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Unconscious memory formation during anaesthesia

Jackie Andrade* PhD

Reader in Psychology

Department of Psychology, University of Sheffield, Sheffield, UK

School of Psychology, University of Plymouth, Plymouth, UK

Catherine Deeproze PhD

Research Psychologist

Department of Psychology, University of Sheffield, Sheffield, UK

Do patients form memories of intra-operative events when they are adequately anaesthetized? Studies of memory priming during anaesthesia with depth or awareness monitoring provide some evidence that they do, although only the most basic form of memory function, perceptual priming, persists when patients are unconscious. The probability of memory encoding increases as depth of anaesthesia decreases. There is a theoretical possibility that patients can be adversely affected, through memory priming, by comments made in the operating theatre, and some evidence that positive intra-operative suggestions can benefit patients.

Key words: implicit memory; explicit memory; depth of anaesthesia; priming; awareness; consciousness.

This article concerns the extent to which the human brain continues to process auditory information during general anaesthesia. Specifically, we ask whether any type of memory function persists during anaesthesia and, if it does, whether patients' well-being could be affected by overhearing conversations and sounds in the operating theatre. Our review focuses on the more recent studies in the literature (from the mid-1990s onwards) that measured memory carefully and used measures of awareness or anaesthetic depth to rule out periods of consciousness during surgery.

* Corresponding author. Professor Jackie Andrade, School of Psychology, University of Plymouth, Drake Circus, Plymouth, Devon PL4 8AA, UK. Tel.: +44 1752 233157; Fax: +44 114 2766561.

E-mail address: j.andrade@plymouth.ac.uk

LEVINSON'S STUDY: MEMORY FOR A MOCK CRISIS

The first experimental study of this topic suggested that patients could have remarkably accurate and detailed memories of salient information presented during surgery.¹ Levinson staged a mock crisis during dental surgery, in which the anaesthetist exclaimed '*Just a moment! I don't like the patient's colour. Much too blue. His (or her) lips are very blue. I'm going to give a little more oxygen*'. The anaesthetist hyperventilated the lungs and then said everything was fine and to continue with the operation. None of the ten patients explicitly recalled this or other intra-operative events on recovery, but under hypnosis a month later four of the patients reported the crisis almost verbatim. Another four patients displayed anxiety as they recalled hearing something, and two had no recollection. People are notoriously susceptible to suggestion under hypnosis and may have picked up subtle cues from Levinson, who was the hypnotist as well as the experimenter, but even so this study provided a dramatic illustration of the potential for memory functions to operate in the absence of consciousness.

IMPLICIT MEMORY

Despite providing a warning that patients could be picking up operating theatre conversations while they were unconscious, Levinson's study triggered little research interest until the mid to late 1980s, when sensitive tests of memory became available via psychological research (Figure 1).

The psychological studies of interest were those in which indirect methods of testing memory revealed evidence of learning, even when participants performed at chance when asked directly to recall or recognise stimuli. For example, Eich² presented spoken homophones, paired with words that implied one interpretation (e.g. window-*pane*), to participants who were concentrating on another task. Later, the participants were unable to pick out those homophones on a recognition test but on

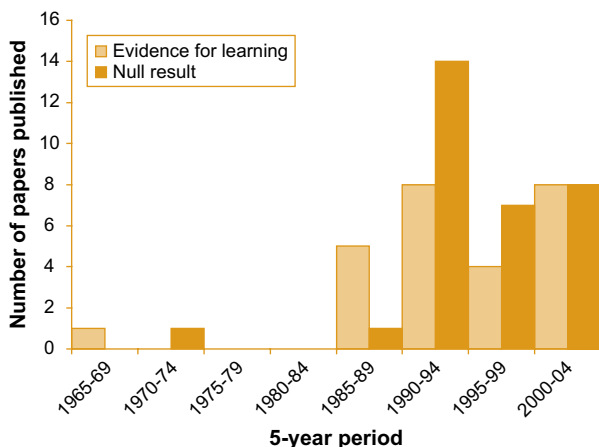


Figure 1. The number of papers testing memory function during anaesthesia, so-called 'learning during anaesthesia', since Levinson's key study in 1965, by five-year period. Andrade (1995) and Ghoneim and Block (1992, 1997) review the early papers. In the current five-year period, three papers have reported evidence for learning during anaesthesia [24, 25, 33] and two have reported null results [21, 31].

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