Increased Reading Speed for Stories Presented during General Anesthesia

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Background: In the absence of explicit memories such as the recall and recognition of intraoperative events, memory of auditory information played during general anesthesia has been demonstrated with several tests of implicit memory. In contrast to explicit memory, which requires conscious recollection, implicit memory does not require recollection of previous experiences and is evidenced by a priming effect on task performance. The authors evaluated the effect of a standardized anesthetic technique on implicit memory, first using a word stem completion task, and then a reading speed task in a subsequent study.

Methods: While undergoing lumbar disc surgery, 60 patients were exposed to auditory materials via headphones in two successive experiments. A balanced intravenous technique with propofol and alfentanil infusions and a nitrous oxide–oxygen mixture was used to maintain adequate anesthesia. In the first experiment, 30 patients were exposed randomly to one of the two lists of 34 repeated German nouns; in the second experiment, 30 patients were exposed to one of two tapes containing two short stories. Thirty control patients for each experiment heard the tapes without receiving anesthesia. All patients were tested for implicit memory 6–8 h later: A word stem completion task for the words and a reading speed task for the stories were used as measures of implicit memory.

Results: The control group completed the word stems significantly more often with the words that they had heard previously, but no such effect was found in the anesthetized group. However, both the control and patient groups showed a decreased reading time of about 40 ms per word for the previously presented stories compared with the new stories. The patients had no explicit memory of intraoperative events.

Conclusions: Implicit memory was demonstrated after anesthesia by the reading speed task but not by the word stem completion task. Some methodologic aspects, such as using low frequency words or varying study and test modalities, may account for the negative results of the word stem completion task. Another explanation is that anesthesia with propofol, alfentanil, and nitrous oxide suppressed the word priming but not the reading speed measure of implicit memory. The reading speed paradigm seems to provide a stable and reliable measurement of implicit memory. (Key words: Intravenous anesthesia; memory; reading time.)

CONSCIOUS awareness associated with recollection of intraoperative events is a rare complication of anesthesia, with an incidence of 0.2% in recent studies.1,2 It can be detected after operation by tests of explicit memory such as recall and recognition.

However, in the absence of intraoperative consciousness and postoperative explicit memories, implicit memory during anesthesia has been shown after operation using indirect memory tests. In these studies, typically patients are exposed to word lists or stories during operation; memory traces of these auditory stimuli are assessed after operation with direct (recall and recognition) and indirect methods.3 A classic indirect task is the word stem completion task. During anesthesia, participants are presented with words. After operation they are asked to complete stems of words (e.g., BAN-) with the first word that comes to mind (e.g., BANANA). Some of these stems are the first letters of previously presented (study) words, and others are not. If the critical stems are more often completed using study words than would be

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Received from the Department of Anaesthesia, Medical School of Hanover, Hanover, Germany. Submitted for publication December 31, 1997. Accepted for publication November 10, 1998. T. F. Münte is supported by the Hermann and Lilly Schilling Foundation, Essen, Germany (TS 13/196/96). Presented in part at the Vienna International Congress: Anaesthesiology and Intensive Care Medicine, October 28–31, 1997, Vienna, Austria, and at The Fourth International Symposium on Memory and Awareness in Anaesthesia, July 11–12, 1998, Harrow, London, United Kingdom.

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expected by chance alone, this indicates implicit memory of those words. Indirect test methods are usually based on the phenomenon of "repetition priming," which facilitates the task performance in a memory test after a previous presentation of words or phrases. Such facilitation occurs without conscious recollection of the testing material. A key feature of indirect memory tests is that the participant is unaware that he or she is participating in a memory test. The repetition priming effect is attributable to a separate memory system called "implicit memory." The implicit and explicit memory distinction is supported by many studies of amnesic and healthy persons. Those with anterograde amnesia, who fail completely in standard tests of explicit memory such as recall and recognition, can have unimpaired implicit memory. This indicates a dissociation of these two memory systems.

