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Attentional performance and negative vs. positive symptoms in schizophrenia

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Introduction

In the last two decades there have been great advancements both in theory and research on cognition and schizophrenia. For instance, certain cognitive features (e.g., attentional deficits on vigilance tasks) are now among the best existing markers of vulnerability to schizophrenia (see reviews in Nuechterlein & Dawson, 1984, and Vázquez & Ochoa, 1989). Several authors have recently called for a further step in these studies by relating clinical characteristics of schizophrenia to cognitive performance (Neale et al., 1985). Following this challenge, the purpose of this study was to analyze the relationship between attentional performance in a dichotic listening task and positive and negative symptoms of schizophrenia. In addition, we selected a task (i.e., dichotic listening) which could also provide us with a measure of cerebral dominance (Fuentenebro et al., 1988).

Cognition and schizophrenic positive and negative symptoms

Schizophrenia research shows a renewed interest in the description of schizophrenia symptomatology in terms of positive symptoms (PS) and negative symptoms (NS). This descriptive approach arises from the Kraepelinian tradition of searching for symptoms that be predictive of the course of the illness (Vaillant, 1978). NS represent the absence of a behavior or function that is normally present in normal subjects, such as flat affect, alogia, avolition, anhedonia, and attentional impairment. PS, on the contrary, represent the presence of abnormal behavior, such as hallucinations, delusions, formal thought disorder, and extravagant behavior (Andreasen, 1979; Andreasen & Olsen, 1982).

Although differentiation between two types of symptoms is well documented, and their study constitutes a very active area of research, there is a debate regarding the possible subtyping of patients according to these symptoms. In Andreasen's model, positive and negative symptoms are considered to be the two extremes of one dimension (Andreasen, 1985; Andreasen & Olsen, 1982). Crow (1980a,b), on the other hand, has proposed that PS vs. NS belong to two independent dimensions. Thus, according to Crow's model, positive and negative symptoms may coexist in the same individual, an idea which appears to be supported by assessments in clinical patients (Sommers, 1985; Green & Walker, 1986b). A recent analysis of these two models, using confirmatory factorial analysis methods, provided mathematical confirmation for Crow's model but not for Andreasen's (Lenzenweger, Dworkin, & Wethington, 1989).

Negative symptoms are more likely to be associated with severe cognitive deficits (Johnstone et al., 1978), neuroanatomical (Ota et al., 1987) and genetic abnormalities (Dworkin & Lenzenweger, 1984). Furthermore, these symptoms are less responsive to neuroleptics than are positive ones (Johnstone et al., 1978).

Some recent research has analyzed the relationship between laboratory attentional measures and negative vs. positive symptomatology. PS (e.g., positive thought disorder) have been found to be associated with attentional deficits such as distractibility in auditory tasks (e.g., digit span memory - Harvey et al., 1988).

However, other authors (e.g., Nuechterlein, et al., 1986; Knight et al., 1985) have found that NS, rather than PS, are related to a poorer cognitive performance. For instance, Nuechterlein et al. (1986) found a negative correlation between performance on a degraded Continuous Performance Test (CPT) and negative symptomatology (evaluated by the BPRS Anergia factor, which includes flat affect, motor retardation, emotional withdraw, and disorientation). The correlation of CPT performance with PS (i.e., the Thought Disturbance factor of the BPRS) was close to zero.

Harvey et al. (1988) have suggested that these discrepancies in the results could be due to differences in the stimulus modality used in the various experimental tasks. Whereas NS have been found to correlate with poor performance in visual attentional tasks (e.g., Nuechterlein et al., 1986; Cornblatt et al., 1985), PS correlate with poor performance in auditory attentional tasks.

The major goal of our study was to test whether clinical features such as positive and negative symptoms are supported by an experimental measure of attention to verbal stimuli. In fact, attentional deficits are often categorized as a type of negative symptom and this clinically rated association must be validated using external objective criteria for attentional performance (Neale et al., 1985; Nuechterlein et al., 1986).

Schizophrenia and lateralization

Considerable attention has also been paid to the relationship between schizophrenia and hemispheric functioning. Despite the increase of research in this area (see Bruder, 1983; Nasrallah, 1986; Gruzeliier, 1986; Nachson, 1988) there is no absolute agreement on the interpretation of the experimental findings. For some authors, the data support a left-hemisphere (LH) deficit, while for others, the data support a right-hemisphere (RH) deficit. Others have argued that the data provide evidence for an interhemispheric transfer (IHT) dysfunction.

