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A System about Which There is No Awareness Originates in the Right Hemisphere: Support from Studies of Schizophrenia

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Abstract

Problem theory depends on an a priori relation between six key problems. People appear to have adapted to it through evolution. A protective system called the backup operates when of these problems, the freedom problem, is salient. Neuroscience findings about this especially support the theory. Yet awareness is entirely lacking. It is argued that a system R originates on the right, parallel to one on the left, L that becomes the mind. R and L invent different languages for decision making and are kept apart. Accepting and exerting influence are also kept apart, leading to four subsystems. Each is active in a different microstate type and one EEG frequency band becomes important there. R and L communicate by leaving images in the cortex. R decides which of the key problems is important. Studies of schizophrenia are reviewed because the disorder is associated with poor judgment of what is important. Indeed different kinds of observation repeatedly point to the malfunctioning or abnormality of R in the disorder, supporting its supposed role. Competition between certainty and freedom problems provides R with a dilemma of choosing between them. R creates images with false information that turn attention one way or the other. Hallucinations typically turn attention to the certainty problem. Information that creates a difficult false task turns it to the freedom problem. Hallucinations interfere with perception and create loss of connectivity on the left, but that from the backup is greater. Some drugs, risperidone for example, might resemble chemical triggers for one of the later key problems. A study of R's normal functioning points to its intelligence and understandability. It listens in to conversations. Treatment that raises hope about the certainty and freedom problems and clarifies L's behavior for R is suggested. Integrating education with the key problems would strengthen R.

Keywords: Problem theory; Backup; Lateralization; Microstates; Schizophrenia; Mismatch negativity; Connectivity; Risperidone; Treatment; Education

Introduction

At the center of problem theory is the discovery of an a priori relation between six problems of everyday life, called the key problems. These are gaining sufficient of the following variables: certainty of knowing the environment and all that happens in it of its own accord, this includes the internal environment, freedom to do as one wants, power to control, and success in what one attempts to do, regardless of the goodness of the consequences in other respects, satisfaction, what is good from the viewpoint of the self, other's good state, the health and happiness of other people, unity with other people when working alongside them, and fairness or justice in the comparisons of how members of one's group are treated. Previously the key problems were defined as ones of raising hope about gaining sufficient certainty, freedom, and so on. The new definitions fit the present article better but make no difference to the application of the theory. It is still assumed that people try to raise hope as before.

The a priori relation that has been discovered is represented in Figure 1. It is readily checked. The key problems are on the left of the figure. They are arrived at by the successive sub-division of the overall problem presented by living. There is evidence that children work through the key problems with slightly more than 18 months on each. The difference from 18 months is ignored here. At first the estimates for the ages of the transitions were based on overt behavior [1] and were only roughly at 18 month intervals. The EEG data, described below, which was studied later [2], pointed to the changes between key problems occurring more closely at 18 month intervals. The estimates were subsequently revised to match the EEG findings [3]. The sequence of six problems is repeated at least once more, from 9 to 18 years, Children first clarify each problem and separate it from the remainder. They concentrate all serious attention on it for a while, then alternate between it and the remainder, as if to learn how to switch problems. They then finally reject the problem, leaving the remainder, and go down a level to the freedom problem and then to the others in turn. The outcome is that adults switch between the key problems mostly appropriately, though more readily switching to one, as well as possibly being influenced in some degree by inborn factors that lead to further repetitions of the sequence of key problems every nine years.

Some of the support came from the study of isolated societies. Here people have all tended to focus attention on one of the key problems [3,4]. The evidence was helpful in constructing lists of strategies, patterns of behavior that raise hope, for each key problem.

Table 1 gives examples from the certainty list. What is important with this problem is what happens in the environment of itself as observed when one is at rest. Yet some certainty strategies do involve activity. This applies with experimenting to see how people and things behave of themselves. There is activity, but what is important is what happens afterwards, when one is at rest. For example an infant might drop an object just so as to watch its fall. Activity is needed in letting the object go, but interest centers on what happens of its own accord afterwards. With identifying and using constancies, infants engage in repeated movements, such as rotating an object so as to see it from different angles. Yet the relevant observations are all made while at rest. The strategies of keeping traditions going, keeping to a routine, require activity, but this is of a repetitive kind and there is no interest in how the activity is produced. An example of the influence of the anthropological data is the inclusion of the strategy of believing fatalistically in a predetermined life story from the study of the Ojibwa, a North American Indian society.

Support also comes from the changes with age of children's EEGs, as reported by Thatcher [5]. The coherence between a pair of electrode sites reflects the similarity, coordination, and coupling between underlying cortical areas. The changes in coherence in the theta range, 3-8.5 Hz, can be matched to changes in overt behavior [2]. Thus graphs of change in the coherence between the following pairs of sites, Fp2-T6, F8-T6, T4-T6, and F8-O2, tend to go together and match changes in overt behavior relating to the certainty problem. The sites are all on the right and T6, which reflects the rear of the temporal lobe, is central. Changes in F3-P3, F7-P3, P1-T3, T3-P3, and T3-C3, go together and match changes in overt behavior with the freedom problem. Here the sites are all on the left, and P3, which reflects the parietal lobe, is central. Thus the coherences reflect work on the key problems. There is other evidence that the certainty problem is dealt with on the right, primarily in the temporal lobe, and that the freedom problem is dealt with on the left, primarily in the parietal lobe [6].

The backup, an aspect of the functioning of the brain

With the freedom problem attention is turned away from the goodness of effects other than success at what one is trying to do. Hence if one is stuck on a task there is no way of extricating oneself. Also dangerous tasks might be undertaken. Hence work on the freedom problem requires the backup. This includes a cut-out to discontinue attempted work when stuck and an override to avoid danger.

Evidence of the backup was first found in the EEG study of children reported by Thatcher mentioned above. The interhemispheric coherences P3 -P4 and T5-T6 vary in the same way as the work on the freedom problem. Yet they could not contribute to this because it is done wholly in the left hemisphere in infancy [6]. Thus P3-P4 could be used to trigger the cut-out, which suppresses the left parietal. As T6 reflects the right temporal lobe and hence work on the certainty problem, T5-T6 could be used to trigger the override when uncertainty is high [7].

Table 1: Examples of certainty strategies.

Gaining and analyzing distinctive information
Experimenting to see how people and things behave, of themselves
Identifying and using constancies
Thinking ahead and examining all the different possible outcomes of a situation
Finding reliable friends and groups
Fitting in with people's requests and expectations
Giving people the impression that they want or expect and the story that they want or expect to hear
Impressing people for example with one's competence and loyalty
Staying in a well-known place like the home
Narrowing the field of one's activities
Arranging for a steady stream of stimulation
Keeping traditions going
Keeping to a routine
Freezing, remaining immobile
Believing fatalistically in a predetermined life story
Turning attention to facts that raise hope about certainty but away from facts that lower hope about it

*Note: Adapted from The strategies of living in different societies (Rev. ed.) by G. Burnand, 2012 [3].

