Functional Disorganization of Representations in Schizophrenia

by Arnaud Plagnol, Bernard Pachoud, Bertrand Claudel, and Bernard Granger

Abstract

The first part of this article describes a model of disorganization of representations in schizophrenia. We assume that subjects with schizophrenia have some interfering activity in memory. Such an interfering activity induces a functional decontextualization of information and the reciprocal is true. This model accounts for different classes of cognitive troubles that have been observed in schizophrenia. In the second part, we describe a text-comprehension experiment that studies two paradigmatic cases of episodic and semantic contextualization of information: the “compartmentalization” and the “thematization” of fictional narratives. Compartmentalization refers to the way in which representations of different narratives are separated in memory; thematicization refers to the way in which representations of one narrative are structured in function of a theme. In our experiment, compartmentalization and thematicization are assessed by a method of priming in word recognition. In agreement with our model, the results show that subjects with schizophrenia are impaired in compartmentalization and thematicization when compared with anxious-depressed subjects.


Cognitive troubles in schizophrenia have been observed at all levels of information-processing, including attention, memory, language, and reasoning. For some time now, “cognitive hypotheses” on schizophrenia have followed one another with no unitary model on which researchers agree (e.g., Widlocher 1993). Nevertheless, there is some convergence on the elementary processes of disorganization.

In this article, we propose a general model of disorganization to account for cognitive troubles in schizophrenia. This model is based on the hypothesis of an interfering activity in memory, which induces a functional decontextualization of information. It is far from original in all its aspects, and we briefly discuss some related models. We then describe an experiment intending to show that schizophrenia subjects have an impairment in some paradigmatic cases of contextualization of information: the “compartmentalization” and “thematization” of fictional narratives.

For our sample of schizophrenia subjects, we use the DSM-III-R (American Psychiatric Association 1987) criteria because this nosographical system gives the most restrictive definition of schizophrenia (Andreasen and Flaum 1991). However, our model of cognitive troubles may apply to some patients not filling the DSM-III-R criteria of schizophrenia. Our purpose is not to determine a particular cognitive level that would be specifically impaired in subjects filling specifically these criteria (or even which would causally explain the schizophrenic troubles). Indeed, a nosographical entity is defined by a cluster of clinical symptoms
that do not necessarily correspond to a characteristic pathological process (e.g., Plagnol and Barrois 1993). From an epistemological point of view, a nominalist attitude is currently best in psychopathology (Birley 1990), and this is especially true for schizophrenia, the definition of which has been problematic since Bleuler (Dalen and Hays 1990). The advantage of using DSM-III-R in our research is the clear and restrictive definition of its criteria; one can select some patients who have a good chance of showing the troubles that our model claims to represent.

We used a control group of anxious-depressed subjects, for whom our model predicts some results different from those of schizophrenia subjects. As our objective is not to explain a specific impairment by a specific disease (or vice versa), we do not need a control group of patients paired to the group of schizophrenia subjects for all possible factors, but only for the factor “specific disease.” From our point of view, the important point is the selection of patients clearly diagnosed with a clinical anxiety-depression syndrome, with the control of some DSM-III-R criteria. Our group of anxious-depressed subjects will therefore differ from the group of schizophrenia subjects for factors other than the diagnosis. Our experimental purpose is only to support our model, which predicts that a paradigmatic type of organization of information is impaired in some patients diagnosed as having “schizophrenia” on the basis of clear criteria, and that these impairments are different from those observed in some patients selected as “anxious-depressed” on a similar basis.

Disorganization by Functional Decontextualization of Information

Cognitive disorders are disorders that can be defined in representational terms. Two phrases can sum up the cognitive disorders that have been considered characteristic of schizophrenia from Bleuler (1911/1950) to the DSM-III-R: disturbed associations and incoherence. Some authors prefer to speak of formal thought disorders (instead of cognitive disorders). This ambiguous phrase allows us to delay dealing with whether these disorders are caused by an original impairment of thought processes or by an original impairment of language processes, a problem that has been much debated. Some authors prefer to speak of formal thought disorders (instead of cognitive disorders): This ambiguous phrase allows us to delay dealing with whether these disorders are caused by an original impairment of thought processes or by an original impairment of language processes, a problem that has been much debated. Some authors prefer to speak of formal thought disorders (instead of cognitive disorders): This ambiguous phrase allows us to delay dealing with whether these disorders are caused by an original impairment of thought processes or by an original impairment of language processes, a problem that has been much debated.

Language Disorders in Schizophrenia. The definitions of “disturbed associations” and “incoherence” are themselves problematic, and some meanings of these phrases could also apply to some symptoms of mania or even of depression. Many works have tried to define the most characteristic impairments of schizophrenic language. For example, Andreasen (1979a, 1979b) has observed these deviant aspects of language in schizophrenia: incoherence (lack of connection between words), tangentiality (irrelevant replies), derailments, illogicality, loss of goal, self-reference, perseveration, poverty of speech, and poverty of content of speech. Rochester and Martin (1979) showed that schizophrenia subjects lacked an appropriate use of pronoun reference. Hoffman et al. (1986) dwelled on patients’ impairment in discourse planning, and Harrow et al. (1989) on their impaired perspective (i.e., the ability to discern appropriate behavior in a given context). Frith (1992) noted their difficulties in taking into account the communication context (notably the listener’s knowledge).

