouping. She had placed a blue triangle with two red trapezoids. "I thought I could correct it," she said, "because the colours blended and made it look a different shape, a different size." In other words, she hoped to change the perceptually different blocks somehow through "blending" their different colours. She did not operate with conditions as they were.

She further illustrates, in an objective experimental situation, one of the most interesting functions of fantasy: the capacity for disregarding an obstacle by hiding it, and then treating it as though it doesn't exist. It will be remembered that, as part of the standard prompting technique in this experiment, the experimenter points out an incorrect grouping to the patient by turning up one block so that the syllable printed on it is uppermost, and then pointing out to the subject the disagreement with the syllable on another block already so exposed. I expressed objection to a move this patient had made, by turning the block up and saying, "That has a different name, hasn't it?" Her way of meeting this incompatibility was to look at the two disagreeing syllables and then, saying, "We can turn it down!" she inverted the block so that the syllable was no longer in sight. She then replaced the block next to the other one with evident satisfaction. By this manœuvre the offending syllable was hidden, and so for her the disagreement ceased to exist.

The solutions proposed by these patients when they are unable to meet the experimental situation are very similar to attempts at solution of life-situations seen clinically in schizophrenia. The patient is unable to accept or to cope with the inflexible order of real events, and so he tries to change the fact by setting aside or ignoring the objective rules, or by declaring a change to have taken place in the materials and persons, or in their inter-relationships. When the game does not bring success he may simply change the rules; or he may disclaim responsibility for his ineffectiveness, as for instance the patients in

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these experiments did by saying that the test itself was incomplete, or that the conditions provided for the task were inadequate. These ways of meeting failure are by no means confined to abnormal persons ; but the degree to which our patients had developed them and the character of the proposals they made were decidedly pathological.

3. *Incongruity between Act and Word.*

The loose cluster-thinking of our schizophrenics involves a type of organization that allows contradictory constructions to exist side-by-side whereas, according to our view, a closer integration would bring them into conflict and facilitate the elimination of the non-assimilable constituents. Clinically this may have some bearing upon the phenomena of ambivalence and ambitendency. One expression of such inadequate organization may be seen in the incongruity between an act, or the result of an act, and the verbal explanation or the verbal characterization of it which the patient gives.

In our experimental situation this non-correspondence extends, from a simple inability to supply a word or a phrase that will coincide with a manipulation or its result, to a complete contradiction of the actual facts. The patient, while looking directly at a grouping of blocks he has made, may give a verbal formulation of it that is in flat contradiction to the perceptual configuration—at least as the normal person experiences it. For instance, groupings made up under the eyes of the experimenter obviously on the basis of colour, are described as having been put together because the blocks are " the same shape ", which they are not—and vice versa. Yet the patient doing this is neither uninterested nor inattentive ; he is not colour-blind, as evidenced by his correctly naming the colour of any block on demand ; and he is not incapable of more complicated generalizations, as will be demonstrated in the next section.

To begin with the simpler examples, Patient B made up a group of all red blocks but could not so characterize it. Instead, he was able only to enumerate the different shapes : " This is a square, this is round, that has four angles, these two are different, and this is a triangle ". It would seem so much simpler to say, " They are all red " ; and indeed at other times he showed himself quite able to speak of colour appropriately.

Patient C made a group of three blue blocks, otherwise unlike. When asked why she had put these together she replied, " To clean the body spirit " (which with such other phrases as " trying to better myself ", " best for any physical flesh ", and " exercise an animal life ", represents part of her continual preoccupation with erotic material she relates to the onset of her illness). Further questioning failed entirely to elicit the simple answer, " blue " or " colour ", which at other times she could give. Patient E grouped four red blocks together, but also failed, even with prompting, to characterize the result of her own just completed act correctly in words.

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Flat contradictions of the following type also occur. Patient C made a grouping which was a mixture of different sizes, shapes and colours ; the basis of her selection could not be inferred by the experimenter. When asked, " What seems to be alike here ? " she looked directly at the blocks and replied, " Colours ". (Are they alike ?) " Yes." Actually green, white, yellow and blue were in the group.