There was a little evidence of corresponding EEG findings in the research on Alzheimer's disease. There is more in the research on schizophrenia [See Appendix 1]. Still the main evidence for the backup comes from research on brain activity as observed via blood flow or metabolism [8]. Three studies, one each from research on hypnosis, post-traumatic stress disorder and dissociative identity disorder, linked the cut-out with a minimum activity at similar points in the left precuneus, averaging – 7 – 64 35, Talairach and Turnoux coordinates are used here and later. Only one study, that of hypnosis, gave evidence about the override, linking it with low activity at - 60 -58 0. These points were called the cut-out and override points. Subsequently the research on Alzheimer's disease yielded evidence of the cut-out in four studies, averaging – 7 – 69 38 [9]. One study provided evidence of the override point at – 58 – 57 2. Finally the first five studies of schizophrenia that were encountered that yielded evidence of the cut-out point averaged – 7 – 65 33 [See Appendix 1]. This is close to the average for the previous observations, – 7 – 67 37.

The backup has a special importance in relation to Alzheimer's disease, where it offers the only current explanation for the highly left sided atrophy. The theory also accounts for the strong genetic influence [9].

As the backup represents an adaption to the freedom problem, the evidence about it supports how human beings have evolved so as to exploit and adapt to the relationship represented in Figure 1. Thus as well as the theory being based on an a priori relationship that is readily checked, and supported by the study of child and group development and isolated societies, there is now strong support for the theory from the study of the brain.

Yet people appear to have no awareness whatever of the key problems and how they change. This is especially evident when small groups of people are studied. In particular Bennis and Sheppard [10] point to six phases that match the key problems closely. Group members were observed to switch between problems in unison, without comment, "mercurially", as if unaware of the change. People always try to raise hope of what is important, but what is considered important shifts without awareness. Previously the unawareness was attributed to activities becoming habitual and automatic. But the unawareness is present in children who are influenced for the first time.

Hence an aim is to argue that an intelligent and understandable system, called R, originates in the right hemisphere in parallel with the system, called L, which becomes the mind. R decides which of the key problems is to be regarded as important, yet without ever having awareness. Schizophrenia is a condition where judgment of what is important is defective. Its negative symptoms reflect a lack of importance of ordinary social and self-maintaining tasks. Sudden changes in what is regarded as important account for thought blocking and inappropriate shifts in the theme of conversation. Thus the argument is supported by showing that a coherent account of schizophrenia can be written where studies repeatedly point to the malfunctioning or abnormality of R.

A System R Originates on the Right

R and L cannot communicate directly because they spontaneously develop different languages

The cortices of the two hemispheres lack connection at first. L emerges spontaneously on the left and it is assumed that R does the same on the right, independently. Each has a hippocampus, and that on the left is

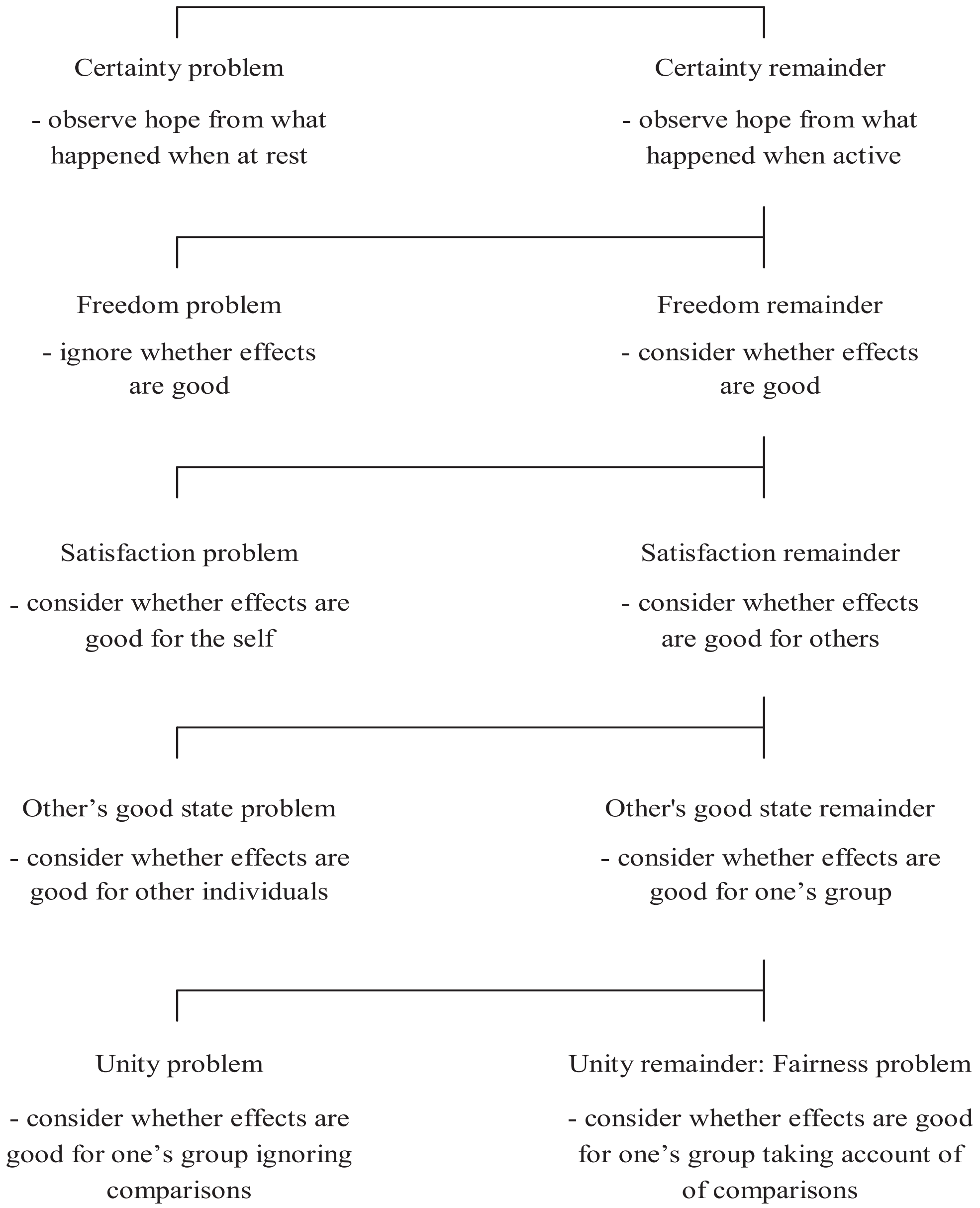

Figure 1: Figure 1 shows the relation between the key problems. The first five key problems are on the left, and the sixth, fairness, is on the bottom right. They are produced by the successive subdivision of the area of attention. The first subdivision is between the certainty (about the environment) problem where attention rests on what happened when at rest or in some settled repetitive activity, and the certainty remainder on the top right, where attention rests on what happened when active and when attempts were made to produce effects. The second key problem, of freedom and power to control, is arrived at by ignoring whether the effects are good, other than merely successful, and so on. The various steps represented in the figure reflect decisions about the area of attention that are made by the child. Adapted from Human Development: Childhood, Adolescence, and Personality, in Terms of a Unifying Theoretical System by G. Burnand [1,3].

known to be active when people say that they are having memories [11]. Yet it is such memories that are used in deliberate decision making. Hence L takes part in decision making and it is assumed that R does the same, independently.

