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Memory impairment and auditory evoked potential gating deficit in schizophrenia

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Abstract

Impaired sensory gating and memory function were reported in a study of 10 schizophrenic patients and 10 age- and sex-matched normal subjects. The P50 component of the auditory evoked potential was used as an index of gating. Explicit memory was tested with the Wechsler Memory Scale and implicit memory by artificial grammar learning. The schizophrenic patients showed deficits in both verbal paired associate and visual reproduction tasks. They demonstrated impaired implicit learning in color patterns but not letter strings. They also showed impaired P50 sensory gating. Three-dimensional brain mapping revealed a differential distribution of brain potentials in the processing of S1 and S2 at either P50 or N100 in both groups. However, the group difference was not statistically confirmed. In the controls, both implicit letter-string learning and explicit verbal paired associates were positively correlated with N100 gating, suggesting an association of the early attentive component with lexicons. In the schizophrenic patients, color-pattern implicit learning was positively correlated with P50 gating. The modality-specific impairment of implicit learning in schizophrenia may reflect a failure of adaptive filtering on the flooding input from color patterns.

Keywords: Implicit learning; Schizophrenia; Artificial grammar; Sensory gating; Auditory evoked potentials; P50

1. Introduction

Memory deficits in patients with schizophrenia have been extensively studied (Danion et al., 1992). Research findings indicate impairments in tests of episodic memory (McKenna et al., 1990), explicit memory such as free recall and frequency monitoring (Gras-Vincendon et al., 1994), and semantic memory such as sentence verification, category judgment, and vocabulary (Clare et al., 1993). Explicit memory is assessed with recall and recognition tests in which the subject makes explicit reference to the context of a specific learning episode. In contrast, implicit memory is expressed by the extent to which previous experi-

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ences or learning episodes facilitate performance on a task at hand without conscious or intentional recollection of those experiences or the context of the learning process (Schacter, 1987). Although there are still controversies about the implicit memory deficits in schizophrenia, many studies have revealed relatively well-preserved functions in the performance of tasks such as repetition priming with stem-completion (Gras-Vincendon et al., 1994), pursuit rotor, jigsaw learning (Clare et al., 1993), and associative memory (Bazin and Perruchet, 1996). Even when schizophrenic patients reveal difficulty in some implicit tasks, it may be due to non-memory psychological influences (Gras-Vincendon et al., 1994).

However, disruption of implicit sensory processing in schizophrenic patients has been evidenced in many latent inhibition studies (Brauch et al., 1988; Guterman et al., 1996; Swerdlow et al., 1996). Inhibition can be described as adaptive learning that filters out irrelevant stimuli. In additional to the aforementioned tasks, implicit learning can also be implemented through artificial grammar acquisition. Artificial grammar learning is an implicit process, detecting the regularities in a series of stimuli generated by a finite-state-rule system. Artificial grammar acquisition is used to detect the regularities in a series of letter strings generated by a finite-state rule system (Reber, 1967, 1977) and to judge whether a new letter string adheres to the rules at a level above chance. During this process, the examinees are not able to report explicit knowledge about their judgments. In this study, we applied an implicit learning paradigm, which follows Reber's artificial grammar rules, to investigate the ability of schizophrenic patients to do implicit sensory processing with two different modes of stimuli, namely letter strings (Fig. 1a) and color patterns (Fig. 1b).

Patients with schizophrenia have an impaired ability for sensory gating that may result in the flooding of information. The sensory gating defect has been demonstrated using the decrement ratio of the P50 component of the auditory evoked potential (AEP) in a conditioning-testing paired paradigm (Boutros et al., 1991; Judd et al., 1992; Clementz et al., 1997, 1998). However, the contribution of the N100 component to sensory gating is controversial. The controversy regarding the N100 component mainly concerns its gating effect. Unlike the P50, which is relatively impervious to the manipulation of attention during the test, the S2 of N100 reflects attentional control. The attenuation of N100 to S2 may be influenced by attentional manipulations (Guterman et al., 1992). Furthermore, the gating effect of N100 suffers from significant test–retest variability (Adler et al., 1982; Freedman et al., 1983).

The P50 sensory gating reflects mainly preattentive processing (Jeger et al., 1992) whereas N100 indicates an early-attentive component. Since memory function is a multi-stage operation, we have attempted to examine both the preattentive P50 and early-attention N100 components through AEP gating.

In this study, we examine the association between memory function and sensory gating in a paired stimuli AEP paradigm. The relationship between the neurophysiology of sensory gating and the neuropsychological functions in explicit as well as implicit learning were explored.

2. Methods

Ten schizophrenic patients (mean age 35.1 ± 10.6 years, five women and five men) and 10 normal control subjects (mean age 33.3 ± 9.9 years, five women and five men) participated in the study with informed consent. The 10 schizophrenic patients were recruited consecutively from the psychiatric ward and diagnosed according to DSM-IV criteria (American Psychiatric Association, 1994). The patients participated after their active symptoms had subsided and standard inpatient treatment with medication had been instituted. Habits of cigarette smoking were assessed in both patients and controls. On the day of the laboratory study, subjects were restricted from smoking, coffee drinking, and alcohol use. They had no past history of epilepsy, alcoholism, or mental retardation. None had received electro-convulsive therapy within the 3 months preceding the study.

All patients and subjects completed the Wechsler Memory Scales (WMS). Verbal paired associate and visual reproduction learning tasks were used as indicators for their explicit memory capability.