In general, the neurophysiological, neurochemical, dichotic listening, handedness, and neuropsychological data (Flor-Henry, 1976; Gur, 1978; Goldstein, 1986; see Nasrallah, 1986 for a review) appear to more strongly support the LH hypothesis. The most commonly accepted explanation is that LH deficits arise from an overactivation of that hemisphere, which then interferes with normal brain functioning (Gur, 1978).

Part of the evidence for the LH hypothesis comes from the study of *handedness* in schizophrenic patients. Most of studies have found a lower prevalence of right-handers in schizophrenic samples as compared to normal control subjects, although is not clear whether there is a higher prevalence of left-handers in schizophrenia than in normal populations since studies are difficult to compare (Green et al., 1989).⁽¹⁾ Although atypical handedness is not a pathological characteristic by itself (Chapman & Chapman, 1987; Green et al., 1989), this condition is often associated to a number of brain disorders (Annet, 1985; Green et al., 1989). Some studies have even found that left-handedness in schizophrenic patients is related to negative symptoms and ventricular dilation (Andreasen et al., 1982). Thus, although the etiology of abnormal lateralization in schizophrenia is still unknown (Sanjuán & Leal, 1985, 1986), abnormal lateralization may provide important information about patients' functions.

Dichotic listening tasks

Another way of assessing lateralization is with dichotic listening tasks, in which auditory stimuli are simultaneously presented through both ears. Normal subjects usually show a difference in performance for left- vs. right-ear stimuli. The direction and magnitude of that difference varies with the type of stimuli used (Walker & McGuire, 1982; Porter & Hughes, 1983). With verbal stimuli, normal right-handed subjects show a right ear advantage (REA), that is, a better performance for stimuli presented to the right ear than for

stimuli presented to the left-ear, although this difference is small (10-15%, approximately). With nonverbal auditory stimuli, both normal and schizophrenic subjects show a left-ear advantage (LEA). One interesting characteristic of dichotic listening tasks is that competing stimuli are presented simultaneously to each ear. Thus it is hypothesized that good performance in this task requires an adequate *attentional* level (see Bruder, 1988).

In a comprehensive review of schizophrenia and dichotic listening, Bruder (1983) found that with verbal material, schizophrenic patients show REA and sometimes (especially in paranoid patients) even greater REA than normal subjects'. Schizophrenic patients, as a group, rarely show LEA. Later studies have also confirmed that (e.g., Green & Walker, 1986a; but see Johnson & Crockett, 1982 and Hatta et al., 1984 for an exception). Despite this normal (or increased) REA, schizophrenic patients show a poorer overall performance than do normal subjects on the listening task (e.g., Green & Walker, 1986a; Takahashi et al., 1987).

Although the interpretability of dichotic listening tasks has received some criticism in the measurement of laterality, they still provide very useful information as to how meaningful vs. nonsense stimuli might be processed differently (Walker & McGuire, 1982).

Despite some pessimistic views on the reliability of dichotic listening tasks as a measure of lateralization (Porter & Hughes, 1983), it is now clear that reliability can be greatly increased if several cautions are taken into account (Speaks, 1988; Bryden, 1988; Harshman, 1988).⁽²⁾

In any case, even though the use of dichotic tasks is debatable as a global measure of dominance, they may be still very useful to provide information on the processing of language in both normal and abnormal brains (Porter & Hughes, 1983).

Dichotic triads

A typical task, and one which we have employed in our study, is to present subjects with three pairs of words, and immediately upon presentation, to ask them to recall as many words as they can. This procedure of using word triads has been used to investigate *attentional* performance and hemispheric *lateralization* in patients diagnosed with Alzheimers' disease (Bouma & Van Silfhout, 1989), depression (Bruder et al., 1989), and schizophrenia (Bruder, 1983, 1988; Nasrallah, 1986).

There have been few studies that have addressed the relationship between positive and negative symptoms and laterality. In a recent study using triads of words, Takahashi et al. (1987) found that schizophrenic patients' REA tended to be greater than that of normal subjects (7% vs. 2%). This difference on the REA was significant

when a subgroup of hallucinatory schizophrenic patients was compared to the normal sample. The authors interpreted this finding as a support for Gur's (1978) hypothesis of LH overactivation given that the LH is directly involved in auditory hallucinations. Finally, schizophrenics' recall was poorer than normals'.