If either R or L is to make a persisting decision it each must have a set of images that are related together in a persistent way in order to record it. In other words each must invent a language so as to describe the decision.

The hippocampuses become myelinated, ready to function, a month before birth [12]. This implies that decision making by R and L occurs even then. Although the corpus callosum begins to be myelinated 3 or 4 months after birth, observations of infants indicate that a stable relation between the hemispheres develops only at 5 months [13].

Hence R and L are independent for 6 months, and during this time each will create its own non-verbal language within which decisions are made.

Yet, because of slight differences between the neural structures and between their sensory inputs, these could not be exactly the same. There will be no common language with which the systems could communicate. Indeed there is evidence that the two hemispheres develop differently, consistent with them supporting quite different language systems. The left hemisphere enables fluent speech but the right does not. As shown by what happens in deep hypnosis, where R is in control, R has very limited speech yet a relatively good understanding of speech, as when other people speak [8]. R and L are able to use the same words but their underlying language organizations are different.

R and L are separated by being active in different microstates

R and L must be kept apart or else they will interfere with one another. This could only be done by the brain dealing with each system alternately, like a builder working on two houses, doing a bit on one and then a bit on the other repeatedly. At the same time the acceptance and exertion of influence need to be separated because each system accepts influence mainly from one hemisphere, whereas exerting influence must be bilateral equally. Hence there must be four subsystems that each requires repeated periods of time.

Such periods of time are evident in the EEG and are called microstates. In them the overall pattern of electrical potential changes over the scalp remains stable for 80-120 ms before rapidly changing to a different one [14]. Four microstate types are always identified in the resting state EEG. Type A microstate mainly involves the left hemisphere-this could be where L accepts influence. Type B mainly involves the right hemisphere-this could be where R accepts influence. Type C is bilateral and towards the back of the cortex-this could be where R exerts influence in collecting information from the environment, using inputs from both sides of the brain. Type D is also bilateral and covers the whole of the cortex-this could be where L exerts influence on voluntary activity bilaterally. It allows any sensory inputs and motor outputs to be related to one another, as required for skilled activity. It will be assumed that this is indeed what happens. The assumption is encouraged by the lack of any compelling alternative explanation for the microstates.

Yet the EEG does not change abruptly at the end of each microstate. The only way that microstate types could have independence from one another is if they are each associated with different EEG frequency bands and a particular frequency band only becomes important during a particular microstate type.

Now there is evidence that R exerting influence is linked to low theta below about 5.5 Hz and L exerting influence is linked to high theta above about 5.5 Hz [2]. For example Demiralp and Basar [15] used a series of identical stimuli where every fourth stimulus was omitted. Participants were told that their task was to predict and mark mentally the times of occurrence of the omitted signals. The third successive stimulus would have been a time of high expectation of having certainty raised about the omitted stimulus coming next. Thus although L will be involved superficially, R will be heavily at work on the certainty problem, exerting influence in providing images for L to use. Low theta, 3 Hz, was observed there. High theta, defined as 5.5-7.5 Hz, was observed, for example, by Yamada [16] during a video game. Here L will be exerting influence in producing effects, as for the certainty remainder. Thus high theta becomes important when L exerts influence.

Hence low theta becomes important in microstate C where R exerts influence and high theta becomes important in microstate D where L exerts influence. High and low theta are distributed bilaterally consistent with R and L exerting influence rather than accepting it.

The microstate A, where L accepts influence, and B, where R accepts influence, will be linked to other frequency bands. Omitting alpha, which is known to be inhibitory, the EEG frequencies divide at 20 Hz. Above and below this serve different functions. Above 20 Hz, high beta and gamma will be linked to A because L is responsible for skilled activity and higher frequencies will optimize this. Low beta, 13-20 Hz, will be linked with microstate B where R accepts influence.

There is a substantial dorsal area that is common to all four microstates. This could be home to lasting images that are created by R or L and read by the other. The sharing of inputs from the sense organs might lead to images that are sufficiently like sensory inputs being recognized by both systems. For example this could be where R creates size and shape constancies, creating images of objects that are independent of distance, orientation, or lighting, so as to raise its own expectation of certainty about the environment, and where L reads them and uses them. R and L could share the same phonetic word images while at the same time having to learn their meanings independently.

As R and L do not communicate directly, the selection of the key problem must be controlled entirely either by one or the other. Yet the first problem, the certainty problem, is dealt with only by the right hemisphere in infancy [6]. Hence R must control attention to the certainty problem. It therefore controls attention to all of the key problems, directing attention to one at a time. Any influence that L has must be via its influence over R.

However what R is responding to in selecting the appropriate key problem has yet to be studied. Possibly R is much influenced by other people's facial expressions. If so then L might influence R by imagining particular facial expressions. Because of such possibilities, R might be only partly independent from L.

Support from Children's EEGs

The changes with age of children's EEGs reported by Thatcher, mentioned above, support the role of R in controlling attention to the key problems. There are changes of direction of the graph of F8-O2 at each of the transitions between key problems, every 18 months, most of them large [2]. This implies that there are changes in the way that the coherence is being used at each transition. As F8-O2 is on the right and involves the visual cortex it implies that R is active in all of the transitions and that visual images are used in labeling. There are no similar changes on the left, consistent with L having no role in the selection of key problems. The actual labeling of the first key problem by R is reflected in observations by Bell and Fox [17]. There was EEG power growth at 7-8 months in the right visual cortex and at 9-10 months in the left. Accordingly the clarifying phase of the certainty problem, as identified from the overt behavior of infants, is 7-10 months. Thus R labels activities relating to the certainty problem in the right hemisphere at 7-8 months and activities relating to the certainty remainder in the left at 9-10 months, so as to clarify the problems. The large scale of the effects suggests that the task is import to R and that intense effort is put into it. Overall the findings are consistent with visual image labels for the key problems being held in the right cortex where they can optimally influence R. Those for the remainders, which have only temporary importance, are held in the left cortex. Yet as they are in the rear of the brain they can still influence R.

Support from Findings about Dissociative Identity Disorder

In deep hypnosis, and probably in shallow hypnosis as well, the hypnotist is communicating with R [8]. Thus when studied under hypnosis the identities are found to have selective memories. This means that they could help by selectively remembering facts that help to decide the key problem. Yet when the identities are studied outside of hypnosis they do not have selective memories [18,19]. This means that they could not help L in selecting the key problem, in the way that they could help R.

These findings point to R on its own mediating the choice of key problem, without any help from L. Still L could have some influence over R.

Support from Studies of Schizophrenia

The retention of an earlier hypothesis

A hypothesis for schizophrenia was put forward earlier [2,20]. The term recurrent confusion was preferred to schizophrenia, where confusion refers to the set of symptoms involved. Both confusional states and recurrent confusion were regarded as resulting from a competition between certainty and freedom problems. Here the term disorder is used to refer to both isolated and recurrent conditions. The hypothesis was supported by a wide range of research that need not be duplicated here.

