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## Impaired verbal memory is associated with impaired motor performance in schizophrenia: relationship to brain structure ☆

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### Abstract

Deficient ability to take advantage of predictable elements in the performance of cognitive tasks has been proposed as an underlying factor for a number of deviances in schizophrenia. In a schizophrenic sample ( $n=39$ ), we propose and test the view that certain memory and motor anomalies arise because of a compromise in the capacity to take advantage of the redundant (predictable) features of cognitive tasks. Results demonstrate a relationship between reduced capacity to take advantage of predictable features of two different cognitive processing tasks, one verbal memory, and the other motor. Poorer verbal recall on high-redundancy word lists was associated with a reduced ability to produce synchronous finger tapping in response to a high redundancy auditory stimulus, and inversely correlated with formal thought disorder ratings. These relationships, we suggest, reflect a specific and common schizophrenic deficit in the use of redundancies, not attributable to a generalized deficiency in performance. Structural imaging evidence from a subsample of these subjects ( $n=16$ ) implicates frontal areas as the locus of this cognitive impairment. © 2000 Elsevier Science B.V. All rights reserved.

**Keywords:** Frontal Lobe; Memory; Motor; MRI; Redundancy; Schizophrenia

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## 1. Introduction

Deficient ability to take advantage of predictable elements in the performance of cognitive tasks has been proposed as an underlying factor for a number of deviances in schizophrenia. For example, research indicates that redundancies in information input improve cognitive performance in normals (Lewinsohn and Elwood, 1961; Lawson et al., 1964; Gerver, 1967; Raeburn and Tong, 1968; Levy and Maxwell, 1968; Truscott, 1970), but do so to a lesser extent in individuals with schizophrenia (Koh, 1978; Lewinsohn and Elwood, 1961; Maher et al., 1980). Additional evidence of impaired use of context in verbal behavior is provided by reports of lower predictability of utterances produced by schizophrenic subjects (Manschreck et al., 1979), of the comprehension of ambiguous words in the context of a sentence (Chapman et al., 1964), and of the evoked potential response to incongruous endings to sentences (e.g., Niznikiewicz et al., 1997). In recent work in this laboratory (Manschreck et al., 1997), we have found that major depressive subjects perform similarly to normals in a context-aided verbal memory task, whereas schizoaffective subjects perform like schizophrenic subjects, suggesting that reduced recall in this task is especially characteristic of the spectrum of schizophrenic disorders.

The relationship of impaired context-aided memory to other psychopathological features of schizophrenia is only partially understood. In an earlier report on contextual influences on memory, reduced ability to profit from context was associated with the presence of formal thought disorder in schizophrenia (Maher et al., 1980). Interestingly, evidence of reduced ability to take advantage of predictable (or redundant) task features has been observed in studies of motor synchrony, or the ability to produce rhythmic responses to highly predictable auditory stimuli. This impairment is related to the presence of formal thought disorder in schizophrenia patients (Manschreck et al., 1981), and patients with Crow's (1980) Type II features (Manschreck et al., 1985).

A core question arising from these reports concerns whether failure to use context is specific to the processing of verbal input and retrieval, or whether it reflects an impairment of a more fundamental process whereby initial sequences of any kind of input are normally used to generate correct anticipations of later input, whether verbal, visual, or in some other medium. Evidence for an impairment of this mechanism beyond verbal tasks is limited but suggestive (Manschreck et al., 1981; Pishkin and Williams, 1984; Steffy and Gailbraith, 1980). In order to provide a basis for testing the implications of this latter alternative, it may be helpful to summarize briefly the essential assumptions underlying the concept of 'redundancy', and the related concept of 'context'.

### 1.1. Redundancy and context

The concept of redundancy derives from Shannon's (1948) formulation of information theory. According to this, the occurrence of an event conveys information to the extent that it is correlated with the occurrence of a specific future event. The higher the correlation, the more redundant is the occurrence of the next event. Context consists of the complex of prior and/or co-incident events from which probability estimates can be made about future events. The use of context to improve prediction of coming events is adaptive, permitting the individual to anticipate the future and to prepare adaptive responses accordingly. An inability to utilize context reduces the capacity of the individual to prepare for the next event, limiting him or her to reacting to each event only after it has been identified. According to this formulation, the automatic computation of sequential probabilities is an integral part of adaptive behavior and is a basic feature of an intact system for information processing.

The processing of context and the calculation of predictive probabilities itself is not experienced in consciousness, but occurs at what Neisser (1967) termed the "preattentive level". In addition to making it possible for the individual to make appropriate preparative response in anticipation of a coming event, redundancy also permits the reduction of focused attention to the event itself. The allocation of attention to an event can be reduced

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