Functional Decontextualization of Information. From the point of view of information-processing, research has shown that all these language abnormalities show a failure of the schizophrenia subjects to consider context. For example, schizophrenia patients have a greater tendency than control subjects to interpret a homonym by its dominant meaning, independent of the semantic context (Chapman et al. 1964; Swinney 1984; Servan-Schreiber and Cohen 1991). The problem of contextualization in schizophrenia was pointed out a long time ago and is discussed thoroughly in Chaika (1990). Schizophrenia patients do not seem to have so much an impairment in linguistic competence as a decrease in performance, at least when the disorders are not too old (Schwartz 1982; Frith and Allen 1988; Pachoud 1992), so perhaps the lack of contextualization...
"decontextualization") in schizophrenia is originally functional.

These language disorders lead us to consider a model of disorganization of representations by functional decontextualization of information. To develop such a model, we can use the cognitive theories of language comprehension, which allow us to understand the contextual effects through the processes of activation of representations (Kintsch 1988).

A context can generally be defined as a structured system of representational units, whose relations determine the interpretation of a piece of information. In the subject processing linguistic information, the context corresponds to the set of active representations in memory. This set contains two types of elements: first, the elements directly activated by the explicit "external" linguistic information (the linguistic context); second, the elements activated by association or inference from the knowledge stored in long-term memory. The second element yields the implicit information necessary to comprehend the explicit information.

Networks of Spreading Activation. The formal framework of networks of activation allows us to model the interactions of some representational units precisely, and therefore we can model the contextual effects. It can be carried out in many ways, but we will not consider the technical details here since the underlying ideas are very simple.

In a network, the representational units are the nodes; these nodes are connected by some links of different strength, corresponding to the associations between representational units; each node has a value of activation that correlates with its importance in the network. Spreading of activation in the network depends on the associations between the representational units; that is, it depends on the strength of the connections between the nodes. Contextual effects can be explained if the spreading of activation allows a concentration of activation.

For example, in the text comprehension model of Kintsch (1988), the spreading is modeled by multiplying the vector describing the state of activation by the matrix describing the connections. Thus, the nodes isolated in the network are deactivated, while the nodes relevant to the context will be mutually strengthened (because they are mutually connected); the more relevant the node, the more its value of activation will be strengthened.

Interfering Activity. From our point of view, the important point is that contextual effects are determined by the structures of memory. The structures of memory involved in processing a piece of information can change with each subject not only because the encoded representations can change, but also because the functional state of activation of representations can change. The contextualization of information will therefore be modified in memory conditions if the spreading of activation is disturbed. Generally speaking, every interfering zone of activation in memory will disturb the process of concentration of activation and, therefore, the contextualization of information, notably the selection of associations or inferences.

For example, within such a framework, one could account for the "attentional bias" toward threatening information that is observed in anxious subjects (Eysenck et al. 1987; Williams et al. 1988; MacLeod 1990). We could assume that in these subjects an important amount of activation is usually taken by some zones of memory concerning threatening information. In the same way, the mnemonic bias toward negative information that has been described in depressed subjects (Mathews and Bradley 1983; Teasdale and Dent 1987; Williams et al. 1988) could be understood if we assume that in depression, an important amount of activation is usually fixed in some zones of memory concerning negative information.

If one now assumes some multiple interfering zones in memory, globally and uniformly distributed in the whole network of representations, one can mathematically prove that such a "state of diffuse activation" will hinder the concentration of activation and will induce a functional decontextualization of the information in memory. It is intuitively obvious, because the concentration of activation is normally obtained by mutual strengthening of the relevant nodes, but these relevant nodes will be "swamped" in a diffuse state of activation. Using the formalization of Kintsch (1988), one can show that in a "diffuse" state of activation, there are no contextual effects that allow the disambiguation of homonyms or the hierarchization of associations (Plagnol 1993).

The loose associations of schizophrenia subjects are therefore explained by the functional decontextualization induced by a diffuse state of activation: The probability
of selecting irrelevant associations is increased if the values of activation are not graded in function of a context. Moreover, some irrelevant associations can be directly activated by some interfering zones, accounting notably for "self-reference" and "impaired perspective."

Note also that because of the activation fixed in the interfering zones, there is less activation available for processing information, which accounts for the general decrease of performances in schizophrenia subjects. This general decrease is similar to the classical decrease of performances observed in experimental psychology when overload is induced by some interfering tasks (e.g., Baddeley 1986).

The hypothesis of a diffuse state of activation accounts for the decontextualized observation in language processing of schizophrenia subjects. The following examples show that this hypothesis also clarifies the other types of cognitive problems experienced by these subjects.

Perceptual and attentional troubles. Research on perceptual and attentional processes in schizophrenia subjects has demonstrated their difficulties in discriminating a target in the presence of irrelevant information. For example, the Perceptual Span of Apprehension (Neale 1971) is reduced in schizophrenia patients (Asarnow and MacCrimmon 1981; Strauss et al. 1987). This test assesses the ability to identify relevant letters among irrelevant letters. In the same way, the deficit in selective attention in schizophrenia (Everett et al. 1989) was exhibited by some tasks like the Stroop Test (Stroop 1935), in which the subject had to name the color of a word that names a different color (e.g., for the word "red" written in black, the subject has to say "black"). This task involves inhibiting the semantic information in the word. The Information Overload Task (Comblatt et al. 1985) is also useful here. The subject must indicate the picture that corresponds to a word pronounced by a voice in the presence of interfering sounds. This test reveals a greater distractibility in schizophrenia subjects.

All these observations can be predicted with the hypothesis of a diffuse state of activation in memory. A strong interference in activity in memory reduces the amount of resources available for the activation of the target. If this interfering activity is diffuse, the representations referring to irrelevant information receive some activation, which hinders their inhibition.