Work on the certainty problem is mainly done in the right hemisphere and work on the freedom problem is mainly done in the left hemisphere. Thus the hypothesis went on to claim that the competition between the certainty and freedom problems results in a competition between the hemispheres. This is relieved by focusing attention on one. Here the hypothesis that the disorder is caused by the competition between the certainty and freedom problems is retained, but emphasis is now placed on the consequent dilemma faced by R about where to direct attention.

The effect of the disorder on microstates

A meta-analysis by Rieger et al. [21] indicated that in the resting state EEG, the microstate type B is shorter. During this microstate type, R accepts influence primarily from the right hemisphere. Its shortening implies that R cannot be fully accepting influence normally and is therefore malfunctioning. The finding was reliable without a Bonferroni correction. One is not necessary here because the theory specifically relates to the malfunctioning of R and therefore focuses attention on the microstate B rather than the other microstates. Type C, where R exerts influence, is more frequent, implying that R is functioning abnormally. Type A, where L accepts influence, is unaffected, implying that L is accepting influence normally. Yet type D, where L exerts influence, is shorter. This implies that L is behaving abnormally because of the abnormality of the images left by R.

There is evidence of a lowering of the intra-hemispheric EEG coherence at low beta [22]. This is the frequency band involved when R accepts influence during the microstate B. Its lowering again implies that there is a weakening of the influence on R and that R is therefore functioning abnormally.

Now in early life the influence accepted by R is entirely from the right. Yet valuable information for R will be available on the left, and R is expected to come to use this in some degree. Thus it is the low beta coherence on the left that is lost in the disorder [23]. This implies that R has shifted to a less mature pattern, more divorced from the functioning of L, and is again abnormal.

R is assumed to identify what is important with each key problem by leaving images in the cortex that L reads. If R does this erratically it will lead to sudden changes in what L recognizes as important. This accounts for thought disorder where there is thought blocking, a sudden halting of thought, and failure to adhere to a theme. Thus the occurrence of thought disorder was put forward earlier as one of the reasons why R is expected to be abnormal in the disorder.

R's lack of concentration

The alpha band of the EEG is inhibitory [24]. It is normally desynchronized temporarily after the occurrence of a novel stimulus, allowing attention to be given to the stimulus. Yet Kayser et al. [25] found that the desynchronization was diminished among patients at high risk of developing the disorder, especially at 9Hz and among patients who later become psychotic. This reflects an inability to concentrate on a new topic. The abnormal reaction was found only on the right, as if R cannot attend fully to a new topic, again implying that R is malfunctioning.

R is unable to function veridically, and therefore creates false information

Unable to work with the truth, it is assumed that R creates false information that intensifies one of the problems. This resolves the dilemma. Thus R can create hallucinations that lower hope of certainty and turn attention to the certainty problem. Experiences of the environment that are not reliably repeated lower hope of certainty about it. Thus hallucinations that occur sometimes but not others will lower certainty. Verbal hallucinations are typically self-derogatory. They additionally lower hope of certainty because they threaten the place of the patient in society. Alternatively R creates grandiose and persecutory ideas that entail a false difficult task that lowers hope of freedom and turn attention to that. Atypically some patients have hallucinations that tell them to perform antisocial acts. This will draw attention to the restrictions against such acts and hence intensify the freedom problem. Also where hallucinations occur at regular intervals the regularity can help with certainty instead of lowering hope about it. This will turn attention away from the certainty problem and help to turn it to the freedom problem.

L is continually using the results of R's activities with the certainty problem, such as in providing images of objects that have size, shape and color constancy. Hence L automatically accepts the hallucinations and false task as real.

In a key study discussed more fully previously [2,20], McGlashan et al. [26] describe a continuum between two patients, Maria and Cynthia. Maria had an unsettled early life, hence a chronic certainty problem, and a recent loss of freedom in a restrictive job, hence a temporary freedom problem. She had hallucinations. Indeed several studies link hallucinations with an unsettled history [27].

Cynthia had a restrictive family background, and hence a chronic freedom problem. Several studies of settled homes point to them being restrictive in various ways [2]. In addition Cynthia had a temporary certainty problem caused by recently being rejected by a prospective spouse. She had persecutory ideas that entailed a false difficult task of overcoming the opposition of a powerful group of people. This would have limited her freedom and turned attention to that. The backup is only active with the freedom problem. Hence the importance of the freedom problem with Cynthias is shown by evidence that only they have the backup, as described in Appendix1.

With Maria and Cynthia one problem was chronic and one temporary. Both patients turned attention to their chronic problem. Similar activity might have occurred in the past. Thus patients have a history of the false attribution of reality that will have been linked with their chronic problem. When they were children, they could lie for no reason [28]. When students they reported perceptual aberrations, mistaken sights and sounds [29].

Gruzelier et al. [30] found that some patients, who would have been Marias, had poor recognition memory for words. This indicated a right hemisphere specialization. Others, who would have been Cynthias, had poor recognition memory for faces. This indicated a left hemisphere specialization. Recovery was accompanied by loss of these memory defects as if the specialization was no longer necessary. Still memory for faces will be important with the certainty problem, whereas memory for words reflects the left hemisphere and hence the freedom problem. Therefore the observations equally show that, in recovery, attention is less confined to either the certainty or freedom problems.

The argument requires hallucinations to be regarded as deliberate creations by R. Accordingly a study by Kopecek et al. [31] found that patients with prominent verbal hallucinations, as compared to patients who have none, have more activity in the right middle frontal gyrus. Sommer et al. [32] compared hallucinating with non-hallucinating states in the same patients, using an adequate number of patients. Hallucinations were again linked with raised activity in the right middle frontal gyrus. As the homolog on the left is associated with willed activity [33] this is expected to reflect the "willed" activity of R that would be needed to initiate the creation of hallucinations. In addition the right insula was especially active during hallucinations, as if to reflect R's effort [34]. During its exerting influence microstate C, R would be free to exploit the speech areas on the left. Thus during hallucinations activity increased in Broca's area and its homolog and other speech related areas [31].

In order to overcome the language difference, R's images have to resemble sensory inputs. Thus the images are deposited in speech perception areas on the left, where Y's accepting influence microstate A is active. This is shown by fMRI findings and by the reduced ability of the right ear [35].

As noted earlier, in the disorder generally, microstate D, where L exerts influence, is shorter, whereas type A, where L accepts influence, is not. A study by Kindler et al. [36] found that type D also shortens during hallucinations, type A still not being affected. This is consistent with L accepting influence in the normal way and the images of hallucinations that R deposits being responsible for the shortening of D.

As R exerts influence in creating the necessary images, interhemispheric coherence is expected at low theta. Thus Weller and Montagu [37] found raised coherence between the temporal lobes at frequencies in the range 3-5 Hz. They used bipolar recordings so as to avoid a single reference site. This technique was approved by later investigators who found that different single reference sites produced different assessments of coherence.

