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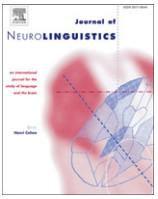

Abnormal N400 responses but intact differential hemispheric processing of ambiguity in schizophrenia

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ABSTRACT

Disordered thinking in schizophrenia may be a consequence of the selection of conceptual associates of dominant meanings of ambiguous words despite contextual information suggesting subordinate meanings are more appropriate. Previous work using short sentences showed a large N400 event-related potential to subordinate meaning associates and a behavioral semantic bias, but results were variable. The current experiment used word pairs to simplify the procedure and to less tax memory maintenance. Furthermore, hemispheric responses were compared, as evidence suggests the left hemisphere may select dominant meanings, while the right hemisphere may keep all possible meanings active. Subjects indicated whether two words (CUE, TARGET) were related. The CUE, presented for 1 s, could be an ambiguous or an unambiguous noun, and the TARGET, presented 1.25 s after the onset of the CUE, was a dominant or subordinate associate, or a related or an unrelated word, respectively. The N400-effect was calculated from difference waveforms over 400–600 ms. Groups (23 schizophrenia, 25 matched controls) showed significantly different N400-effects to the words (group × word, $p = 0.04$). Controls showed a graded response, with dominant < subordinate < unrelated. Schizophrenia patients showed the largest N400-effect to subordinate associates, with less activity to dominant meaning associates and unrelated words. Both groups showed a right hemisphere distribution to unrelated words and substantial left hemisphere activation to subordinate associates (word × hemisphere, $p < 0.001$). These data support a semantic bias in schizophrenia. They also demonstrate a special role of the right hemisphere in maintaining broad

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homograph meaning hierarchies. This hemispheric specialization appears to be intact in schizophrenia.

1. Introduction

Many words in English have multiple meanings, making them ambiguous in isolation. These different meaning may be more or less related (polysemy: foot in a shoe, foot in inches, foot of the mountain), or have different roots altogether (homonymy: bat meaning cudgel from Latin root batteure versus bat meaning flying mammal from Scandinavian root bakka). In addition to the homonymous written words spelt the same (homographs like bat above), words that are spelt differently but pronounced the same (homophones: bare, bear) also add to conceptual ambiguity. These ambiguous words necessitate the use of context for disambiguation. Getting hit by a bat on a playground should bring to mind a different scenario than getting hit by a bat in a dark cave.

Persons with schizophrenia show thought disorder, characterized by loose associations, tangentiality, disorganization, and loss of global focus. A central issue in understanding schizophrenic thought disorder is whether semantic memory structure affects the disordered train of thought in schizophrenia, or whether such digressions are random. There is data to suggest that schizophrenic error patterns are not random (Chapman, Chapman, & Miller, 1964). In a series of papers, Chapman and colleagues examined homograph processing in schizophrenia and argued that schizophrenic thought was biased towards strong associates of dominant meanings even if contextually inappropriate. Thus, the associational abnormalities in schizophrenia were dependent on the pull of proximal associates in the semantic network (semantic bias).

For example, Rattan and Chapman (1973) designed two multiple choice homograph tests, one with associated but contextually incorrect choices, the other with no associates. Schizophrenics performed poorly on the task with incorrect associates, but normally without incorrect associates. Roberts and Schuham (1974) reported that schizophrenic subjects' performance dropped directly with increases in associative distractions. Blaney (1974) demonstrated increased bias during lexical access for ambiguous words, and Chapman, Chapman and Daut (1976) showed that schizophrenics were able to detect weak associates when strong associates were not present. These data suggest that schizophrenics may have all meanings of homographs in their lexicon, but cannot use context to choose subordinate meanings, particularly if the contextual cues are temporally remote.

It remains unclear whether this semantic bias reflects an abnormality that is early or late in the processing stream. Chapman and colleagues suggested that a late-stage failure to utilize preceding context was the central abnormality. This lack of controlled context-based inhibition remains a strong possibility (see esp. Cohen & Servan-Schreiber 1992). However, an alternative explanation is faulty early semantic activation, namely hyperpriming. Hyperpriming of contextually inappropriate associates due to their strong semantic relatedness could lead to the preselection of dominant homograph meaning networks despite contextual cues toward subordinate meanings. Thus, another central issue in understanding schizophrenia is the degree to which abnormalities reflect early automatic versus late controlled processes. There is evidence for hyperpriming in schizophrenia at shorter SOAs. Schizophrenic subjects show an *increase* in the effect of priming on a lexical decision task (Maher, 1983). This facilitation effect on priming has been replicated (Baving, Wagner, Cohen, & Rockstroh, 2001; Kwapil, Hegley, Chapman, & Chapman, 1990; Spitzer et al., 1994). Spitzer and colleagues further showed that schizophrenics demonstrated *increased* second order priming (e.g., lemon primes sour, which primes sweet; Spitzer, Braun, Hermle, & Maier, 1993). These data suggest that schizophrenics show greater initial activation in semantic networks than controls. By contrast, a large body of literature has argued for a lack of context utilization in schizophrenia. The influential theory of Cohen and Servan-Schreiber (1992, 1993) suggested that thinking in schizophrenia was more highly influenced by the local context or immediate associations of current words rather than the global context of the larger discourse. Kuperberg, McGuire, and David (1998) showed that thought disordered patients were less sensitive to syntactic or semantic violations and thereby linguistic context. This could be understood as a smaller scope or time window of context. At SOAs over 750 ms, schizophrenics appear to perform worse than