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Research report

Impaired emotional memory recognition after early temporal lobe epilepsy surgery: The fearful face exception?

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ABSTRACT

Introduction: Recognition memory may be enhanced for emotional stimuli compared to neutral ones. Neuropsychological studies in adults with temporal lobe epilepsy (TLE) have reported disorders in this emotional memory enhancement but few studies have focused on children and adolescents with TLE. However these young patients are at particular risk for memory impairments.

Methods: We included 25 patients aged 8–18 years with temporal lobe resection (TLR) for refractory TLE and compared them with 50 age-matched healthy controls for emotional memory recognition tasks involving faces and words. Recollection and familiarity memory processes were explored using the R/K/G paradigm and identification of emotional facial expressions was evaluated.

Results: In the control group, recognition was enhanced for emotional faces and words compared to neutral ones. In patients, no memory enhancement effect was found, except for fearful faces. Memory enhancement for fearful faces relied on familiarity-based judgments in patients whereas it was supported by recollection in controls. In left-TLR patients, memory recognition of emotional material was correlated with identification of emotional facial expressions whereas this was not the case for right-TLR patients.

Conclusion: Together, these findings indicate that temporal lobe integrity is crucial for children to develop normal interactions between emotions and memory. In the case of early lesions, fearful expressions might possibly increase memory for faces but through familiarity rather than through recollection as in healthy individuals.

1. Introduction

Interaction between memory and emotional stimuli is well documented in adults through the phenomenon of emotional memory enhancement (see Dolan, 2002 for a review). Memory appears to be improved for emotional events compared to neutral ones. Neurophysiological studies (McGaugh, 2000) and neuroimaging findings in adults (Murty et al., 2010 for a meta-

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analysis) and adolescents (Vasa et al., 2011) indicate that emotional memory enhancement relies on the modulation of memory consolidation occurring in the medial temporal lobe (MTL) by the amygdala. Few studies, however, have addressed the emotional modulation of memories in children and adolescents (Davidson et al., 2001).

Temporal lobe epilepsy (TLE) occurring during childhood is known to be associated with neuropsychological disorders. Children encountering TLE are at particular risk for learning disabilities (Fastenau et al., 2004; Mitchell et al., 1991; Schouten et al., 2002; Williams, 2003) and are predisposed to episodic memory impairments (Mabbott and Smith, 2003; Jambaqué et al., 1993, 2007; Nolan et al., 2004) and emotional dysfunctions (Caplan et al., 2004; Golouboff et al., 2008). Problems may be present before the first seizure, suggesting the potential influence of epileptogenesis, antecedent neurodevelopmental abnormalities, and genetic and environmental susceptibilities (Hermann et al., 2012). To our knowledge, only one study has investigated emotional memory in children or adolescents with TLE (Jambaqué et al., 2009). Results suggested a lack of emotional enhancement for memory of stories and lists of words in patients aged 11–15 years compared to normal controls. Adult neuropsychological studies are more numerous but have yielded conflicting results. Some studies reported normal verbal memory enhancement for emotional words in adults with right or left temporal lobectomy (Brierley et al., 2004; Buchanan et al., 2001; Phelps et al., 1997). Nevertheless, patients in Phelps et al. (1997) did not show emotional enhancement for intense taboo words. The impact of MTL damage also differs depending on the lateralization of the lesion: no effects of emotion on memory for words are found when the lesion is left lateralized (Brierley et al., 2004; Buchanan et al., 2001; Glogau et al., 2004) and dysfunctions are more pronounced when the amygdala is bilaterally affected (Brierley et al., 2004). Bilateral damage to the amygdala not only impairs emotional memory but also produces dramatic deficits in the identification of fearful facial expressions (Adolphs et al., 1999). While Brierley et al. (2004) did not observe any correlation between performances in emotion perception and memory, other authors showed the coexistence of impairment in labeling and memory of facial expression in patients with left TLE or left temporal lobe resection (TLR) (Carvajal et al., 2009; Glogau et al., 2004).

In the case of refractory TLE, seizure control can be obtained with surgical treatment consisting in TLR. Brain plasticity during active childhood TLE and after TLR leads to functional reorganization. Thus, cognitive outcomes, especially memory functions, appear to be improved with seizure control after early TLR (Jambaqué et al., 2007). Early TLR may be a suitable model for studying emotional memory in the case of early MTL damage in a seizure-free context, since patients with early amygdala damage are more impaired than those with later acquired lesions (Shaw et al., 2005). Studies in non-human primates furthermore evidenced that early lesions of the MTL lead to severe long-term memory and socio-emotional disturbances whereas effects are only transitory in the event of inferior temporal lesions (Bachevalier et al., 2001; Málková et al., 1995, 2010).

Emotional memory enhancement is frequently explored *via* a recognition memory task, especially when using faces or pictures. According to dual processing theory, recognition memory is supported both by recollection – which involves revival of the encoding contextual details – and by familiarity – which refers to a feeling of simply having being previously exposed to the event (see Yonelinas, 2002 for a review). Remember/know procedures are frequently used to evaluate the involvement of these 2 processes (Gardiner, 2002). In adults, emotional memory enhancement appears to be supported mostly by recollection, especially in the case of negative pictures (Ochsner, 2000).

In the above-mentioned studies, memory for emotional events was examined for verbal and/or non-verbal stimuli. Some authors found that recognition memory for faces is less affected by MTL lesions than words recognition in adults (Bird et al., 2008; Aly et al., 2010). Aly et al. (2010) additionally found that patients with MTL lesions were impaired in recollection while familiarity-based recognition was preserved for both faces and words. The question remains as to whether the development of emotional memory enhancement for words and faces is affected in the same way by MTL lesions.

The present study aims at describing emotional memory in the case of TLR for refractory TLE in pediatric patients compared with age-matched healthy controls. This issue was addressed using non-verbal (faces) and verbal (words) stimuli. Recollection and familiarity memory processes were explored using the R/K/G paradigm (e.g., Yonelinas, 2002). It is hypothesized that TLR patients will show no memory enhancement for emotional stimuli. We furthermore assumed that the R/K data would show that TLR patients are impaired for recollection memory. Moreover, we expected that the ability to identify emotional facial expressions would affect the memory for such stimuli in patients, particularly in the case of left TLR.

2. Methods

2.1. Participants

2.1.1. TLR patients

Twenty-five patients aged 8–18 years (mean age: 13.06 ± 3.7 years) who had been surgically treated for refractory unilateral TLE participated in the study. Experimental sessions were conducted during follow-up neuropsychological evaluations at the Pediatric Epilepsy Neurosurgery Department of the Fondation Rothschild (Paris, France) between November 2009 and April 2011. Informed consent for the neuropsychological study was obtained from patients and their parents. Inclusion criteria comprised (1) unilateral mesial and anterior TLR including the amygdala and hippocampus, (2) at least 1 year post-surgery period, (3) successful seizure control after surgery (Engel classification, class I), (4) right handedness assessed with a standard test (Dellatolas and Agostini, 1988), (5) enrollment in a regular school, and (6) IQs ≥ 70 on the Wechsler Intelligence Scale for Children – IV. The group was composed of 13 right TLR (RTLR) and 12 left TLR (LTLR). Histopathological analyses performed on removed tissues revealed the presence of hippocampal sclerosis (HS) in 15