The loss of connectivity

The blocking of speech perception via the right ear might reflect the reduced use and consequent atrophy of areas that deal with speech perception. Accordingly Kasai et al.[38] found that Heschl's gyrus, which is a primary speech perception area, and an adjacent part of the planum temporale, have progressively reduced grey matter during the disorder. Some corresponding loss of connectivity can be expected.

Still loss of connectivity can also be expected to result from the backup. In the longer term, the suppression of the left parietal during the cut-out will entail the inactivity of the normal connections on the left and their consequent atrophy. With the override, R takes over the sensory inputs and motor outputs on the left. Yet this still might leave open the use of imagery for fantasy. Thus some evidence suggests that in the disorder fantasy is associated with immobility [39]. This is a sign of the override when there is no one in apparent authority giving commands and suggestions [8]. If the override and fantasy often occur concurrently but separately, they might add to the loss of connectivity rather than to atrophy of the gray matter. Accordingly Benetti et al. [40] found that the connectivity loss occurred especially with patients without hallucinations, who would be Cynthias and have the backup.

The recurrent confusion

As mentioned earlier, the isolated and recurrent forms of the disorder are both regarded as caused by competition between the certainty and freedom problems. The recurrent form occurs when vulnerability to this stress is raised, so that the confusion occurs more readily. Any genetic or chromosome abnormality that affects the brain is likely to weaken the position of R, increasing the risk of the recurrent disorder. R's position will be weakened when the corpus callosum is relatively large or small [41], so that it joins the hemispheres too soon or too late. The switching between the problems will develop less well and R will fail sooner.

R might be weakened by disruptive past events that hamper its dealings with the certainty problem. Also as there is no direct communication between R and L, R will be partly dependent on overt activity and speech for information about L. Hence a life style of isolation or inactivity will starve R of knowledge of L.

The developments after 21 years might create a lasting vulnerability. Thus the sudden transition from one problem to another every 18 months night involve chemical triggers that raise R's sensitivity to some aspect of the key problem. The nine year sequence of key problems is worked through at least twice and the triggers might continue through life. Their effects will weaken because of increased body mass. Alongside this R attempts to match the key problem to the social situation, probably are being influenced by other people's facial expressions as well as by past history that emphasizes one or two of the problems.

Accordingly it is assumed that there is at least a third repetition of the sequence, with certainty at 18-19.5, freedom at 19.5-21, and satisfaction at 21-22.5 years. After 21, the satisfaction problem draws attention to doing, hence the freedom problem, and experiencing, hence the certainty problem, at the same time. Possibly a chemical trigger raises sensitivity about disgust. Doing that avoids the experience of disgust might become especially attractive.

The Rs of typical people might have sufficient confidence with the certainty and freedom problems to be able to combine them. Yet a severe competition between the certainty and freedom problems, caused by low confidence with both, might obstruct this. R is then left with a dilemma of choosing between the certainty and freedom problems. These conditions might make the dilemma especially troublesome for R. Once created they might be readily re-created, causing continued vulnerability.

The satisfaction problem came to attention at 3-4.5 and again at 12-13.5 years. What happens after 21 probably largely depends on what happened at these times. Still [3] the pressure to perform particular work on a problem depends on the difference between present hope and the anticipated hope, the hope anticipated when the work is done. Thus it is not only low present hopes about the problems but also high anticipations that intensify the competition at this time, leading to failure to deal with the satisfaction problem in spite of earlier success.

R is central, L is peripheral but can still be important

Besides the argument about R's dilemma causing its malfunction, further evidence described in Appendix 2 implicates the malfunctioning or abnormality of R. Yet L functions normally in the sense that it accepts influence from R in the normal way. R feeds L abnormal images and L follows. In this way R is central to the disorder.

Nevertheless Ls control the environment. Thus people at risk or in a prodromal state might become aware of the severity of their condition and the need to find as easier life style. A successful reduction of commitments might depend on the ability to make and apply deliberate decisions and on intelligence, as well as on receiving advice and having the means to make changes. Thus Mechelli et al. [42] found that among people at risk for the disorder only those with low left parahippocampal volume developed psychosis. Pantelis et al. [43] found that people prodromal for the disorder had relatively less gray matter on the right, consistent with R's abnormality. Yet those who later became psychotic had less grey matter in the left parahippocampal area, and other areas on the left that could affect intelligence. Now the hippocampus is involved in deliberate decision making. Hence a deficient left parahippocampal area can be expected to weaken this. Thus the role of L is peripheral but can still be important. The finding might apply only to patients who have the power to alter the environment or pattern of behavior. It might therefore relate to social class.

R's functioning is normally intelligent and understandable

There is evidence that the right hemisphere, and hence R, is involved in work on the certainty problem in infancy [6]. As mentioned earlier, for example, object constancy develops, where objects are seen as the same regardless of distance, orientation and lighting. The tasks involved must place some intellectual demands on R, and this implies that R can function intelligently.

The nine year sequence of the key problems derives from a sequence of influences that probably involve chemical triggers. These turn R's attention to each of the key problems in turn in childhood and later. Yet alongside it, and becoming more prominent, is a direction of L's attention to the key problem that matches the social implications of the current situation. This might be an extension of R's continuing work on the certainty problem because in matching L's attention to the current social conditions it makes L's behavior more predictable. This again appears to be intellectually challenging.

The certainty problem involves observations of the environment when one is at rest. It therefore requires an image of rest as a label. Some soft object that the infant has had in the cot from three months of age, begins to be essential to rest. Infants will insist on having this object with them when they go to sleep. Busch et al. [44] found that parents reported incidents like the following. One night a six-month-old boy would not go to sleep. In order to try to comfort him they gave him his toy penguin, he immediately calmed down and went to sleep. The object has been called the 'first transitional object', but here it is called the rest object. Wolf and Lozoff [45] found that if infants shared the mother's bedroom then there was no actual object as a rest object. Still in these conditions mothers almost invariably held their infants during the passage to sleep. This could have created conditions where part of the mother or her clothing became the rest object. Thus Busch et al. report an instance where part of the mother's clothing became the rest object.

It is understandable that a visual image derived from the rest object is used by R to label the certainty problem. Support for this comes from how the rest object is typically lacking in autism. This disorder can be attributed to the disorganization caused by the lack of a label for certainty [20].

The freedom problem involves gaining success at any task. Thus an image of an all-powerful person might be used to represent it. Accordingly Abelin [46] observed that infants encouraged their fathers to play roughly with them, as if to help to create this image.

The satisfaction problem is one of gaining sufficient good outcomes for the self, through one's activities. One might understand it being be represented by an image that combines form and color. Form could stand for the activity required and color could stand for good outcomes. Support for the use of a color-form image comes from evidence of slowed performance with such images among children with attention deficit hyperactivity disorder [47]. These children lack experience of good independently achieved effort-outcome sequences. Thus Carlson et al. [48] observed children of 3.5 years with their mothers. Children are preoccupied with the satisfaction problem at this age and their experiences will relate to that. Those children who later developed inattentiveness and hyperactivity had mothers who would stroke the hair or face of their child, stay close and lean towards the child, who would lean away. They also teased and provoked the child. This implies a relative lack of experience of independently achieved effort-outcome sequences by the child. This could disrupt the use of a color-form image to represent the satisfaction problem and cause the slowing with color-form images generally.