Patient D expressed himself more obscurely, but showed the same type of incongruity between act and word. Asked why he had grouped certain blocks together he gave the following account : " Because I found out that the form and the shape were not the way they should have been done, because there were two different words. So I tried to equalize them up in numbers ". In another operation he spoke of having arranged groups so that the number of blocks would " equalize " the number of groups. The fact is that these formulations he offered were at complete variance with his actual manipulations as well as with the configurations that lay before him. Only one block in the collection had been turned up and he had made no attempt to see what " words " (syllables) might be on the others ; neither had he grasped correctly the principle underlying the difference in the syllables ; nor had he actually made any attempt, as he expressed it, " to equalize them up in numbers ".

Of a different grouping in another attempt he said that he put them together " to make them correspond in opposition to the shape and form ". This generalization implies a much more organized attack than actually occurred. He really began by picking out three triangles (shape), then selected two tall blocks of other shapes to place them beside a similarly tall triangle (height), and finally placed a flat round block next to the tall round one (shape) —obviously shifting his basis much more simply than his explanation would indicate.

Behind the screen of asocial idiom one finds in the following operations of the college student, Patient B, instructive examples of non-correspondence between word and act. He had just made up a group, as indeed many normal subjects do, consisting of all circular blocks, plus those which seem directly derived from circles, viz., the two hexagons and the two half-circles. Now the normal person readily states this principle on demand ; but this patient could do no better than the following : " That group substantiates that the hexagons are differentiated from the round objects ". Asked, " Why did you put all these *together* ? " he said, " Those would compare the generality— the hexagon has six sides, and the round objects have surface, and the hexagons have surface and radius ". This is hovering all around a valid generalization ; but it remains almost entirely unintelligible because of the inexact terms he used and because of the lack of any focal point in the structure of his formulation.

When the experimenter had turned all the blocks up, with the syllables or " names " now showing, the patient was able to sort them into the four correct

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groupings in two minutes by paying attention exclusively to the syllables. But he was then unable to state this quite simple principle, in accordance with which he had just acted, and which, in fact, still stared him in the face. The principle he gave, in his unprecise idiom, was " such are continued from wood and all the objects have surface. Another generality is that all objects have length and width and girth. . . . The actual objects are different entirely, as the round objects are different from the triangular objects, and the semi-circular objects are different from the rectangular objects ". Here the failure to give a simple characterization to an obvious grouping, which he had himself made, and on the basis of identity of syllables still plainly visible to him, is in striking contrast to the manipulative sorting which, when reduced by the experimenter to a matter of syllables, he managed quite smoothly and accurately. In other words, his own performance, and the visible result at which he was looking, appear in these examples to have little effect upon the language organization. It is almost as though one person had understood what was to be done, and had done it, while another person, surveying only the result, had then failed to grasp the situation that had been set up by the first.

The same patient was sometimes able to *state* an approximately correct principle for grouping the blocks, but at the same time was unable to *do* anything about it. In fact, had he been able to act upon some of the principles he succeeded in verbalizing it is possible that he might have solved the problem. Sometimes his verbal formulations of a situation were fairly consistent within themselves but did not correspond to the actual situation. In other words, he was able to act according to principles evident to the experimenter which the patient could not formulate in words; and he could set up hypotheses which, however, he apparently was not able to translate into corresponding action. The word and the act seemed often to belong to different systems of integrations.

4. *Attempts at Generalization.*

Examples of schizophrenic generalization and hypothesis formation have already appeared incidentally in the material presented. The subject is, however, important enough to merit special attention. For even in such severe disorganization of thinking as these patients showed, generalization and the formation of hypotheses appear not only often but also in a variety of forms. Such bases for classification and grouping as the following were invoked by them: shade, colour, mass, weight, shape, material, names, type, radius, angles, opposition and equalization.