A similar dissociation of explicit and implicit memory functions has been shown in patients under general anesthesia. The memory paradigms used in persons with amnesia have been adapted for use in anesthetized patients. However, previous studies have yielded conflicting results. The discrepancies are likely the result of differences in study parameters, such as the type of memory test, the intensity of surgical stimulation, various pharmacologic agents and their dosages, the interval between the initial stimulus presentation and the implicit memory test, the nature of the stimulus material, and the physiologic status of the patient. Therefore, it remains unclear under which conditions implicit memory persists during anesthesia and what measures are best suited to detect implicit memory in anesthetized patients. In both the experiments described here, we took great care to adhere to a standardized anesthetic technique using propofol, alfentanil, and nitrous oxide in a homogeneous population of patients undergoing only lumbar disc surgery. Our main goal was to determine whether there is implicit memory of verbal material presented during general anesthesia comparable to a control group of nonanesthetized patients, which was included in each experiment. We wished to develop a test that could detect implicit memory, if present, during a standardized anesthetic regimen. Initially, we evaluated the word stem completion task, because previous studies had indicated a dramatic effect during various types of anesthesia. However, despite the positive results in control patients, we could not detect any implicit memory effect in anesthetized patients. Thus, we evaluated a different test of implicit memory previously unused in anesthetized patients, the reading speed task. This task has been used to detect implicit memory in patients with amnesia and in healthy controls.

### Materials and Methods

**Patients**

Between April 1996 and September 1996, 30 patients were enrolled in experiment 1; between November 1996 and March 1997, 30 other patients were enrolled in experiment 2. The study was approved by the Medical Ethics Committee of the Hannover Medical School. The 60 patients, who were all undergoing elective lumbar disc surgery, gave written informed consent. The patients were informed the day before surgery that a tape with common German nouns (experiment 1) or short stories (experiment 2) would be played to them while they were anesthetized during surgery and that they would undergo a psychologic test several hours after the operation. Patients with a native language other than German or who were older than 45 yr were excluded, as were those with neurologic or psychiatric diseases, head trauma, hearing impairment, or psychoactive medication. Two control groups (30 participants for each experiment) were recruited and consisted of volunteers from the departments of trauma and internal medicine (table 1). These persons listened to the tapes without anesthesia and completed the implicit memory tests after a comparable delay. There were no significant differences between the study and control groups with respect to age, gender, education, employment status, or, in experiment 2, experience with computers (table 2).

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Table 1. Control Patients: The Main Diagnosis and Number of Subjects

<table>
<thead>
<tr>
<th>Main Diagnosis</th>
<th>Word Stem Completion</th>
<th>Reading Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal fixation or removal of internal fixation</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>Corrective osteotomy</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Extirpation of a benign smooth tissue tumor</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Intestinal diseases (food intolerance, pancreatitis, diarrhea, duodenal ulcer)</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Glomerulonephritis</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Paroxysmal supraventricular tachycardia</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Spontaneous pneumothorax</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Pulmonary sarcoidosis</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

All volunteers recruited from the trauma departments participated in the experiments the day before or several days after the surgery.
Table 2. Patients: Anesthetic and Surgical Details