In our study we have employed a dichotic triads procedure for two reasons. It can provide 1) a relatively reliable and valid measure of lateralization, as well as 2) an index of cognitive capacities (i.e., short-term memory), a feature often neglected when describing this task (e.g., Bruder, 1983).

Method

Subjects

Participants were selected from the inpatient population of the Hospital Clínico Universitario de San Carlos (Madrid). Patients were 15 consecutive admissions who met DSM-III-R criteria for schizophrenia. Subjects were included in the study when their more acute symptoms had attenuated according to an evaluation procedure described below. Some characteristics of this group are presented in Table 1.

Table 1. Characteristics of the schizophrenic group. Ranges are shown in parenthesis

| Subjects | Age | Mean number of hospitalizations | Mean age of onset |
|----------|-------------------|---------------------------------|---------------------|
| N=15 | 26.4±4 (19-36) | 3.53±2.7 (0-11) | 19.2±4.6 (12-30) |

The patients comprised a relatively young sample (median age=26.4 years; range=19-36). Two patients were female, and for only one patient it was the first admission. The mean of admissions for the total sample was 3.5. Seven patients had three or less prior admissions and the remaining sample had four or more admissions (the admissions ranged from 0-11). All the schizophrenic patients received the same neuroleptic treatment (Haldol or fluphenazine decanoate) because they also were included in a parallel pharmacologically-controlled study in which neuroleptic plasma level were monitored monthly by radio-immuno-assay techniques (Fuentenebro et al., 1988).

DSM-III-R diagnosed patients were assessed on a weekly basis to determine their symptom stability for the study. This stabilization occurred within approximately 2 to 3 weeks after admission. Within the first week after stabilization, patients participated in the experimental session.

Assessment

Psychopathology. Patients' clinical status was evaluated by the Brief Psychiatric Rating Scale (BPRS, Overall & Gorham, 1962), a frequently used structured interview consisting of 18 items which include psychotic symptomatology. Each item is rated by the interviewer on a 7-point scale, using a clear set of scoring rules. Although we used the expanded version of the BPRS (Lukoff, Nuechterlein, & Ventura, 1986), which adds 7 more items and provides structured questions for each item and behavioral anchors to evaluate them, we are reporting results from the commonly employed 18-item BPRS.

Subjects began to participate in this study once they were symptomatically stabilized according to their BPRS scores. A patient was considered 'stabilized' when all of his/her psychotic symptoms (Hallucinations, Unusual Thought Content, or Conceptual Disorganization) was returned to a 'moderate level' (i.e. a score of 5 or less).

Positive and negative symptoms. The Scale for the Assessment of Negative Symptoms (SANS; Andreasen, 1981) and the Scale for the Assessment of Positive Symptoms (SAPS; Andreasen, 1982) were also completed for each of the subjects. These two interview-based scales evaluate the types and severity of PS and NS described above.

We did not use the classificatory scheme proposed by Andreasen & Olsen (1982) -which subtypes patients into 'positive', 'negative', and 'mixed' types- because of conceptual problems in subclassifying subjects according to this unidimensional criterion (e.g., Green & Walker, 1986; Lenzenweger et al., 1989). Thus, raw scores for each subscale are reported.⁽³⁾

Lateral dominance. Patients' hand and foot dominance were assessed by several items from the Harris Lateral Dominance Inventory, which consists of several simple motor tasks (Manoach, Maher, & Manschreck, 1988; Craft, Willerman, & Bigler, 1987). Dominance consistency (right hand vs. left) was assessed by observing which hand the patient used in signing his name. To avoid mirror responses (Green et al., 1989), the pen to sign the name was left in the center of the table. Foot preference was assessed by observing which foot

the patient used to kick a ball.⁽⁴⁾ Right- or left-consistency was diagnosed when the patient used the hand and foot of the same side.

Experimental dichotic task

Patients were given a dichotic listening task consisting of triads of words. Each dichotic trial consisted of three pairs of words presented simultaneously to each ear. Thus, on each trial subjects were presented with three words in their right ear (e.g., life-year-woman) and three different precisely coordinated paired words on their left ear (e.g., day-home-mister). There were 2 practice trials and 12 test trials.