For instance, Patient A grouped triangles together and could state that this was because each had three sides; and on another occasion he grouped blocks correctly according to shape and was able to say so (*shape*). He also tried to make four groups in each of which there were to be no two blocks entirely alike.

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He grouped blue blocks together and when adding a white one pointed out that it had blue ink on it and hence belonged with the blue ones (colour). He accounted elsewhere for having grouped together two red blocks with a white triangle, apparently as an afterthought, in this way, " There are three sides to the white (triangle), so there must be two reds to one white ". At another trial he inferred that the syllable *mur* on a block meant " murder ", and tried to decide which colours would murder yellow. Such hypotheses as these do not usually lead to success; but they must not therefore be disregarded. Generalization need not be either correct or successful to be generalization. These patients not only generalize, but they also present an undeniable variety of attack.

Patient B referred to the whole problem as " an intelligence test ". Once he seemed about the grasp the solution when he said of his own accord, " Same arrangement of letters substantiates (distinguishes ?) such from the mixture " (*syllables*). A moment later he shifted to *colour*, and then went on to *shape* as his basis, all without success. He characterized one grouping he had made as based upon the blocks' being " equal in some respect and different in other respects " (*similarity* and *dissimilarity*). He said of two blocks that they were alike because each " has a *surface* ". Of another group he said they might be alike because " I presume that such have *weight* ". On another occasion he pointed to three circles, saying of each separately, " This has a *radius* ". Asked, " Do any others have a radius in that group ? " his answer started off like a proposition in geometry and ended, as nearly all his attempts did, in a cul-de-sac. " If a circle be drawn around this hexagon, from this point to this point, the radius would be to this circle one-half of the generality." He consistently grouped the troublesome hexagons with circular blocks, as normal subjects tend to do, and sometimes stated the relationship intelligibly. Once he said that by way of " contrast, the triangles would be parts of the squares ", that " the hexagons can be continued from the round objects ". Both of these generalizations were correct, although inaccurately expressed. Finally, in another connection, he spontaneously contrasted " round objects " with the squares and trapezoids, saying " that triangles are classed more with squares and rectangles (trapezoids) . . . because they have straight angles and lines on one side ". In none of these attempts at generalization was he able to make effective use of what principles he enunciated. It is, however, to the variety of hypothesis and to the shifting from one to the other, that his productions owe their significance.

Patient D gives us other illustrations. He made up *colour* groupings, and also incomplete groupings on the basis of *form*. At times he attempted to get equal numbers of blocks in opposite squares so that they would *balance* each other; and he also tried to make the *number of blocks* in a group equal the *number of groups*. This patient, also, suffers not so much from a lack of general principles as from their defective organization and worse utilization.

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His preoccupation with what he regards as engineering can be found running through his types of hypotheses.

Patient C showed among other things the ambiguous use of terms in her generalizations. In looking for a "common characteristic", she grouped different colours together, saying, "I thought they were *common* colours, *ordinary* colours". Her ambiguous use of the term gave her a misleading principle. She later accounted for another group she had made, all members of which were blue, by saying, "checkers, dominoes—most anything in *common*". She was at other times able to use *colour* correctly as a basis and sometimes to state this as a principle. Patient E was also able to make and formulate colour groupings; but most of her verbalizations were in vague, mystical and erotic terms, examples of which have already been given.

Although none of our patients was successful in completing the problem without exposure of all the syllables, or in formulating the principles after the syllables had all been exposed, their failure cannot be laid to an inability to generalize or to form hypotheses. Sometimes a generalization based upon one particular grouping was correct; more often it was not. Generalizations and working hypotheses were given which involved quite complex and sometimes easily intelligible principles; but they were not, and usually could not possibly be, integrated with the actual manipulations. A group of blocks might be made up by the patient and a general principle stated; but the actual grouping and the principle formulated did not necessarily belong to the same system, or even to the same order of events.