Apart from the basic deficit in selective attention, schizophrenia patients also have a more specific difficulty in maintaining selective attention over time. Their performances on the Stroop Test, deteriorate significantly more than those of control subjects when they have to carry out a longer version of that test (Everett et al. 1989). This poorer performance can be explained by the difficulty that schizophrenia subjects have in maintaining the gradient of memory activation necessary for processing information in the context of a particular task, notably for maintaining the structure of goals necessary for this task in working memory.

Similarly, the slowness in processing visual (Saccuzo and Braff 1982) or auditory (Korboot and Damiani 1978) information in schizophrenia can be easily explained if the decrease of available resources increases the time necessary to obtain the critical threshold of activation of the target's representation that will trigger the response to the stimulus.

Memory problems. A diffuse state of activation of representations allows us first to predict a global deficit of mnemonic performances induced by the global decrease of available resources; we can also predict a relatively more important deficit in all tasks involving some contextual effects, that is, involving the functional structuring and the gradient of activation of representations in memory.

In addition to a generalized memory deficit in schizophrenia subjects, research has shown that they have difficulty using the structure of the experimental material to optimize their performances. For example, in recalling lists of words, schizophrenia subjects increase their performances significantly less than do control subjects when the contextual constraints increase (Levy and Maxwell 1968; Maher et al. 1980). Their performances are also more deteriorated in recall than in recognition tasks (Calev 1984), which can be explained in our model if one considers that recall tasks involve structuring representations (and so contextual effects) more than recognition tasks do (e.g., Kintsch 1970). Moreover, some studies have shown that mnemonic performances of schizophrenic subjects are better when some orienting tasks facilitate an effective structured encoding (Calev et al. 1983).
ability of information-processing, induced by an interfering activity in memory (or “self-generated stimulation”) with diminished filtering of irrelevant information (Bourne et al. 1977; Pishkin et al. 1977). Pishkin and Bourne (1981) show that schizophrenia subjects are not impaired (as compared with normal subjects) when the problem consists of applying a simple conceptual rule to some concrete physical attributes. However, they are impaired on more abstract problems, because the mnemonic load is more important. Of particular note, the performances of schizophrenia subjects are particularly deteriorated when they have to discover a disjunctive rule (e.g., the subject has to find the concept red or square from the attributes red and square). This type of rule makes it particularly difficult to reject an irrelevant attribute. Moreover, schizophrenia subjects are relatively unable to use mnemonic cues yielded by some immediately available examples of the concept they are to find: If there is more than one example, their performances deteriorate. Pishkin and Bourne explained this by an abnormal sensitivity to mnemonic overload. In the end, schizophrenia subjects do not show much improvement in their performance when tasks are repeated, which is easy to understand if they are not able to maintain the memory context necessary for learning effects.

The hypothesis of a diffuse state of activation therefore allows us to elaborate on a general model of disorganization of representations. We consider this lack of specificity an advantage in accounting for the cognitive problems of schizophrenia subjects: Such troubles have been observed at all levels of information-processing.

Experiment

Compartmentalization and Thematization of Fictional Narratives. Tulving (1972) introduced the distinction between episodic memory and semantic memory. Episodic memory refers to the spatial or temporal data stored in memory, notably concerning personal events. Semantic memory refers to the conceptual and organized knowledge stored in memory, notably the knowledge necessary for linguistic competence. Thus, we can distinguish between episodic and semantic contextual elements. In testing our model of disorganization by decontextualization of information, studying the comprehension of fictional texts is useful because it yields some very clear examples of episodic contextualization and semantic contextualization.

Fictional narratives define some episodic contextual elements, which must be taken into account in information-processing. Indeed, a fictional narrative refers to a possible world, different from the real world. When one reads Don Quijote, textual information must be referred to the world of Don Quijote in order to be differentiated in memory from information about the real world (or from information about another possible world). Thus, a possible world clearly defines an episodic contextual element that must be taken into account when a piece of information about it is processed. Each set of representations referring to a possible world corresponds functionally to a separate compartment in memory, so we can talk of “compartmentalization” of information in memory (Potts and Peterson 1985).

Networks of activation allow easy modeling of the ability to distinguish between different possible worlds. To functionally ensure compartmentalization, we must assume a specific “modal” node for each possible world W, connected to all nodes belonging to the representation of W. The stronger these connections are to the modal node, the plainer the compartmentalization. Modal nodes are particular cases of “contextual” nodes, which some authors suggest using where there is a functional separation in memory between different sets of information (e.g., Potts and Peterson 1985).

Structures of semantic memory can change with subjects and therefore are not normative. Nevertheless, fictional narratives can involve semantic structures (and therefore some semantic contextual elements) that have a strong probability of being taken into account in information-processing, at least by nonpathological subjects. Indeed, if a narrative has a clearly defined theme (such as a traffic accident, or a love encounter), it involves some highly structured fragments of semantic memory (“schematas”; Rumelhart 1975) corresponding to this theme. These fragments allow the associations

2There is also a distinction between explicit memory and implicit memory. Explicit memory refers to knowledge and processes that subjects can intentionally control and account for. Implicit memory refers to strongly automatized processes and knowledge that subjects use unconsciously. Both explicit and implicit memory can be involved in episodic and semantic memory.
and inferences that yield the information necessary to understand the text.

Note that the compartmentalization depends on the thematization: The closer the themes of two stories, the more connected in memory the representations of these stories and the less sharp the functional compartmentalization (Seifert et al. 1986; McKoon et al. 1989).