Effort demanding tasks are often employed for detecting performance differences in schizophrenic subjects (see Nuechterlein & Dawson, 1984). Thus, in order to increase the effort needed to perform the task, the rate of presentation was 1 word/sec. A female voice presented the stimuli. Each pair of words had the same frequency of usage in Spanish language (Juilland & Chang-Rodriguez, 1964). To minimize semantic networking of the presented words, only nouns were employed.

A stereo reel-to-reel REVOX tape deck was used to produce the stimuli tape. The tape was presented at the same comfortable output level for each subject using a SONY stereo tape deck with standard noise-reduction system and stereo closed headphones (SENNHEISER). In order to prevent the effects possible differences in the hardware of left and right circuits (García & Romero, 1987) the position of the headphones was counterbalanced across the subjects. Patients were tested individually in a quiet room.

Patients were instructed to listen carefully to the three pairs of words and, immediately after their presentation, they were asked to recall as many words as possible in any order. Subjects were given ten seconds of silence after each trial to verbally report remembered words. Thus, the task has an important short-term memory component. Patients' performance was evaluated by separately recording their responses for right (R) and left (L) ears in each trial.⁽⁵⁾

Besides this measure of overall patients' cognitive performance, data from the dichotic tasks also served as a measure of hemispheric dominance (Bruder, 1983; Nasrallah, 1986). Although the difference between these two scores (R-L) is often used to provide a measure of perceptual asymmetry, it is a problematic measure given that it is correlated to total task performance (R+L) (see Bruder et al., 1989 and Chapman & Chapman, 1987 for technical discussions of this issue). To avoid these problems, we calculated an index of «right ear advantage» (REA) according to the following formula: (right ear-left ear/right ear+left ear) -e.g., Takahashi et al., 1987.

Procedure

Subjects were evaluated during a baseline session that included completion of a structured interview (the Brief Psychiatric Rating Scale-Expanded, 1986) and the Andreasen's Scales for Positive and Negative Symptoms.

After completing this information, each patient participated in an experimental session that included the dichotic listening task along with other cognitive measures (e.g., CPT tests) which are not reported here. After these experimental tasks, subjects' laterality was briefly evaluated by the hand and foot procedure described above.

Results

The means and standard deviations for the SANS and SAPS scores are presented in Table 2.

Table 2. Means and standard deviations for the corrected scores on the subscales of the Scale for the Assessment of Negative Symptoms (SANS) and the Scale for the Assessment of Positive Symptoms (SAPS). Also reported are correlations between these subscales, performance in the Dichotic Listening Task (i.e., "Percentage of correct responses"), and the lateralization index (i.e., Right Ear Difference, REA).

| Symptomatology | M | SD | DICHOTIC | | | TASK |
|--------------------------|------|------|---------------------|--------|---------|-------|
| | | | % Correct responses | | | REA |
| | | | (Total) | (Left) | (Right) | |
| Positive symptoms | | | | | | |
| Hallucinations | .53 | .79 | .335 | .209 | .365 | .157 |
| Delusions | .63 | .69 | .416 | .251 | .425 | .121 |
| Extravagant behavior | .27 | .41 | .768* | .648* | .594* | -.032 |
| Thought | .42 | .52 | .648* | .447 | .557* | .091 |
| Total Score | 1.88 | 1.91 | .621* | .439 | .576* | .126 |
| Negative symptoms | | | | | | |
| Affect | .99 | .77 | -.017 | .206 | -.158 | -.235 |
| Alogia | .85 | 1.01 | .582* | .490 | .479 | .017 |
| Anhedonia | 1.43 | 1.33 | .396 | .227 | .455 | .190 |
| Abulia | 1.21 | 1.21 | .124 | .035 | .439 | .154 |
| Attention | .82 | .95 | .087 | .071 | .128 | .047 |
| Total Score | 5.44 | 4.31 | .311 | .247 | .315 | -.052 |

* $p < .05$ ($N=15$) for correlations.

As can be seen, schizophrenic patients manifested more negative than positive symptoms in all subscales. In fact, the total score for positive symptomatology ($M=1.88$) was significantly lower than for negative symptomatology ($M=5.44$), $t(29)=-3.23$, $p < 0.003$. This result was

expected given the fact that stabilization (i.e., reduction of *positive* symptoms was a requirement for patients to be included in the study). Positive and negative and symptoms were positively correlated in our sample, $r = 0.67$ ($p < 0.01$).