When the certainty problem comes to attention for the second time at 9 to 10.5 years, R has to convey to L the importance of the certainty problem. There are bad dreams, such as the destruction of trucks and houses by fire or tornado, being chased, shot or kidnapped, death of the mother or best friend, or of the mother running away [49]. These would tend to draw attention to the certainty problem. As they come at an appropriate time the dream images are understandable as being left by R.

Much of R's functioning is hidden from view. Yet from what one can observe it appears to be intelligent and understandable.

R listens in to speech

In the first 18 months infants mainly work on the certainty problem such as in developing object constancy. This is done by R and the right hemisphere is dominant at this time, as tf R is in control. Infants then learn to speak only one or two words and their understanding of other's speech is very limited. Hence Rs could not acquire much language ability at this time. Yet when people are in deep hypnosis in later life, when R is in control and L is suppressed, they are able to understand other people. For example they can take part in experiments and obey the necessary instructions [8]. This means that R must have been listening in to speech and acquiring an ability to understand it even though R does not speak.

Is the malfunction of R central to psychosis?

The existence of R helps in developing a view of schizophrenia that accounts for a wide range of research. Yet as R deals with the certainty problem, repeated major changes to the environment that create sufficient uncertainty might cause R to fail to function helpfully. Attention will remain confined to the certainty problem, leading to L's persistent use of depressive strategies, such as staying in a well-known place like the home, narrowing the field of one's activities, freezing, remaining immobile (Table 1). Thus there is well known empirical link between environmental change and depression. In these circumstances the consequent behavior might be attributed to depressive psychosis. This raises the question of whether, although the normal functioning of R is intelligent and understandable, its malfunctioning is central to psychosis in general.

Implications for Treatment

Risperidone might match the trigger for the other's good state problem

Every eighteen months in childhood the sensitivity to one of the key problems is suddenly raised, lowering hope about it and turning attention to it. How this is achieved has not yet been studied. With some of the problems the release of a chemical trigger might induce the change. If a drug matches the trigger its regular use might continually confine attention to one key problem.

Risperidone might resemble the trigger for the other's good state problem. This problem is linked to parenthood, as it is children who especially need help. Accordingly risperidone stimulates prolactin and reduces sexual interest and potency [50]. In a game, as compared to trifluoperazine, it made patients cooperative and trusting of partners and hence more helpful [51].

A strategy that might be lost because of a persistent focus of attention on other people is that of working systematically-organizing one's own behavior to optimal effect. This might account for the observation by Purdon et al. [52] that patients receiving risperidone failed to improve and even declined in performance with repetition of the Tower of Toronto puzzle, which appears to call for a systematic approach. Typical people might switch to the satisfaction problem in dealing with the puzzle, and one of the listed strategies for this problem is working systematically [3]. Patients on risperidone might be unable to do this.

Lastly there is no benefit from high doses. A dose that is sufficient to turn attention to the problem has similar effects to a larger one. Doses above a standard dose of 4-6 mg a day give no extra benefit [53]. In a study of long acting injections of the drug, 50 and 100 mg a fortnight had identical effects [54].

An implied treatment

In the theory hope and confidence both mean the believed probability of attaining sufficient certainty. Here the term confidence might be preferred. One aim is to raise the 'confidence' of R about the certainty and freedom problems so as to lower the stress caused by its dilemma. Another is to clarify L's behavior for R. The suggested treatment involves exercises to raise confidence about the problems and conversation about the problems and how they relate to the patient's life.

In a 'confirmation exercise' someone looks at something, closes the eyes and remembers it, then looks again to confirm that it is as remembered. This might be repeated, such as five times or more. It is assumed that this provides an experience of certainty about the environment that raises hope of certainty. Here a booklet with pictures of objects and scenes would be helpful. It might start very simply, such as with black and white and the primary colors, but remain simple. The most helpful level of complexity might be determined by experience.

An exercise for the freedom problem is to engage in confirmation exercises before and after producing an effect. Here jigsaw puzzles would be helpful. Confirmation could occur before and after fitting each piece. Simple jigsaws, where the addition of a piece produces a noticeable change, would be required. Difficult jigsaws have similar pieces where the placing of a piece can make little difference to the resulting picture.

Conversations about ways of raising confidence about certainty and freedom, the conditions that lower confidence, and how the problems relate to someone's life, can be used. R is assumed to listen in to them and gain confidence about the problems and in understanding L. Thus the reports by Carlson [55] and McGlashan et al. [26] suggest that this is helpful. Carlson treated students who were in a confusional state. She identified two simultaneous stresses that would have reflected the competing certainty and freedom problems. They had either just entered college or were soon to leave, lowering hope of certainty. At the same time they were either in the grip of a first affair or were being pressured by parents about vocational choice, lowering hope of freedom. In effect the certainty and freedom problems will have been clarified and related to the patient's life. R will listened in and have confidence raised. Similarly McGlashan et al. found that Marias benefit from a discussion of the inescapable uncertainties of life. Rs specialize in the certainty problem and Marias have an unsettled early life with experiences of uncertainty. Hence the Rs of Marias are expected to follow a conversation about certainty relatively well and gain in confidence.

The Rs of Cynthias would have less background of experience of uncertainty and might gain less from listening in to its discussion. The effects of a loss of a companion would be countered by experiences of stability, expectations of a lasting relationship with a therapist or of membership in a therapeutic group. This might help R with the certainty problem so that it no longer competes with the freedom problem. Hence R might not have to re-assert the false task. It remains for L to overcome the past influence from R. The false task that derived from R's false information, might be repeatedly put aside by L so as to concentrate on other tasks. This might become habitual and automatic. Thus McGlashan et al. report that Cynthias improved by 'sealing over'. As Maria and Cynthia are at the ends of a continuum, most patients might benefit from a combination of the treatments. Yet Cynthias' Rs still might benefit from listening in to a discussion of the inevitable restrictions that occur in life, and the different ways of, or strategies for, raising hope of freedom.

R will be accustomed to picking up information from casual conversations. Hence the treatment might best employ conversational conditions, at a sufficiently simple level. Material for conversation can be found in the strategy lists for each of the problems. In isolated societies everyone tends to concentrate on one key problem, and the behavior in them has been related to the strategy list for that problem [3]. There is a workbook that examines reasons why particular strategies are helpful [56]. Discussions of conditions that lower hope about certainty [57] and freedom [2] are available.

A sign of the greater confidence with the problems will be the emergence of concern about the satisfaction problem. This will lead to interest in tidying and various hobbies where one can see the goodness of the effects that one produces. This represents the normal pattern of development. It implies that R's stress has been reduced sufficiently for its preoccupation with the dilemma to be given up, allowing the freedom and certainty problems to be combined within the satisfaction problem.