Our model of disorganization by decontextualization predicts that the compartmentalization and thematization of fictional narratives will be impaired in schizophrenia subjects. Our experiment tests this hypothesis.

Method. To study the compartmentalization of fictional texts, we used the method of priming in word recognition (Ratcliff and McKoon 1978). After the subjects had read a series of texts, they were presented with a list of words and asked whether each word was in one of the texts they had read. The recognition time for a word (the target) is shorter if its representation in memory is activated by reading the preceding word in the list (the prime), which is theoretically the case if the representation of the target and the representation of the prime are related in memory (the more related they are, the quicker the answer).

To assess compartmentalization, one compares the facilitation of the response to the target when the prime and the target stimulus refer to the same text, as well as when they refer to two different texts. According to the hypothesis of compartmentalization, response times should be shorter in the first case, because the activation of the target by the prime is stronger if

we the target and the prime belong to the same functional compartment. Such results have been observed with normal subjects (Seifert et al. 1986; Plagnol 1993). With schizophrenia subjects, the compartmentalization should be impaired, while the propositional structuring (assessed by the priming effect between two words of the same proposition) should be relatively preserved (because the propositional structuring depends less on context effects than the compartmentalization).

We also assessed the compartmentalization in a control group of anxious-depressed patients: According to our model, a correlation between anxiety and interfering activity in memory could occur in a control group of anxious-depressed patients. As stated above, a local interfering activity in memory could explain the attentional and mnemonic bias for threatening or negative information observed in anxious-depressed subjects. Thus, we could observe some minor effects of decontextualization in anxious-depressed subjects.

We used fictional narratives with well-defined themes. The test of word recognition included some words semantically related to these themes: The thematization was assessed by studying the responses to these "thematic" words.

Material. Twelve texts were constructed in French, each about a brief story. These 12 texts were grouped in three series of 4 texts, corresponding to three tests of word recognition. Each series consisted of two pairs of texts with the same theme (e.g., a traffic accident). The macrostructures of two texts sharing the same theme were similar.

Within each text, eight words were used as test words in the test of word recognition:

- One "thematic" word, that is, a word semantically related to the theme of the text.
- Three "peripheral" words, that is, words not semantically related to the theme of the text (one was used as a target, the two others as primes; see below).
- Two words belonging to a same elementary proposition ("microproposition").
- Two words belonging to a same "macroproposition" (i.e., a particularly important proposition, summarizing the text; see Kintsch and Van Dijk 1978).

Each test of word recognition consisted of a list of 42 words that appeared successively in the center of a computer screen. The correct response was "yes" for 26 "positive" words and "no" for 16 "distractors." Among the positive words, 12 experimental prime-target pairs were defined by two consecutive test words.

Eight of these experimental pairs were designed to study the compartmentalization of the four texts in memory. These eight pairs correspond to eight different combinations, with two types of target and four types of prime. The target could be of a thematic or a peripheral type. The four types of prime were as follows:

- S: peripheral prime from the same text as the target (the prime came from the first quarter of the text and the target came from the last quarter, or conversely).
- T: peripheral prime from a text different from the text of the target but sharing the same theme.
D: prime from a text different from the text of the target and not sharing the same theme.

N: neutral prime constituted by the word “PRET” (READY): this word was an exception, because the subject had to answer “yes” to it systematically, as though it was in none of the four texts.

Four other pairs of test words corresponded to the study of four “propositional” conditions:

Ma: prime and target of the same macroproposition.

Na: neutral prime (“PRET”), target belonging to the macroproposition.

Mi: prime and target of the same microproposition.

Ni: neutral prime (“PRET”), target belonging to the microproposition.

The list also contained 16 distractors, for which the right answer was “no.” Four of these were semantically related to the theme of one of the four texts (thematic distractors), and four others were semantically related to a peripheral word of one of the four texts (peripheral distractors). The last eight distractors were not semantically related to any word of the four texts (nonrelated distractors).

**Design.** Four different orders of words in the recognition test were defined, corresponding to four groups of subjects, so that each text was tested in the same way for each of the eight prime-target combinations testing compartmentalization. Table 1 contains the pairs of test words used in the first recognition test for each subject group.

For example, the thematic target is “route” (road) for text A whose theme is a car accident. In the recognition test for group 1, the pair of test words “épicerie – route,” tests the condition S; “épicerie” (grocery) also belongs to text A. The test for group 2 includes the pair of test words “église – route,” testing the condition T; “église” (church) belongs to text A’, which has the same theme as text A. The test for group 3 includes the pair of test words “rouge – route,” testing the condition D; “rouge” (red) belongs to text B’, whose theme (love at first sight) is different from the theme of text A (car accident). The test for group 4 includes the pair of test words “PRET – route,” testing the condition N; “PRET” (READY) is the neutral prime.

A target word was seen in the recognition test by each of the four groups of subjects, with one of the four different types of prime (S, T, D, N—the type of prime was different for the four groups). Likewise, each prime word was used as a prime in all possible conditions, with a constant type of target (thematic or peripheral).

A text was tested by a pair of test words for each of the four propositional conditions; each of the four groups received one pair corresponding to a different condition (see table 1).

For each series of four texts, the order of presentation was set in such a way that the mean distance between a text X and the text sharing the same theme (which yielded the primes of type T for a target of X) was identical to the mean distance between X and the text not sharing the same theme, which yielded the primes of type D for a target of X.