This ineffectual result was often the outcome not of too great restriction in compass of the generalizations, but rather of too little. The generalization might even be quite correct as stated, but still much too inclusive to be valid for the restricted group alone, and not for other groups or members of other groups. Since, moreover, the patients in generalizing were unable to eliminate what we have called the fringe-elements of their organization, they often drew the circumference of their generalizations large enough to include these also. The end-result was very similar to that which had been found in the study of schizophrenic logic (5), viz., their thinking appeared more as a conglomerate of elements than an organized integrate of constituents—a loose cluster-form in place of the closely organized, and hence more restricted and definitive concept-form.

Discussion.

In this study it has been possible to carry the analysis of schizophrenic thinking farther, because of the fact that the experimental situation brought out manual operations visible to the experimenter, in addition to concomitant verbalization. Thus intermediate steps in the manipulations, inasmuch as

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they were experienced jointly by experimenter and patient, could often be made the subject of mutual discussion. The results in general supplemented the earlier analyses (5, 6, 7) which are summarized at the end of the introductory section of this paper.

Described there was a loose cluster organization in which essential links were missing (*asyndesis*), fringe-elements included, and clear psychological boundaries lacking. Unprecise approximate terms and phrases were found to serve the schizophrenics in place of the more definitive and socially current ones. Personal idioms were used without any attempt to make them intelligible to the listener. In the severely disorganized, the theme of the problem was recognizable, appearing as fragments in the stream of the more compelling personal preoccupations. These features were found not to be characteristic of the normal child's thinking under similar conditions, nor of the deteriorated seniles that were studied.

The character of the problem-situation used in the present study permits one to characterize schizophrenic thinking still farther. An attempt will be made in the following discussion of experimental results to relate the findings with comparable phenomena (*a*) in the normal person, and (*b*) in common clinical experience with schizophrenics.

(1) *Over-inclusion.*—These schizophrenic patients failed to solve the problem confronting them largely because they were unable to circumscribe it. They could not maintain the spatial and temporal limits of the experimental situation, which therefore fused with other environmental and with imaginal material into a poorly organized whole of great complexity and instability. The boundaries, which should establish fairly definite limits to the problem situation within the patient's field of action, fluctuate and fail to crystallize into anything definite and delimiting. As a result there is intrusion into the situation of what should be irrelevant, and extension of the patient's operations into regions where they cannot possibly be applied successfully.

Sizing up any problem consists essentially in a preliminary restriction of the field of operation to what is necessary, and the inclusion of as little more than that as possible. This, of course, presupposes an organized structure; without organization there could be no boundaries and no definite field. The normal effective person, finding himself faced with an unfamiliar problem or a new life-situation, sets out to delimit it. He determines how much he can leave out, and within what limits he can or must operate. As he begins work after such a preliminary restrictive orientation the situation develops for him a structure having boundaries. These boundaries must be able to shift as developments demand it; but at the same time they remain sufficiently stable to keep his operations confined within a limited field. The boundaries are temporal as well as spatial, and apply as well to the structure of his thinking as to the arrangements and potentialities of the situation with which he is working. His thinking must be governed by the situation; it must therefore

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be restricted to what the situation permits. Indeed, the extent to which the normal person can define and restrict the situation may alone determine the effectiveness of his operations.

It often happens that a normal person cannot effectively determine the limits within which he must act, and what does and does not belong within those limits. Under such circumstances he likewise fails to organize the situation in such a way that his operations are confined within effective limits. In consequence, the organization which to another person appears as "the problem" may not exist for him at all. When, for example, a normal person is unable to keep purely personal matters out of a situation, when they are neither helpful nor strictly relevant to it, his behaviour may come to resemble in a milder form what we have seen in these schizophrenic patients. That is, a life-situation under these conditions does not become sufficiently restricted, and the fringe-elements are not eliminated. Emotional reactions of a purely personal character, and not actually essential to the situation under consideration, when nevertheless included in it, may destroy the relative neutrality which is necessary if one is to maintain an objective attitude. The outcome is that, instead of growing progressively more and more definitive and delimited, such a life-situation may become so entangled with extraneous material and with personality problems as to defy solution.