The exercises are based on theoretical expectations that they will raise R's confidence in dealing with the problems involved in its dilemma. They might be impractical or unhelpful in practice. It is questionable whether the treatment can be combined with drug treatment. Typical antipsychotics have adverse effects on learning [58]. Yet risperidone for example might turn attention to the other's good state problem and hence away from the certainty and freedom problems where the new learning is needed. Still what is happening in the brain might be too complex to be sure of this.

The treatment might help early in the disorder. Yet it would be better if people had been educated in accord with the key problems previously. If children could choose, they would engage in activities related to each key problem as it emerges in turn. This would help L in developing of patterns of work on the key problems and help R in distinguishing between the problems. An education that is integrated with progress through the key problems will facilitate this. Otherwise unrealistic strategies such as turning attention to facts that raise hope about the problem and away from facts that lower hope about it are encouraged. They will weaken L's interest in working actively on the key problems and fail to clarify them for R.

Conclusions

An aspect of the functioning of the brain is the backup, which includes a cut-out and an override. It is needed when there is concern with the freedom problem. Observations related to it add strong support for problem theory in that they point to an adaption to it that has developed through evolution.

There is support for a system R developing on the right in parallel with the system on the left, L, which becomes the mind. It is R that selects the key problem by attributing importance to it. As R and L do not communicate directly there is no awareness of this. The study of R's functioning suggests that it is normally intelligent and understandable.

Studies of schizophrenia have been reviewed because this disorder is associated with poor judgment of what is important. They repeatedly implicate R, supporting the argument that R controls the judgment of what is important.

An outcome of the review is an account of the disorder where some drugs might be helpful because they resemble the triggers for one of the later problems. Risperidone might resemble the trigger for the other's good state problem. The review points to the possible helpfulness of exercises that raise R's confidence in dealing with the certainty and freedom problems. Conversation about how the problems relate to the patient's life helps because R listens in. Thus the acceptance of the existence of R leads to an account of schizophrenia that incorporates many findings and implies a form of treatment. The account also draws attention to how an education that is integrated with progress through the key problems in childhood would strengthen R.

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Appendix 1

Evidence of the backup in the disorder

The backup is not specific to abnormal conditions and is part of normal activity. Yet it becomes overactive in some patients and this could include Cynthias, who turn to the freedom problem. The reorganizations that are required by the backup will be disruptive temporarily. Hence both cut-out and override are expected to be imposed quickly. They might therefore contribute to thought blocking. Yet, once triggered they might persist. The cut-out will lead to a loss of creativity. With the override, aside from compulsive obedience to someone in apparent authority, nothing more than conventional responses are expected. Hence the immediate effect of the backup might be stereotypy of thought. Sabri et al. [59] studied never medicated patients of mean age 32 years, mean illness duration of 2.7 years, in an acute phase. A radiotracer was used to study blood flow while participants were at rest. Stereotyped thought was related to the lack of activity in the parietal and temporal lobes, as if both cut-out and override were involved.

EEG evidence of the backup in the disorder

One prediction can be made about the frequency bands involved. R is now thought to control the backup and it uses low frequency theta in exerting influence. Hence the initiations of the cut-out and override are expected to be associated with low theta.

Observations of coherence are affected by electrical changes at the EEG reference site and disagreements between early studies were attributed to errors that arose in this way. As mentioned earlier, one way of avoiding such errors is by using bipolar recordings. Here pairs of sites are used fairly close together in each area instead of one. Thus Ford et al. [60] worked in this way with medicated paranoid patients, mean age 26 years, who will have been Cynthias and have the backup, in comparison with patients with other disorders. They found interhemispheric coherence in the theta and alpha bands, at rest, between areas close to T5 and T6, which would reflect the override. It was noted earlier that Weller and Montagu [37] found interhemispheric coherence between temporal areas between 3 and 5 Hz, using bipolar recording. This indicates that the theta involved is low theta, consistent with R exerting influence. Kam et al. [22] studied medicated 40 year old female patients who had many residual symptoms (mean PANSS 62.1). The T5-T6 coherence was high for the alpha ranges but not for theta. Still this might reflect the override being triggered when the electrodes were applied. Hence the theta might have ended before the recording began. The coherence of low alpha, 8-10 Hz, was especially prominent both between and within hemispheres. As noted earlier, it has been claimed that alpha is inhibitory, consistent with R using this to suppress the left hemisphere. A study of local coherence over the whole scalp using many electrodes, in connection with Alzheimer's disease, shows the influence of the override radiating outwards from a point close to T5 [61].

Evidence of the high use of the override by some unmedicated patients comes from a study of interhemispheric alpha coherence by Morrison-Stewart et al. [62]. When the overall data was considered without prior hypotheses, no conclusions could be drawn. Here however T5-T6 can be considered on its own. In an at rest eyes open condition, the standard deviation in the T5-T6 coherence was 1.85 times higher for unmedicated patients than for controls ($F=3.43$, with 9, 29 degrees of freedom, $p<.05$), consistent with some patients using the override.

Ford et al. and Kam et al. also both found raised coherence in the theta range with P3–P4 or areas close to them, pointing to activity of the cut-out. The only task where patients could have become stuck was that of conforming to the instructions. Kam et al. told patients to sit still and keep the eyes closed. Yet a reference electrode was put on the nose. Patients could have become stuck on whether or not to peep. This would mean that the cut-out would be triggered during the recording, consistent with theta being involved. Thus the overall EEG findings are consistent with both cut-out and override being initiated with theta and, at least with the override, low theta is involved.

Metabolism and blood flow evidence

The first five studies that were encountered with evidence of low activity at the cut-out point are as follows.

Hawco et al. [63] studied patients of mean age 24 years, time in treatment 1.4 years, SAPS 10.6, SANS 19. Participants watched a video of a trip through a virtual village where they saw objects beside different people at different places. They were told to pay careful attention to the object, person, and location and to remember them. Later they were scanned while saying which of two objects had been seen with particular people or in particular places. Selecting which objects had been seen in particular places was associated with low activity at – 2 – 60 36, converted from Montreal Neurological Institute coordinates (MNI). This is assumed to be the cut-out point because of its closeness to previous observations of the location of the point. There was no similar finding with selecting which object had been seen with a particular person. However in both conditions the patients had low activity in the parietal lobe, which also points to the cut-out being active.

Harvey et al. [64] used chronic patients, mean age 42 years, illness duration 21 years, BPRS 40, SANS 27.1. Participants rated the affective state of someone shown on a video. Failure to predict the affective state, as judged by the person on the video, was associated with low activity at – 5 – 65 25, assumed to be the cut-out point, more with patients than with controls. There was no corresponding evidence of suppression of activity in the parietal lobe.

Hashimoto et al. [65] studied patients of mean age 31 years, illness duration 7 years, PANSS 37.4. They used video clips of someone moving about with points of light attached to parts of the body, and called it 'biological motion'. Points of light moving about in an uncoordinated way were called 'scrambled motion'. A series of clips was shown and a button had to be pressed when there was a repetition. Cortical activity with biological motion, relative to that with scrambled motion, was low at – 8 – 68 38, converted from MNI, assumed to be the cut-out point, for patients relative to controls. There was corresponding evidence of some suppression of activity in the parietal lobe.

