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Verbal memory compensation: Application to left and right temporal lobe epileptic patients

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Abstract

This study investigates the compensatory impact of cognitive aids on left and right temporal lobe epileptic patients suffering from verbal memory disorders, who were candidates for surgery. Cognitive aids are defined in the levels-of-processing framework and deal with the depth of encoding, the elaboration of information, and the use of retrieval cues. Results indicate differential compensatory impact for left and right epileptic patients and are discussed according to the HERA model and the compensation framework.

Keywords: Cognitive compensation; Verbal memory; Temporal lobe epilepsy; Hemispheric specialization; Levels-of-processing

1. Introduction

Temporal lobe epilepsy is the most important focal epilepsy due to its high prevalence, drug resistance, and commonly disabling effects on memory functions (Engel, 1996). Seizures concern hippocampal and parahippocampal structures, which mediate declarative memory (Cohen & Squire, 1980; Eichenbaum, 2001; Nadel & Moscovitch, 2001). Thus, poor memory is a primary complaint of patients with temporal lobe epilepsy (TLE). Indeed, a large body of literature is devoted to memory impairment in TLE and studies have frequently focused on the potential differences that occur when seizures are generated from left versus right temporal lobe (Andersson-Roswall, Engman, Samuelsson, Sjöberg-Larsson, & Malmgren, 2004; Griffith, Pyzalski, Seidenberg, & Hermann, 2004; Helmstaedter, 2002; Reminger et al., 2004; Schwarcz & Witter, 2002).

One way of approaching memory deficits is the levels-of-processing framework (LOP) developed by Craik & Lockhart in 1972. In this framework, the durability and distinctiveness of memory traces are direct functions of the nature and quality of the encoding operations. Depth of processing is seen as a processing continuum from shallow (sensory) to deep (semantic) processes, with some types of processing (typically sensory analyses) preceding others (typically conceptual analyses). So, the deeper the initial processing, the better subsequent memory performance is expected to be. To complete this theoretical approach (Lockhart & Craik, 1990), two other main concepts have been added: elaboration and encoding specificity. Therefore, memory performance depends upon three dimensions, depth of processing, elaboration, and encoding specificity (kind of retrieval) of the information operative at the two memory stages, encoding and retrieval.

The first dimension in the LOP theory, "depth of processing", states that deeper processing is associated with higher levels of subsequent remembering. Encoding information at a shallow level (e.g., phonetic) leads to worse

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performance than encoding information at a deeper level (e.g., semantic). For example, memorizing ‘‘brain, train, rain’’ leads to worse performances than memorizing ‘‘bear, horse, dog.’’ These results have been obtained in numerous experiments with healthy subjects (e.g., Bentin, Moscovitch, & Nirhod, 1998; Craik & Tulving, 1975; Fujii et al., 2002) and are explained by the fact that encoding semantic information activates semantic associates in memory that are more efficient for the retrieval of information than less meaningful phonetic associates.

The second dimension, ‘‘elaboration,’’ demonstrated by Craik and Tulving (1975), states that an elaborated memory trace is remembered more readily. Information is ‘‘elaborated’’ by paying attention to the specific meaning i.e., the semantic aspect of associated information (Symons & Johnson, 1997). The richness or extensiveness of processing (Lockhart, Craik, & Jacoby, 1976) makes it possible to retrieve elaborated information via several pathways (Einstein & Hunt, 1980; Lockhart et al., 1976). Among the ways to handle elaboration, the self-reference effect (Kuiper & Rogers, 1979; Maki & McCaul, 1985; Rogers, Kuiper, & Kirker, 1977) describes the fact that asking the subject if the word describes him/her produces a better memory trace. In addition, the ‘‘self-generated cuing’’ paradigm, introduced by Mäntylä and Nilsson (1983), involves the subject in elaborating the information to be memorized by making him/her producing the cue to be matched with the information.