In the recall task, the mean "percent correct responses" was 60.2% ($SD=19.38$) for the right ear and 46.3% ($SD=20.12$) for the left ear, $t(14)=2.37$, $p < 0.03$. The mean REA - a better measure of laterality - was 13.89 ($SD=24.41$), which also confirms the right ear performance superiority. The range of the REA was shown to be from -20% to 85%. Figure 1 shows this overall preference for reporting verbal information presented to the right hemisphere (i.e., linguistically processed by the left hemisphere).

No significant correlation was found between laterality (as measured by the REA) and positive or negative symptoms (see Table 2). Likewise, there was no significant relationship between total accuracy in recall on the dichotic task and REA: $r = -.098$, n.s.

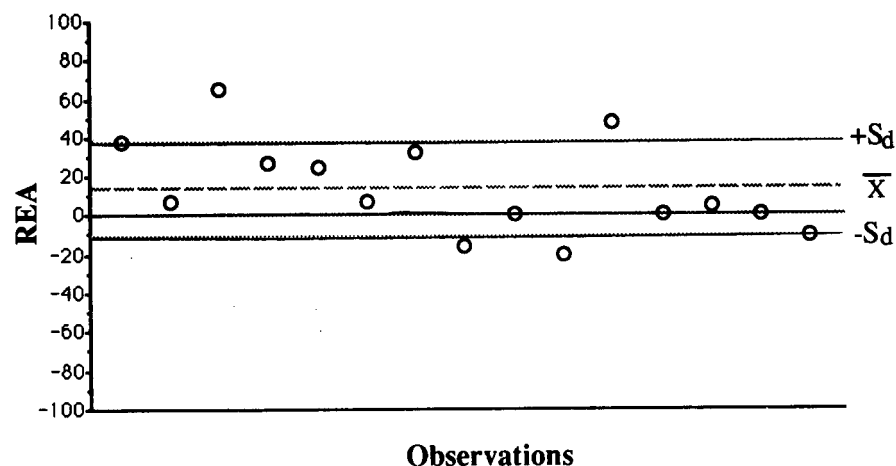


Figure 1. Laterality index $-REA=(R-L)/(R+L)-$ for schizophrenic patients. Positive scores indicate right ear preference.

Correlations between the SANS and SAPS subscales and accuracy of recall on the dichotic task were also computed. The total accuracy on the dichotic listening was significantly correlated with Positive Symptomatology, $r = 0.62$, $p < 0.001$, but not with Negative Symptomatology, $r = 0.31$, n.s. The pattern of results showed generally higher correlations between accuracy on the recall task and positive than negative symptoms. Contrary to what one would expect, all these correlations were positive (with the exception of a couple of them in the Affect symptoms category).

Global performance on the dichotic triads was not significantly correlated with the laterality index. The total percentage of correct responses (i.e., the sum of right-ear and left-ear performance) yielded a correlation of $r = -0.082$, n.s. with the REA.

Discussion

The discussion of the results will address three different issues: a) the positive and negative symptomatological pattern found in our sample, b) the finding of a right ear advantage (REA) for verbal stimuli, and c) the relationship between these types of symptoms and overall cognitive performance.

We found a high positive correlation between positive and negative symptomatology. Clearly, this correlation might vary different for different subsamples of schizophrenics (e.g., good vs. bad prognosis). In any case, our data are consistent with other studies (Lenzenweger et al., 1989), and seem to support the clinical observation that positive and negative symptoms may coexist in the same patients. Therefore, this observed relationship does not support Andreasen's hypothesis of a single Positive-Negative dimension.⁽⁶⁾

In regard to the laterality issue, our results confirm the existence of a REA for verbal stimuli in schizophrenic subjects (Bruder, 1983) which provides more support for "the most striking finding for schizophrenic patients in the dichotic listening research area" (Bruder, 1988, p.554). Although we do not report results from a non-schizophrenic control group, the magnitude of this REA is somewhat higher than what has been reported for normal populations (e.g., Porter & Hughes, 1983) or even for schizophrenic patients using the triads technique (e.g., Takahashi et al., 1987).

This increased REA in our schizophrenic patients might be influenced by the fact that all of our subjects were right-handers. In fact, in normal populations, right-handers show a greater REA for verbal stimuli than do left-handers (Bryden, 1988). Furthermore, the REA effect may be more pronounced in males than in females (Nachson, 1988) and this could also artificially increase the magnitude of our patients' REA given that there were only two women in our sample.

