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# Just do it! How performing an action enhances remembering in transient global amnesia

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ARTICLE INFO

*Article history:*
Received 5 March 2013
Reviewed 5 May 2013
Revised 2 August 2013
Accepted 21 October 2013
Action editor Georg Goldenberg
Published online 30 October 2013

*Keywords:*
Transient global amnesia
Enactment effect
Self-performed task
Binding
Memory for action

ABSTRACT

Transient global amnesia (TGA) is a clinical syndrome characterized by the sudden onset of a massive episodic memory deficit that spares other cognitive functions. As such, it provides a unique human amnesia model for testing the enactment effect (i.e., better memory for performed actions than for verbally encoded sentences). Our main aim was to test whether the enactment effect is preserved in TGA patients, both to have a better understanding and to test the robustness of this effect in a massive amnesia.

Object-action pairs were encoded under four conditions: verbal, experimenter-performed, and two enacted conditions (self-performed and self-performed with choice). We tested object-action pair retrieval using cued recall (CR) and recognition tasks, and source memory using a free recall task. We also assessed binding, executive functions, short-term memory, episodic memory, anxiety and mood. We run correlations to control for their putative effects on memory for action. Data were collected from 24 patients, 16 of whom were examined during the acute phase and eight the day-after, as well as from 18 healthy controls.

The memory performances of the patients in the acute phase improved for both i) the CR score, between the verbal, experimenter-performed and self-performed with choice conditions, and ii) the total recognition score, between the verbal condition and the two enacted conditions. Correlations were found between self-performed task (SPT) enhancement and both the binding and anxiety.

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0010-9452/$ – see front matter 
http://dx.doi.org/10.1016/j.cortex.2013.10.007

In spite of their severely impaired episodic memory, patients with TGA benefit from the enactment effect. These results are discussed in relation to the role of motor components and episodic integration in memory for actions. We suggest that enactment effect can be used in clinical practice and rehabilitation, possible even for patients with a massive memory impairment.



## 1. Introduction

Transient global amnesia (TGA) is a neurological syndrome that occurs in middle age and lasts up to 24 h. Its aetiology remains elusive, despite recent evidence of transient focal abnormalities in the CA1 hippocampal region (Bartsch et al, 2008). This amnesia is characterized by the sudden onset of massive anterograde amnesia with no attendant neurological or cognitive impairments (Quinette, Guillery-Girard, Dayan et al., 2006). During the acute phase, patients also display increased anxiety and a deterioration in mood, which have a deleterious impact on episodic memory functioning (Noël et al., 2008).

Despite the massiveness of the episodic memory deficit, which is present whatever the types of materials that have to be memorized and whatever the encoding and retrieval conditions, TGA patients have been shown to be capable of acquiring new skills in procedural memory (Eustache et al., 1997), the perceptual representation system (Kazui & Tanabe, 1995), and semantic memory (Beauregard, Weiner, Gold, & Chertkow, 1997; Guillery et al., 2001), using priming effects. No study, however, has ever investigated whether TGA patients can improve their episodic memory performance during the amnesic episode.

In the past three decades, many studies have focused on memory for actions (for a review, see Engelkamp, 1998; Nilsson, 2000), a particular form of episodic memory (Tulving, 2002; Zimmer et al., 2001). Most of them focused on enactment effect, an improvement of recall and recognition scores for action phrases (e.g., "put on a glove", "move the pen to the right") when participants perform the actions (subject-performed task or SPT) during encoding compared with classic condition under which participants merely listen to or read the phrases (verbal task or VT).

Of the few studies that have explored this memory for actions in pathological conditions (for review, see Hainselin, Quinette, & Eustache, 2013), the majority have demonstrated the robustness of the enactment effect in children with autistic spectrum disorders, Parkinson's disease and frontal lobe syndrome and Korsakoff's syndrome while only a little benefit was observed in schizophrenia and sometimes in Alzheimer's disease, and in rats (Thompson, 1959). However, a patient with developmental amnesia (Gardiner, Brandt, Vargha-Khadem, Baddeley, & Mishkin, 2006) showed no enactment benefit, suggesting other functions than episodic memory might contribute to this effect.

Although the enactment effect has frequently been studied since the 1980's, there is still no consensus on how it enhances memory (for review, see Madan & Singhal, 2012), including if it is supported by episodic memory. There are two main schools of thought: according to Engelkamp (2001), participants first have to plan the action, involving motor and visual information. This multimodal theory is supported by the advantage of SPTs over experimenter-performed tasks (EPTs), when healthy participants simply observe somebody else performing the action. The planning component does, however, seem to be essential, but needs to be more extensively studied, for example by letting participants choose which actions to perform with the different objects. According to Kormi-Nouri and Nilsson (2001), enactment enhances episodic integration, binding the action verbs and object nouns together. This "glue" theory has mostly been studied by comparing well-integrated ("put the money in the wallet") and poorly integrated ("put the money in the napkin") actions (Mangels & Heinberg, 2006). Although this second hypothesis is a very important topic of discussion, binding itself had never been assessed with a specific task.

Thus, the main aim of our study was to assess whether the enactment effect is sufficiently robust for it to be observed during a massive amnesia episode such as TGA. Our second objective was to gain a better understanding of how enactment enhances memory by investigating the functions that sustain the enactment effect on patients. To this end, we chose to assess binding with a specific task to test the "glue" theory. Inhibition and shifting (as patients have to perform different actions and shift from one to the other), short-term

**Table 1 – Clinical and demographic characteristics of individuals with TGA and controls.**

| | Acute TGA ($n = 16$) | Day-after TGA ($n = 8$) | Healthy controls ($n = 18$) |
|---|---|---|---|
| Sex: women/men | 13/3 | 4/4 | 13/5 |
| Age in years: mean (SD) | 60.56 (5.42) | 68.3[a,b] (6.45) | 61.00 (6.48) |
| Level of education in years: mean (SD) | 11.56 (2.99) | 10.00 (3.51) | 10.56 (2.20) |
| Duration of TGA in hours: mean (SD) | 4.96 (3.37) | 3.81 (2.5) | / |
| No. recurrent patients | 2 (Second episode) | 1 (Second episode) | / |

A comparison of the three groups showed an effect of Group on age, $F(2, 39) = 5.05$, $p < .05$. A *post hoc* Tukey test showed this was due to the presence of older patients in the day-after group compared with the acute and healthy control groups.

[a] Significant difference from healthy control group.

[b] Significant difference from acute TGA group.