The experimental pairs of test words were put in random order on the list, except that on the set of the four subject groups, the mean position of the pairs testing a condition was the same for all the conditions. Moreover, the first two words on the list did not belong to those pairs.

**Procedure.** The experiment lasted about 30 minutes and consisted of a training phase, followed by three experimental phases. Each experimental phase had three steps:

1. Reading four texts, each telling a different story: Each text was displayed on the computer screen for 70 seconds, and a beep warned the subject when only 15 seconds were left.

2. A brief task to “empty” the working memory before the recognition test: The subject had to read slowly and aloud a line of 10 numbers on the screen. Then a brief warning appeared about the test of word recognition, reminding the subject of the exception of the word “PRET” (READY) for which the correct answer was always “yes.”

3. The test of word recognition: The subject answered by pressing a marked key as quickly as possible, “yes” if the subject thought the word was in one of the four texts just read, “no” if the subject did not recognize the word. An interval of 200 ms separated the answer and the display of the next word.

The training phase was similar to the experimental phase, except that the subjects read only two texts of different themes.

**Subjects.** Two groups of subjects have participated in the experiment. The control group of
Table 1. Pairs of test words used in the first recognition test for each subject group

<table>
<thead>
<tr>
<th>Condition</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thematic target</td>
<td>épicérie-route</td>
<td>rouge-beauté</td>
<td>promenade-charme</td>
<td>église-ambulance</td>
</tr>
<tr>
<td></td>
<td>promenade-beauté</td>
<td>église-route</td>
<td>promenade-ambulance</td>
<td>rouge-route</td>
</tr>
<tr>
<td></td>
<td>église-charme</td>
<td>PRET-charme</td>
<td>église-beauté</td>
<td>PRET-beauté</td>
</tr>
<tr>
<td></td>
<td>PRET-ambulance</td>
<td>PRET-cheveux</td>
<td>PRET-marché</td>
<td>PRET-falaise</td>
</tr>
<tr>
<td>Peripheral target</td>
<td>hôtel-falaise</td>
<td>jambes-marché</td>
<td>ballon-cognac</td>
<td>téléphone-cheveux</td>
</tr>
<tr>
<td></td>
<td>ballon-marché</td>
<td>téléphone-falaise</td>
<td>hôtel-cheveux</td>
<td>jambes-cognac</td>
</tr>
<tr>
<td></td>
<td>téléphone-cognac</td>
<td>ballon-cheveux</td>
<td>jambes-falaise</td>
<td>hôtel-marché</td>
</tr>
<tr>
<td></td>
<td>PRET-cheveux</td>
<td>PRET-cognac</td>
<td>PRET-marché</td>
<td>PRET-falaise</td>
</tr>
<tr>
<td>Propositional conditions</td>
<td>femme-émotion</td>
<td>accidents-enfant</td>
<td>rencontre-affaires</td>
<td>cycliste-chute</td>
</tr>
<tr>
<td>Ma</td>
<td>PRET-enfants</td>
<td>PRET-chute</td>
<td>PRET-émotion</td>
<td>PRET-affaires</td>
</tr>
<tr>
<td>Na</td>
<td>crâne-trottoir</td>
<td>voix-ironie</td>
<td>morceaux-lunettes</td>
<td>adoré-roman</td>
</tr>
<tr>
<td>Mi</td>
<td>PRET-ironie</td>
<td>PRET-roman</td>
<td>PRET-trottoir</td>
<td>PRET-lunettes</td>
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<tr>
<td>Ni</td>
<td></td>
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</tbody>
</table>

Note.—S = prime from the same text as the target (the prime came from the first quarter of the text and the target came from the last quarter, or conversely); T = prime from a text different from the text of the target but sharing the same theme; D = prime from a text different from the text of the target and not sharing the same theme; N = neutral prime constituted by the word "PRET" (READY). This word was an exception, because the subject had to answer "yes" to it systematically, as though it was in none of the four texts; Ma = prime and target of the same macroproposition; Na = neutral prime ("PRET"), target belonging to the macroproposition; Mi = prime and target of the same microproposition; Ni = neutral prime ("PRET"), target belonging to the microproposition.

anxious-depressed subjects consisted of 24 patients treated in the psychiatry departments of the hospitals Pitié-Salpêtrière and Necker-Laennec (Paris). Twenty-two of these subjects were hospitalized at the time of the experiment, and two were outpatients.

We wanted a group of subjects who were clearly anxious-depressed, able to participate in the experiment, and could be clearly differentiated from the schizophrenia subjects. The presence of an anxiety-depression syndrome was assessed by the physicians treating the patients, who also determined whether these patients belonged to one of the following DSM-III-R categories: major depression (single episode or recurrent depression, without psychotic characteristics), bipolar depressive trouble (without psychotic characteristics), and generalized anxiety. All these patients had at least 8 years of academic education, which was necessary to complete the experiment. Depressive patients with psychotic characteristics were excluded from the experiment in order to obtain subjects suffering from a "pure" anxiety-depression syndrome and to avoid any doubt about a diagnosis of schizophrenia.

All patients received drug treatment that generally combined anxiolytics and antidepressants (two of the subjects received only anxiolytics but the DSM-III-R diagnosis was "recurrent depression"). The mean age was 45.5 years; the mean length of the disease since the first consultation or hospitalization was 6.3 years; and the mean level of education was 11.7 years of academic education.