Symptomatic chronic patients, mean age 37 years, duration of illness 14 years, PANSS 80, BPRS 26, were studied by Stephane et al. [66]. In one condition, patients were required to read aloud simple one or two syllable words in large letters from a computer screen. In another they just looked at the screen. In the former condition relative to the latter, patients had low metabolism at – 20 – 65 27, assumed to be the cut-out point. The difference was found only with Cynthias, who would have had the cut-out. There was no corresponding evidence of parietal suppression.

Kambeitz-Ilankovic et al. [67] studied patients of mean age 26 years, duration of illness 1-18 months, and PANSS 29.2. Participants heard a recording of their own voice or that of someone else accompanied by a picture of their own face or that of someone else. They had to indicate whether the voice was their own or not, using a joystick. Patients had lower activation than controls at – 1 – 68 38 when the recording was of a participant's own voice but the picture was of someone else. There was no corresponding evidence of the parietal lobe being suppressed.

The interpretation of aspects of these studies in terms of the cut-out only provides alternatives to the interpretations already given by their authors. Still they add to the already substantial evidence about the cut-out point. The mean of the coordinates is – 7 – 65 33, close to the mean of previous observations of the cut-out point, – 7 – 67 37.

There is corresponding evidence of parietal suppression with only two of the studies. This could be due to the lack of anything problematic that provokes parietal activity. Thus the cut-out point is a control or signal point. If activity there is low then the cut-out is active and no new work is done on the freedom problem. If activity is high then work can be done on the problem, leading to activity in the left parietal lobe. In any particular study, the task that is set will determine whereabouts in the left parietal lobe that the contrast between the experimental and control groups will be observed. For example if the instructions given to participants are problematic then low activity will be observed in the inferior parietal lobule that deals with language, during the cut-out. If there is nothing that is problematic for participants then the suppression of the parietal lobe cannot be observed.

It must be noted that a patient versus control group difference could arise at the cut-out point because the controls experience a threat to freedom that patients do not. In the study by Kambeitz-Ilankovic et al., for example, the control group could have objected to having their own voice linked with a picture of someone else. As the cut-out point is also the point where metabolism reflects concern about the freedom problem generally, this could mean that the control group had raised metabolism at the cut-out point, creating the observed patient versus control group difference.

Several studies that involved tasks and fully reported activity in the cortex did not report low activity at the cut-out point. With some of the tasks it might have been hard to become stuck. Thus Singh et al. [68] used patients with mean age 31 years, illness duration 9 years, SAPS 8.6, SANS 12.6. The task was feeling the emotions generated by photographs of the aftermath of a disaster. Harvey and Lepage [69] used patients with mean age 31 years, illness duration 10 years, SAPS 14.0, SANS 18.7. Some scenes were shown followed by a mixture of them and new ones. The task was to indicate whether the scene had been seen before. There were no instructions that scenes had to be remembered. On the other hand with some tasks that gave no evidence of the cut-out someone might relatively easily have become stuck. Yoon et al. [70] used patients with mean age 20 years, illness duration less than 1 year, BPRS 46.5, SAPS 30, SANS 30. The AX task was used, where a series of letters is shown and a button is pressed when X is preceded by A. Someone might have become stuck in interpreting the instructions. In a study by Siemerkus et al. [71] patients had mean age 26 years, illness duration 5 years, SAPS 2.4, SANS 2.1. The task was to negotiate a virtual maze, and here someone might readily have become stuck.

In all of the studies the patients were medicated. The assessments by the various scales, especially comparing Stephane et al. with Yoon et al. and Siemerkus et al., suggest that the cut-out is easier to trigger when the illness duration is longer and the level of residual symptoms is higher.

Appendix 2

R's abnormality in the auditory no-ball task

In the active form of this task a button has to be pressed when a repeated sound is unpredictably replaced by a different one. A passive version where people just listen to the sounds is typically studied. In response to the odd sounds both typical people and patients develop a negative potential on the scalp, called the mismatch negativity (MMN). The response can occur when someone is even reading a book [72]. This would take up L's attention so fully that the effect appears to be attributable to R, in these conditions.

Usually both R and L will contribute to the MMN. R deals with the certainty problem and each odd sound will lower certainty about the environment. R will try to raise expectation of certainty by predicting the odd sounds. Yet if they occur at random then R will fail. It is assumed that the contribution of R to the MMN derives from this failure experience. With patients, Rs will be affected by their involvement with the certainty-freedom dilemma. They will be primed to expect failure and hence, MMN will occur more quickly. Yet they might be distracted from the new failure, causing the MMN to be less. The contribution from L to the MMN will depend on the sounds being regarded as a puzzle and being given attention. Because of the randomization there will be failure just as with R.

There is evidence of contributions to MMN from both R and L. In a study by Hong et al. [73], participants listened to the sequence of sounds while sitting in a sound proofed room. The MMN of controls was related most to 5-12 Hz, reflecting high theta. This implies that L was involved, exerting influence. The absence of anything but the sequence of sounds might have encouraged controls to regard this as a puzzle that they had to solve. With patients there was almost no sign of MMN being related to high theta. Instead it was related to less than 5 Hz, reflecting low theta, and hence R exerting influence. It is as if patients responded passively, in accord with their passive acceptance of treatments, so that L was inactive. This highlights the influence on L of the attitude differences of patients and controls. An important additional finding was that less than 5 Hz was augmented with patients. This implies that their Rs were abnormally active in the oddball conditions.

Calhoun et al. [74] observed that patients had activity in a particular part of the right temporal lobe, thought to be BA42, during the task, whereas typical people had none. There was no mention of activity on the left. There is BA 42 on both left and right and that on the left is an auditory association area. Hence BA42 on the right might be used by R for thinking in terms of its own nonverbal language. Something that patient's Rs would do, as they sometimes function non-veridically, is to decide to function veridically. The Rs of controls would not have to do this. Hence it might account for the difference between patients and controls. The patients were in full or partial remission. The discrimination from controls was almost complete and was cross-validated. This additional activity required by the Rs of patients might explain the finding by Hong et al. that less than 5 Hz is augmented.

In an EEG study by Takahashi et al. [75] exact Low Resolution Electromagnetic Tomography Analysis (eLORETA) was used with large samples to detect the brain structures that contribute to MMN. Participants watched a silent video while they listened to the sounds and were told to pay careful attention to the video because they might be asked questions about it. The magnitude of the MMN varied widely between patients, and came largely from the left, as if L's attention was often not fully taken up by the video. The only reliable differences between patients and controls was in patients having less influence from the right cingulate gyrus, the right paracentral lobule, and especially the right medial central frontal gyrus and surrounding areas. As noted earlier, activity in the left homolog of the latter area reflects willed activity [33]. Hence the reduced activity on the right might reflect a reduced level of involvement by R. This is consistent with the Rs of patients being distracted by the certainty-freedom dilemma and with having to engage in the additional activity described by Calhoun et al.. Still it reflects another abnormality in the functioning of R.

That the latency of the MMN is less for patients is supported by study by Kargel et al. [76], as well as other recent studies that they mention, though not by some older studies.

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