In our experimental situation one has the opportunity of examining something similar in an exaggerated form. For the disorganized schizophrenic patient "the problem", as the normal person experiences it, often does not exist. The boundaries remain too fluid, particularly with relation to personal material, but also with respect to the impersonal.

A contrast is suggested by these findings between the thinking of disorganized schizophrenics and that of oligophrenics as analyzed by K. Lewin (11, p. 223). While he emphasized "concreteness of thinking and action" in the feeble-minded, he also pointed out that in their thinking the imaginal and the unreal were especially hindered. These are the very constructions which in the normal person show the greatest fluidity. In this sense our results make it possible to differentiate functionally between schizophrenic disorganization of thinking, with its too great fluctuation of boundaries, and the oligophrenic thinking Lewin describes with its too rigid limitation. For our schizophrenic patients the problem-situation ran over into their immediate environment and into spatially and temporally absent environment as well, and even included fragments of their own life problems.

(2) *Altering the conditions.*—Clinically one is frequently impressed with the inability schizophrenic patients may show, in the course of the development of their illness, to face real difficulties. Moreover, when situations arise with which they are unable or unwilling to cope they may meet them by ignoring their existence or by denying their validity. They often declare changes to have taken place in the material surroundings and so may be able to disregard

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obstacles, contradictions, and incongruities. They may try to account for their own failures, or their whole predicament, by finding omissions and inadequacies in the persons and things about them. These *tours de force* enable them to preserve the fiction that the incompetence lies not in themselves but in the environment—something that also occurs in a less exaggerated form in quite normal persons. The responsibility for their failures by this process is removed from the schizophrenic patient's shoulders ; and his inaction or his maladaptation in the face of a situation that requires a solution is justified. Consequently, to him it is the situation, and not his way of meeting or of avoiding it, that is at fault ; and therefore for him responsibility ends when he has pointed out the defects.

Our experimental setting brought out these types of response in an interesting way. The changes proposed by the patients often ignore completely what is possible, unless one change the rules of the game and even the actual materials of the problem. These patients do not accept the situation as it is and work within the frame of what is permitted. They declare the material to be incomplete or in need of various changes, additions, or fusions ; they propose changing the colours and shapes, sometimes according to a bizarre plan ; they ask for more material from outside of the experimental setting, and sometimes suggest impossible conditions for getting them. One of our group wanted to remove an incompatibility simply by hiding from sight the characteristic which seemed to her to constitute the difficulty. Some of the solutions they propose may be imaginable, but cannot possibly be carried out in reality—just as is so often the case with the solutions these patients propose for their now insoluble life-situations.

(3) *Incongruity*.—As is well known, under normal conditions of thought, verbal and non-verbal processes may exhibit with respect to each other a considerable degree of autonomy while occurring simultaneously in the same organism. Talking about one subject goes on at the same time as unrelated non-verbal activity ; one may walk over rough and unfamiliar ground while continuing to discuss or think about some topic of personal interest. In our experiment, however, the circumstances are somewhat different from such dual activity. The patient is asked to describe, to account for, or to generalize about what he sees or what he does. That is, he is *directed* to give an integrated structure which will include the perceptual pattern and the verbalization of it in a unitary act ; or he is directed to give as a unitary structure what he has done and what he has to say about it.

The non-correspondence, described in this paper, between what the patient does and what he says about it is of considerable psychopathological as well as of clinical interest. It points to a type of organization that permits not merely autonomous but competing systems to function side by side. These patients show no gross memory disturbance ; and the incongruity they exhibit is due neither to simple inattention nor to ordinary distractibility.

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A patient might make statements that contradict the perceptual patterns (as the experimenter experiences them) while looking directly at them and giving every evidence of searching for a solution in what he is looking at. He carries out a grouping on one principle; but he states a different one, which does not coincide with the principle upon which he has obviously acted (e.g., colour or shape). The principle he states is not necessarily simpler than the one in accordance with which he has acted; it may, in fact, be much more complex; or it may only be different. It is often more or less in harmony with personal preoccupations; but even this need not necessarily be the case. The account the patient gives, however incorrect it may be, is not as a rule simply an irrelevant statement; it represents a genuine attempt to describe or explain something the patient is doing, or has done; and it is often made with the appearance of great earnestness.