The schizophrenia group consisted of 24 patients treated in the psychiatry departments of the following hospitals: Pitié-Salpêtrière (Paris), Necker-Laennec (Paris), Paul-Guiraud (Villejuif), Ville-Evrard (Neuilly-sur-Marne). Nine of these subjects were hospitalized at the time of the experiment, 10 were in day hospital, and 5 were outpatients. These patients met DSM-III-R criteria for schizophrenia. All these subjects had a basic...
level of education compatible with the feasibility of the experiment (8 years of academic education).

All were treated with neuroleptics, generally associated with some anticholinergic drugs. The mean age was 34.9 years; the mean length of the disease since the first consultation or hospitalization was 12.6 years; and the mean level of education was 10.5 years of academic education.

As we pointed out at the beginning of this article, the two groups did not have to be identical for all possible factors but the diagnosis. In fact, there are some significant differences between the two groups in age, length of illness, and length of previous hospitalizations. Likewise, even though the two patient samples have a similar mean educational level, there would still be potential differences in cognitive skills. The typical schizophrenia group patient began to have problems when he or she was young and the illness has been chronic (at least 6 months according to DSM-III-R criteria), requiring some long hospitalizations. The age at illness onset is more variable in anxious-depressed subjects (but is globally higher than in schizophrenia subjects); they are treated for briefer periods, have fewer hospitalizations, and usually have a good recovery between episodes.

The differences between the two groups reflect some differences between schizophrenia and the anxiety-depression syndrome. From our nominalist point of view, if the two groups were identical for all possible factors but the diagnosis, they would be identical. Of course, such factors as age, length of illness, and length and number of previous hospitalizations could influence performance on the task. It would certainly have been better to control for such major noncognitive characteristics (as many other investigators have done), even if we are interested in patients classified as having schizophrenia or depressive illness, and these characteristics may be part of such diagnosis classification. But, once again, our only objective is to check on the prediction made by our model: Some patients diagnosed as having "schizophrenia" on the basis of clear criteria should have impaired compartmentalization and thematization of fictional narratives, compared with anxious-depressed subjects selected on a similar basis.5

Results and Discussion

Compartmentalization. Only correct answers to both the prime and the target given in less than 4,000 ms and more than 500 ms were taken into account. The data were grouped by type of prime, in order to have enough data for each condition to allow a satisfactory analysis of variance. The mean response time (RT) of a condition is the mean of the mean response times of the subjects. Table 2 gives the mean RTs for the different conditions of priming.

Anxious-depressed subjects. The RT decreases in condition S relative to condition D; the difference is significant at \( p = 0.03 \). Thus, there is a priming effect between two words of the same text, relative to two words of different texts not sharing the same theme. These results show that the anxious-depressed subjects compartmentalize the information between two texts of different themes.

However, one does not observe any compartmentalization between two different texts sharing the same theme in these subjects: The RT in condition T (prime and target of two different texts sharing the same text) is close to the RT in condition S (prime and target of the same text). This finding contrasts with what has been observed in normal subjects in similar experiments (Seifert et al. 1986; Plagnol 1993).

According to this model, if the anxious-depressed subjects compartmentalize the information between two texts of different themes, but not between two texts sharing a same theme, one can hypothesize a moderate interfering activity in their memory. One can thus assume that there is some correlation between anxiety and interfering activity in memory, which could explain some minor effects of decontextualization of information in anxious-depressed subjects. We observed similar results in an experiment with normal subjects when an artificial interfering task was added to the reading and recognition tasks (Plagnol 1993).

Schizophrenia subjects. The RTs are similar for conditions S and D: There is no compartmentalization between two different texts, even if they do not have the same theme, as our model predicted. This seems relatively specific to the schizophrenia subjects, even if the interaction of the within-effect S/D with the between-effect...
Table 2. Mean response times (ms) for the compartmentalization conditions

<table>
<thead>
<tr>
<th>Type of prime</th>
<th>N</th>
<th>D</th>
<th>T</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxious-depressed</td>
<td>1,658</td>
<td>1,624</td>
<td>1,415</td>
<td>1,376</td>
</tr>
<tr>
<td>Schizophrenia</td>
<td>1,741</td>
<td>1,522</td>
<td>1,378</td>
<td>1,537</td>
</tr>
</tbody>
</table>

Note.—N = neutral prime constituted by the word “PRET” (READY); D = prime from a text different from the text of the target and not sharing the same theme; T = prime from a text different from the text of the target but sharing the same theme; S = prime from the same text as the target (the prime came from the first quarter of the text and the target came from the last quarter, or conversely).

Propositional Conditions. Table 3 shows the RTs for the different propositional conditions. The results are very similar for the two groups: The RT is decreased for a prime belonging to the same proposition as the target, compared with a neutral prime. This is true for the macropropositions (decrease of the RT in the condition Ma relative to the condition Na) and for the micropropositions (decrease of the RT in the condition Mi relative to the condition Ni). Between the two groups of subjects, there is no significant difference of macropropositional or micropropositional priming.

Propositional structuring is therefore preserved in schizophrenia subjects, unlike compartmentalization. These results correspond with our model, which predicts a specific impairment of compartmentalization in schizophrenia subjects. The propositional structuring depends less on context effects than does the compartmentalization.

Thematization. The percentage of correct responses (PCR) to the targets used in the compartmentalization conditions and the percentage of errors (PE) to the distractors are shown in Table 4. The global PCR is significantly decreased in schizophrenia subjects, compared with the anxious-depressed subjects (p = 0.04): This fact is in accord with the hypothesis of high-interfering activity in schizophrenia inducing a global impairment of mnemonic performance.