Finally, the third dimension concerns the retrieval stage and refers to encoding specificity (Tulving & Thomson, 1973). Given a specific type of encoding, retrieval is optimized when the retrieval test is designed to utilize the same type of information (Fisher & Craik, 1977; Marmurek, 1995). So, cued recall or recognition provides better retrieval performance than free recall, with no context.

These three dimensions derived from the levels-of-processing theory can be studied together to determine the impact of their interaction on memory performance. Interaction between depth of processing and encoding specificity shows that retrieval (cued recall) is more effective for a deep encoding than for a shallow encoding (Fisher & Craik, 1977). Secondly, interaction between elaboration and encoding specificity has been observed. Mäntyla and Nilsson (1988) demonstrated that self-generated cueing is much more effective in cued than free recall. This indicates that elaboration improves the efficiency of encoding specificity. Thus, interaction between depth of processing and elaboration demonstrated that depth was boosted by elaboration. The superiority of semantic over phonetic encoding is enhanced by elaboration. Finally, the triple interaction has been obtained. Indeed a contextualized recall of an elaborated and deeply processed information results in better performance (Mäntyla & Nilsson, 1988).

In the levels-of-processing theory, the three dimensions could be seen as aids that enhance performance and so could be proposed to compensate cognitive deficits.

As TLE patients’ main complaint concerns their memory deficits, the mismatch between their memory skills and the demands of everyday life (Fisher et al., 2000; Guerreiro, Jones-Gotman, Andermann, Bastos, & Cendes, 2001; Smith, 1989), these patients are candidates for compensation studies to assess the positive impact of the three LOP dimensions (seen as compensation aids) on performance.

In the epileptic research field, some studies have shown that a deficit in memorizing information at a shallow level disappears when patients are helped by deep processing of information, although authors do not agree on the relationship between deficits and laterality of the foci (Helmstaedter & Kurthen, 2001). For some, this compensatory impact of depth of processing is observed only in left temporal lobe epileptic (L-TLE) (Helmstaedter, Gleissner, Di Perna, & Elger, 1997; Jokeit, Okujava, & Woermann, 2001) or right temporal lobe epileptic (R-TLE) patients (Christianson, Nilsson, Säisä, & Silfvenius, 1992; Mungas, Ehlers, Walton, & McCutchen, 1985). Finally, some works do not find any impact of depth of processing, irrespective of the laterality of the epileptic foci (Gleissner & Elger, 2001; N’Kaoua, Lespinet, Barsse, Rougier, & Claverie, 2001; Tröster et al., 1995). Furthermore, it could be noted that in patients who suffer from a Korsakoff syndrome, authors have not found benefits from deep processing whereas patients’ performance levels after shallow processing were nearly normal (Cermak, 1979; Cermak, Reale, & Baker, 1978).

Few studies have investigated elaboration. In a memorization task using self-generated cueing, Lespinet-Najib et al. (2004) demonstrated that elaboration did not help L-TLE patients in phonetic (shallow) or semantic (deep) processing. On the contrary, the R-TLE group benefited from elaboration in phonetic processing, as well as in semantic processing.

The third dimension, ‘‘retrieval’’, was tested by comparing free and cued, or coping recall. Numerous authors have used this paradigm (Christianson, Silfvenius, & Nilsson, 1987, 1989; Savage, Saling, Davis, & Berkovic, 2002). Mungas et al. (1985) found that cued recall only had an impact in L-TLE patients after deep processing. According to Lespinet-Najib and collaborators (2004) L-TLE patients did not benefit from cued recall in deep processing, whereas R-TLE patients did. These findings indicate that the interaction between depth of processing and retrieval does not provide cognitive aid in left TLE, whereas it does in right TLE.

Although verbal memory deficits have been widely studied, there is no consensus as to the profile of left and right temporal lobe epileptic patients’ memory disorders or the compensatory power of cognitive aids, which is crucial from a rehabilitation perspective. While individual cognitive aids may be useful, the impact of their interaction is of real interest. We therefore studied the impact of each dimension of the LOP theory and examined how their interactions potentiated performance. In our approach,