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ScienceDirect
Schizophrenia Research 89 (2007) 261–277
SCHIZOPHRENIA RESEARCH
www.elsevier.com/locate/schres

Delusions and processing of discrepant information: An event-related brain potential study

J. Bruno Debruille [a,b,*], Namita Kumar [b], Dominique Saheb [c], Araba Chintoh [a], Daryoush Gharghi [b], Claire Lionnet [a], Suzanne King [a]

[a] *Douglas Hospital Research Centre, Department of Psychiatry, McGill University, Montreal, Quebec, Canada*
[b] *Douglas Hospital Research Centre, Department of Neurology and Neurosurgery, McGill University, Montreal, Quebec, Canada*
[c] *Department of Psychology of the Université de Montréal, Montreal, Quebec, Canada*

Received 9 March 2006; received in revised form 15 July 2006; accepted 19 July 2006
Available online 1 September 2006

Abstract

One possible explanation for why delusions persist despite the awareness of contradictory information is that the new information fails to be integrated. Interestingly, the amplitude of the N400 event-related brain potential (ERP) has been proposed as an index of the integration of information that is discrepant with expectancies whatever the task in which the potential is found. Thus, delusions may persist because of a deficit in integration as indexed by the N400. To test this hypothesis, ERPs were recorded in 35 schizophrenia patients (mean age = 30.5 ± 5.6 years) and 26 normal controls during a task in which they either had to decide whether or not each target word could be integrated into the category "animal", or had no decision to make, according to the prompt "animal?" or the prompt "inaction". In these conditions, the amplitudes of the N400s to target words that were discrepant with the category were found to be negatively correlated with delusion severity. The patient group was then dichotomized according to a median split of delusion severity, excluding the 5 patients with delusion scores at the median. Mean age, sex ratio, and severity of conceptual disorganization and hallucinations of the two subgroups differed. Controlling for these 4 covariates, the N400s for discrepant targets were found smaller in the 14 More-Delusional patients than in the 16 Less-Delusional patients. These results support the hypothesis that delusions are associated with smaller N400s in patients. Further studies should thus be done to test whether a deficit of N400 processes could have a causal role in the persistence of delusions.

Keywords: Delusion persistence; Semantic integration; N400; Schizophrenia

1. Introduction

1.1. Persistence of delusions

Many studies have focused on the mechanisms by which delusional beliefs are constructed (Manschrek, 1995; Winters and Neale, 1983; Maher, 1988; Kapur, 2003; Kinderman et al., 2003; Freeman et al., 2002; Colbert and Peters, 2002; Frith, 1992; Bentall et al.,

* Corresponding author. Human Neurocognitive Science Laboratory, F.B.C. Pavilion, Douglas Hospital Research Centre, 6875 Blvd. LaSalle, Montréal, (Qc), Canada H4H 1R3. Tel.: +1 514 761 6131x3405; fax: +1 514 888 4099.
E-mail address: bruno.debruille@douglas.mcgill.ca (J.B. Debruille).

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doi:10.1016/j.schres.2006.07.014

2001; Guillem et al., 2003). Other studies have begun to explore how these beliefs are then maintained. For example, one research tradition emphasizes the protection of the psychotic patient's self-esteem through delusions that attribute responsibility for positive events to the self and responsibility for negative events to others (Lyon et al., 1994; Kinderman and Bentall, 1996; Kinderman et al., 2003). Freeman et al. (2001) have begun another line of research to explain the maintenance of delusional beliefs in the face of daily contradictions to the belief as a function of safety behaviours. Indeed, their results suggest that, due to patients' avoidance of situations they falsely believe to be dangerous, they fail to learn to attribute the unexpected absence of catastrophe to the incorrectness of their threat beliefs. Rather, they believe that catastrophe was averted because of their safety behaviors. What might have been an instance of a disconfirmation of a threat belief is turned into a "near miss".

However, safety behaviors are insufficient to explain the persistence of delusions in many patients. Cognitive behavioral therapies (CBT) for delusional patients confront patients with disconfirming evidence for their delusions (Chadwick and Lowe, 1990; Kuipers et al., 1998). Nevertheless, delusions often persists even in the face of contradictory evidence, as specified by the DSM-IV definition of delusion (DSM-IV, p 765, see also Kuipers et al., 1998).

This failure to change delusional beliefs when presented with contradictory evidence is surprising given normal experience. For instance, seeing that the official result of an exam is 'pass' instantly changes a student's conviction that he failed given how badly he believes he had done during the test; or, when walking alone in a street at night, looking back and seeing no one disrupts the belief of being followed. The new information collected appears to be integrated into the representation that is at stake in the belief, and this long-term memory representation appears to be changed by the information.

Accordingly, two hypothetical mechanisms could contribute to the persistence of a delusional belief. The first is a deficit in the mechanism that integrates new information into the representation at stake in the belief. The second could be a deficit in the mechanism that updates long-term memory representations. In either case, the deficit would have to account for both the behavioral problems associated with information related to delusional representations, and the apparent absence of behavioral problems when dealing with non-delusional representations. This is possible if one hypothesizes a deficit of only moderate severity, which would have behavioral consequences only for information that is more difficult to integrate. This may well be the case for information that is contradictory with well-formed delusions. Given that many delusional representations have powerful affective associations (Beck and Rector, 2002), these may require integration and updating processes that are functioning optimally if new information is to change the representation. This would also be true for non-delusional beliefs that are held strongly. In the case of a moderate deficit in either of the processes involved in making use of contradictory information, the consequences of that deficit should be seen specifically in the case of strongly held and or affectively loaded beliefs.

1.2. N400 event-related brain potential and integration of unexpected information

Although deficits in integration and updating of representations may not be visible clinically when dealing with non-delusional material, they might be flushed out using a special technique. In a different research tradition, a particular event-related brain potential (ERP) has been proposed as an index of the integration of information into a more global semantic representation, whatever the task in which this potential occurs (Rugg et al., 1988; Holcomb, 1993; Marchand et al., 2002; Halgren et al., 2002; Misra and Holcomb, 2003; for a review of this idea, see Kutas and Federmeier, 2000). This potential is termed the N400 because it is of negative electrical polarity and peaks around 400 ms after the stimulus onset. It is widely spread across the scalp, usually with a maximum at centro-parietal electrode sites.

Many findings support the idea that the N400 indexes semantic integration. First, the N400 seems to be elicited only by meaningful items, such as words, faces and objects (Greenham et al., 2000; Stuss et al., 1988; Cameli and Phillips, 2000). Second, the N400 occurs only during tasks in which the semantic properties of the stimuli are processed; it is absent or minimal in tasks that prevent that processing by focusing the attention of the subject on non-semantic properties, such as having to decide whether words are written with upper or lowercase letters (Chwilla et al., 1995). Conversely, its amplitude is 'boosted' by tasks that focus explicitly on the semantic properties of stimuli (Kounios and Holcomb, 1994). Third, the N400 is of much smaller amplitude in contexts that facilitate integration by preparing subjects for the meaning of the upcoming stimulus (Bentin et al., 1985; Kutas and Federmeier,