Moreover, in schizophrenia one observes a decrease of PCR for thematic targets, which is more important than the decrease for peripheral targets. This seems relatively specific to the schizophrenia subjects, even if the interaction of the within-effect thematic-targets/ peripheral-targets with the between-effect anxiety-depression/ schizophrenia does not reach significance (p = 0.1). This specific alteration of responses to thematic targets shows that schizophrenia subjects are less able to elaborate or use the themes of the texts than are the other subjects.

The study of the PE to the distractors also confirms the hypothesis of an impairment of semantic contextualization in schizophrenia. Indeed, the PE for the thematic distractors is, paradoxically, significantly better in schizophrenia subjects than in anxious-depressed subjects (p < 0.001). On the con-
Table 4. Percentage of correct responses to the targets used in the compartmentalization conditions and percentage of errors to the distractors

<table>
<thead>
<tr>
<th></th>
<th>Targets (PCR)</th>
<th></th>
<th>Distractors (PE)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Thematic</td>
<td>Peripheral</td>
<td>Thematic</td>
<td>Peripheral</td>
</tr>
<tr>
<td>Anxious-depressed</td>
<td>91.7</td>
<td>74.3</td>
<td>81.2</td>
<td>36.1</td>
</tr>
<tr>
<td>Schizophrenia</td>
<td>81.9</td>
<td>71.2</td>
<td>63.9</td>
<td>35.1</td>
</tr>
</tbody>
</table>

Note.—PCR = percentage of correct response; PE = percentage of error.

Conversely, the PEs for the peripheral and nonrelated distractors are very close for these two groups: The apparent improvement of the PE for the thematic distractors in schizophrenia is therefore not caused by a better performance, but by a lower level of activation of the representations of the thematic words, which can be explained if the themes of the texts are less structured in schizophrenia subjects than in anxious-depressed subjects.

However, the PCR of schizophrenia subjects for the thematic words is still significantly higher than their PCR for the peripheral words (p = 0.008). Their PE for the thematic distractors is also still much higher than their PE for the peripheral distractors. These two simple facts show that the contextualization of information is far from totally impaired in schizophrenia subjects.

Conclusion

The impairments in compartmentalization and thematization observed in schizophrenia subjects confirm the hypothesis of a diffuse interfering activity in these subjects. These impairments are not caused by an age effect: The mean age of the group of anxious-depressed subjects is lower than the mean age of the group of anxious-depressed subjects. One could also question the effect of neuroleptic treatments. The higher cognitive functions are generally improved in patients treated by chronic administration of neuroleptics (see the reviews of Cassens et al. 1990 and King 1990). However, some reports have indicated that some potential negative effects on cognition may be associated with neuroleptics (e.g., Lisksy et al. 1981; Goldberg 1985). Thus, specific effects of neuroleptics on contextualization of information should be evaluated in further experiments. From the point of view of our model, the sedative neuroleptics seem to reduce the interfering activity in memory, so they allow a better structuring of information.

The two groups of patients were not paired for many factors so one could question the effect of these factors on the results—notably the influence of the chronicity level, as it can be assessed by length of illness and length of hospitalizations (both of which were greater in the schizophrenia subjects). Control of chronicity level was not necessary for this experiment, and chronicity is an intrinsic characteristic of schizophrenia, unlike anxiety-depression syndrome. Readers should keep in mind, however, that potential differences in chronicity and other major noncognitive characteristics could have influenced the results (some of the effects of these characteristics possibly even occurring independent of diagnoses). Thus, it would be useful to control for these characteristics in further experimentation. It would also be interesting to study the influence of some of these characteristics on the performances of schizophrenia subjects, notably the influence of the chronicity level. Indeed, our model shows the "vicious circle" of the disorganization processes of representations: If a diffuse state of activation results in an abnormal structuring of information in memory by functional decontextualization, then a destructuring of information in memory induces a diffuse state of activation. Thus, our model predicts a deterioration in performance as a function of chronicity level. Such a deterioration could reflect the temporal evolution of disorganization in schizophrenia, notably the evolution of a "positive" paranoid symptomatology toward a "negative" symptomatology.

*A precise formal simulation of this "vicious circle" can be carried out in the framework of networks of activation (Plagnol 1993).*
tive” hebephrenic or catatonic symptomatology. It would therefore be interesting to study the specific performance of subjects with some subtypes of schizophrenia.

Chronicity could also affect motivation, which in turn can influence performance. All subjects were volunteers, and schizophrenia subjects apparently were well-motivated, even more than the anxious-depressed subjects. The PCR of schizophrenia subjects increased during the experiment (74.2% for the first test, 76.6% for the second test, 79.2% for the third test), unlike those of anxious-depressed subjects (85.4%, 78.1%, and 85.4%, respectively), who typically expressed their lassitude with the experiment during the second series of tests and found some new courage for the last series as the end was near. Note also that during the tasks, subjects were not conscious of the precise objective of the experiment (they knew only that it was an experiment on memory) and could not understand the design of the recognition test. Thus, schizophrenia subjects could not intentionally influence compartmentalization and thematization, which are specifically impaired in these subjects. Nevertheless, it is still possible that the motivations of schizophrenia subjects are different from the motivations of anxious-depressed subjects and that this difference can affect results in a complex way; the motivations can also be considered a reflection of some intrinsic characteristics of the two clinical syndromes.