Although the finding of a increased REA provides support for the hypothesis of the left-hemisphere deficit in schizophrenia (Flor-Henry, 1976; Gur, 1978), additional information from other measures (e.g., regional cerebral blood flow) is needed to confirm this hypothesis.

Finally, the results on the recall task show an unexpected positive relationship with both positive symptoms and, to a lesser extent, with negative symptoms. As we have described above, poor cognitive

performance is associated with positive symptoms in some studies (e.g., Walker & Harvey, 1986) and with negative symptoms (e.g., Nuechterlein et al., 1989) in some others. However, no study, as far as we know, has found a *positive* correlation between a measure of cognitive performance and positive and negative symptoms. Although the positive correlation between PS and NS in our sample might explain this similar pattern of association between both types of symptoms and cognitive performance, it is still difficult to explain the positive trend itself.

Thus, according to our results, schizophrenics' overall performance does not support the inclusion of attentional deficits as components of the negative syndrome, since negative symptoms in general (and low attention in particular) should be negatively correlated with performance on objective attentional tasks. Contrary to that expectation, the actual correlation of total recall with NS was positive and near to zero with the Attention subscale of the Andreasen's scale ($r = 0.087$).

The results on our dichotic task may hold limited interpretability since the task is not specifically designed to measure attention. Even though the task used in our study was a clear measure of attention, the results might still be contrary to those found with CPT measures (e.g., Nuechterlein et al., 1986) given that correlations among different attentional tasks are not very high (Vázquez & Ochoa, 1989). Therefore more studies are needed which analyze the relationship between various cognitive tasks and PS and NS (see Harvey et al., 1988 and Bruder et al., 1989 for related views).

It should be stressed that this study addresses the importance of relating deficits in cognitive performance with clinical features (Nuechterlein et al., 1986). In the case of the PS and NS this type of study is of paramount interest given that cognitive deficits -e.g., low attentional capacities- comprise one of the symptoms included in the clinical characterization of negative schizophrenia (Andreasen & Olsen, 1982). Thus, these studies contribute to the process of validation of clinical subtyping such as with positive vs. negative symptomatology. Likewise, within this context, further studies using different types of stimuli (e.g., verbal and nonverbal), different tasks (e.g., visual and auditory), and different subgroups of patients (e.g., paranoids and nonparanoids) -see Nachson, 1988 and Bruder, 1988- are necessary to get a better picture of the complex associations between positive and negative symptoms and cognitive performance.

Author notes

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Notes

1. These authors have found that studies on handedness in schizophrenia use very different cut-off criteria to assess dominance. Using strict criteria, they have found a similar rate of left-handers in normal and schizophrenic populations (i.e. 10-12%; cf. Annet, 1985) but much higher rates of 'ambiguous dominance' in these patients.
2. For instance, if the number of trials is sufficiently high, dichotic methods may reach high reliability levels (of +0.90 or greater). The minimum number of trials is debatable. Although 6 to 8 blocks of 30 trials seems to yield satisfactory reliability levels (Speaks, 1988), less trials may be sufficient, especially with psychiatric or special populations (Bruder, 1988).
3. Given that each subscale encompasses a different number of items, each patient's subscale score was divided by the number of items contained in that subscale. In doing so, a comparable, homogeneous score for each subscale was obtained. We employed the following denominators for correcting the subscales scores: Hallucinations (7), Delusions (12), Extravagant behavior (4), Formal thought disorder (8), Affect (8), Alogia (4), Anhedonia (4), Attention (2), Abulia (3).
4. Although we had hoped to use this measure of laterality to evaluate its relationship with cognitive performance and right vs. left advantage in the dichotic listening task, we were not able to use it given that all subjects in our sample showed a consistent right-side preference (i.e. signing with the right hand and kicking the ball with the right foot). The absence of left-handed subjects in our sample is surprising given that the incidence of sinistrality among schizophrenic patients is similar or even higher than the 10% generally observed in normal people (Chapman & Chapman, 1987; Manoach et al., 1988).
5. There were very few inventions or intrusions of words from previous trials.

6. Other studies have found no correlation between PS and NS in schizophrenic patients (e.g. Ota et al., 1987).

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