Evidently the organization of behaviour in these cases is such as to allow incongruities to exist that involve contradiction between what the patient has done and what he says he has done. That this is not merely forgetfulness is brought out by the fact that the verbalization may also contradict what is simultaneously present as a perceptual pattern. It is also evident from the inconstant character of the defects that one is dealing with functional rather than with organic factors.

(4) *Generalization.*—In spite of severe disorganization of thinking and characteristic schizophrenic language disturbance, these patients were able to generalize. This may at first appear to contradict the findings of Rawlings (13), Wentworth (17), Bolles (3), and Bolles and Goldstein (4) as cited above. There is actually no fundamental disagreement on this point however. For it was not an inability to make generalizations that accounted for the failures of these schizophrenics, but rather the ineffectual character of their organization. The generalizations were too broad, too involved, too personal, or expressed in too disorganized a language structure. Even when they corresponded roughly with the objective situation they were often quite inapplicable under the circumstances. When, for instance, a grouping was accounted for on the grounds that all the blocks have weight, or surface, or are all made of wood, the defect lies in the failure to exclude at the same time the other members not placed in the group under consideration, but having the same characteristics. Contrary to the findings of Bolles (3) and Bolles and Goldstein (4), there was no striking inability on the part of severely disorganized schizophrenics to shift from one aspect to another. Some of their shifts are listed under the section on generalization in the experimental results.

Some of the more complicated principles given by patients (such as those depending upon the formation of groups having no two members alike, or upon the balancing of numbers of blocks against numbers of groups) failed no more because they happened to be incorrect than because they never were actually tried out. The appearance of personal material in the generalizations

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also points to the typical inability to restrict and eliminate, to maintain adequate boundaries. Finally, the system of language, which is nearly always involved in adult human problem-solving, is itself often grossly disorganized in these patients, and the generalizations naturally suffer in the direction of disorganization of the individual language structure.

Summary.

A qualitative analysis of the thinking of severely disorganized schizophrenic patients in a problem situation brought out the following :

(1) The most striking characteristic of their performance contributing to their failure was the *over-inclusion* of environmental and imaginal material in the neutral problem itself. The patients could not eliminate from the functional pattern those elements which the normal adult would not treat as belonging to the same plane as the problem, or by the same operations. This incapacity may be observed not only by the experimenter but by the patient as well. A comparison is made of the psychological boundaries, as they appear in schizophrenic thought, in normal adults under special circumstances, and as Lewin describes them for oligophrenics.

(2) The schizophrenic patients called for changes in the rules of procedure and in the materials, and declared the situation to be inadequate instead of themselves. This phenomenon resembles their reactions to the inflexible order of real events in their own life-situations.

(3) Non-correspondence occurred frequently between what the patient actually did and what he said he had done, and between the perceptual pattern and the patient's formulation of it. A simple colour grouping, for instance, was characterized in some other way, often more complex, and quite at variance with the patient's operation or its result. Act, or pattern, and word seemed often to belong to different systems of integration.

(4) Generalizations were numerous ; and shifts from one hypothesis to another occurred without evidence of unusual difficulty. The generalizations were unsuccessful because they were (*a*) too broad, (*b*) too involved, or (*c*) too entangled with personal problems and phantasies, or (*d*) because the language structure was so disorganized that it could neither function as social communication, nor serve as a basis for the patient's own performance. Moreover, (*e*) the generalizations, even when quite correct, often did not lead to any corresponding act.

This study develops farther our experimental analysis of schizophrenic thinking, the earlier results of which are summarized at the end of the introductory section. The present report, based upon a method of manipulation and grouping, brings out new aspects of schizophrenic thinking and corroborates the conclusions derived from our study of logical relationships.

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