The most interesting part of our model is the simplicity of its concepts and hypotheses. The notion of activation is only a tool to account for the differential state and the elementary dynamics of representations. The notion of functional disturbances of this dynamic implies the hypothesis of an interfering activity in memory. The notion of a diffuse interfering activity is only necessary to account for a general destructuring inducing a leveling-off of the contextual effects, as it is observed in groups of schizophrenia subjects. The concept of decontextualization is only a formulation in information-processing terms of the cognitive problems attributed to schizophrenia: Decontextualization, disorganization, destructuring, and compartmentalization are notions that imply one another. The framework of the networks of activation is the simplest tool for formalizing the dynamic interactions of some representational units.

Indeed, many authors have used similar concepts. Callaway (1970) proposed a model of cognitive problems in schizophrenia, based on the assumption of disturbances caused by interfering information. Callaway and Naghdi (1982) argued that the “central” (“conscious” and “unautomatic”) processes are specifically disturbed. Chaika (1982) came to the same conclusions in slightly different terms.

Hoffman (1987) was inspired by Callaway’s ideas to use some neural networks to show that an “overloaded memory” has a schizophrenia-like behavior. Memory overload imposed on those neural networks results in misperceptions, loose associations, and parasitic states.

Servan-Schreiber and Cohen (1991) have also used a connectionist framework to account for the decontextualization observed in schizophrenia for some linguistic and attentional tasks. Their model specifically attributes this decontextualization to the reduced dopaminergic activity in the prefrontal cortex described in schizophrenia subjects.

Frith (1992) attributes schizophrenia symptoms to a deficit in the ability to represent mental states (“metarepresentation”). The metarepresentation can be considered a particular case of contextualization: When one ascribes a mental state to a subject, its content has to be relative to the particular context of the mental “possible world” of this subject.

Beyond the different terminology, several researchers reach similar conclusions about the elementary processes of cognitive disorganization in schizophrenia, and this can be summarized by a general formula: interfering activity/overloaded memory = decontextualization.

This agreement among researchers is not surprising if one thinks of the basic cognitive symptoms of schizophrenia: disturbed associations and incoherence. To translate these cognitive symptoms in representational terms and understand the underlying processes, one a priori constructs a model following this formula. We have seen that such a general model accounts for the different classes of cognitive problems observed in schizophrenia, and the results of
our experiment confirm this model, insofar as compartmentalization and thematization are paradigmatic cases of contextualization of information.

Nevertheless, the validation of such cognitive disorganization models with some experimental groups of patients raises serious difficulties. One major problem comes from applying cognitive psychology to psychopathology. Using models of disorganization of representations, we are theoretically on the level of elementary psychopathology, while the selection of experimental groups of patients depends on defining nosographical entities with clinical pragmatist criteria. As we explained above, a nosographical entity is defined by a cluster of clinical symptoms that do not necessarily correspond to a characteristic pathological process. Thus, the theoretical level only roughly coincides with the experimental level, however intensive the search for a specific cognitive anomaly may be. One could hope for a new definition of nosographical entities based on criteria of elementary psychopathology, that is, in terms of a structure of activation of representations. Meanwhile, cognitive models must be limited to account for some clusters of symptoms, and they can be confirmed in their experimental predictions only by selecting groups of patients who have a strong probability of presenting these symptoms (without attributing ontological reality to the disease and without trying to characterize such a disease by using perfectly paired control groups).

Another source of controversy is in the epistemological points of view underlying the different models. Indeed, the dominant point of view is still "linear causality," in which specific deficit causally explains a disease. In this way, one researcher can insist on one process as the origin of the problem, another researcher on another process, and a skeptical mind can note their disagreement. In fact, the two processes may imply each other and no definitive experiment may exist to decide between the two models. In the same way, some authors attribute a particular value to a biological explanation, while others insist on the mutual interaction of biological, cognitive, and affective factors.

We prefer our description for reasons that often do not agree with arguments proposed by other authors to support their theories. Since Bleuler (1911/1950) made the distinction between primary and secondary symptoms, many authors have tried to put these symptoms in a hierarchy, generally with the purpose of exhibiting a specific and primitive abnormality. Our model shows the vicious-circle nature of the processes of disorganization of representations. From our point of view, the problem of the hierarchy of schizophrenic symptoms is akin to the problem of the chicken and the egg.

Our model leads to a general and unified concept of cognitive troubles. As we have seen, some aspects of the anxious-depressed syndrome can be clarified within the same conceptual framework. This unified character is an advantage, not a flaw, if one assumes a nominalist point of view on the nosographical clinical categories.

Our model predicts some cognitive troubles at all levels of information-processing. Moreover, such a model goes beyond traditional cognitive problems such as those observed in attention, memory, and language fields. For example, the phenomena of parasitizing or mental automatism, some auditory hallucinations, or some delirious interpretations can easily be described in terms of zones of interfering activity. Moreover, a diffuse state of activation of representations can be considered as the representational correlate of a deep state of anxiety (schizophrenia subjects usually have a deep anxiety). This relation between a deep state of anxiety and a diffuse state of activation of representations (or, more generally, between a phenomenon of anxiety and a zone of interfering activity in memory) could provide a better understanding of the intermingling of emotional and representational factors in psychopathological processes.

In the end, we present a model of functional disorganization concerned only with the elementary dynamics of representations. We prefer to try to clarify the schizophrenia syndrome independent of any would-be causal exclusive explanation, biological or not.

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Schizophrenia: Questions and Answers

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The booklet describes "The World of the Schizophrenic Patient" through the use of analogy. It briefly describes what is known about causes—the influence of genetics, environment, and biochemistry. It also discusses common treatment techniques. The booklet closes with a discussion of the prospects for understanding schizophrenia in the coming decade and the outlook for individuals who are now victims of this severe and often chronic mental disorder.

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