<table>
<thead>
<tr>
<th></th>
<th>Word Stem Completion</th>
<th>Reading Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patients (n = 30)</td>
<td>Controls (n = 30)</td>
</tr>
<tr>
<td>Age (range), (yr)*</td>
<td>35.4 (23-45)</td>
<td>35.1 (22-45)</td>
</tr>
<tr>
<td>Weight (average)</td>
<td>83.0</td>
<td>Not assessed</td>
</tr>
<tr>
<td>Height</td>
<td>178.96</td>
<td>Not assessed</td>
</tr>
<tr>
<td>Women/ment†</td>
<td>6/24</td>
<td>8/22</td>
</tr>
<tr>
<td>Education (lyr)*</td>
<td>10.3</td>
<td>10.6</td>
</tr>
<tr>
<td>Employed/unemployed/</td>
<td>26/3/1</td>
<td>27/3/0</td>
</tr>
<tr>
<td>student†</td>
<td>Not assessed</td>
<td>Not assessed</td>
</tr>
<tr>
<td>Computer experience</td>
<td>27/3</td>
<td>22</td>
</tr>
<tr>
<td>ASA I/ASA II</td>
<td>27/3</td>
<td>22</td>
</tr>
<tr>
<td>Duration of anesthesia</td>
<td>91.7 (30.3)</td>
<td>106.9 (32.2)</td>
</tr>
<tr>
<td>(min) (SD)</td>
<td>72.4 (22.7)</td>
<td>70 (21.9)</td>
</tr>
<tr>
<td>Duration of surgery (min)</td>
<td>952 (167.2)</td>
<td>878 (414.3)</td>
</tr>
<tr>
<td>(SD)</td>
<td>3 × 50</td>
<td>2 × 50</td>
</tr>
<tr>
<td>Total dose of alfentanil</td>
<td>4.96 (1.66)</td>
<td>4.2 (2.1)</td>
</tr>
<tr>
<td>(mg) (SD)</td>
<td>2.78 (0.14)</td>
<td>2.78 (0.14)</td>
</tr>
<tr>
<td>Blood concentration of</td>
<td>85.54 (5.72)</td>
<td>85.54 (5.72)</td>
</tr>
<tr>
<td>propofol (µg/ml) (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood concentration of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>alfentanil (ng/ml) (SD)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Nonsignificant, Mann-Whitney U-test.
† Nonsignificant, chi-square test.
‡ The blood concentrations of propofol and alfentanil were simulated postoperatively with StanPump software.3 The propofol concentrations during the tape presentations exceeded the C80 for anesthesia in the presence of alfentanil (C80 = 2.27 µg/ml)11 which indicate adequate and similar anesthesia levels for both experiments. StanPump is freely available from the author, Steven L. Shafer, M.D., Anesthesiology Service (112A), PAVMC, 3801 Miranda Ave., Palo Alto, CA 94304.

One illiterate patient was excluded from experiment 1 after operation; one patient in experiment 2 could not be tested because of postoperative nausea and vomiting. One patient refused to participate in the study because he was afraid of being influenced by the tape.

Anesthesia

Anesthesia was administered by three of the authors (S.M., A.D., and E.L.). To standardize the study conditions, we administered both the hypnotic and analgesic agents in continuous infusions. Premedication with 7.5 mg oral midazolam was given 0.5 to 1 h before the operation. After administration of 0.5 mg atropine intravenously, anesthesia was induced with 2 to 2.5 mg/kg propofol and 5 µg/kg alfentanil. After the patients lost consciousness, they were ventilated with 100% oxygen, and 0.5 mg/kg atracurium was given to facilitate tracheal intubation. Immediately after induction, two infusions were started: propofol in a dosage of 10 mg · kg⁻¹ · h⁻¹ for 10 min, 8 mg · kg⁻¹ · h⁻¹ for the next 10 min, and 4 mg · kg⁻¹ · h⁻¹ thereafter, and alfentanil in a dosage of 30 µg · kg⁻¹ · h⁻¹ alfentanil. Nitrous oxide, 60%, was combined with oxygen. Propofol and alfentanil infusion rates were kept constant until the end of surgery. Additional propofol (0.5 to 1 mg/kg) was given whenever heart rate or arterial blood pressure levels increased by more than 10% of preoperative values. Atracurium (10 mg) was given when more than two twitches of the train-of-four were present. Electric activity of the heart, noninvasive blood pressure, ventilation, end-tidal carbon dioxide concentration, peripheral oxygen saturation, and neuromuscular transmission were monitored during operation.

Study and Test Procedures

Experiment 1. Presentation of Auditory Stimuli.

Two audiotapes, each consisting of a list of 54 different low frequency German nouns (<50 occurrences per million),19 were prepared. No two of these words shared the same three initial letters. Examples of
words used in the study are Kamin, Mantel, Stift, Tauber (in English, fireplace, coat, pen, diver). For each word in these lists, there were at least five nouns beginning with the same three letters; that is, for the critical word Kamin: Kamera, Kamerad, Kamm, Kamer, Kampf (in English, camera, comrade, comb, chamber, fight). One half of the participants from each group (15 each from the study and control groups) were randomly exposed to one of the two lists. Each patient was presented with one of the tapes during anesthesia beginning at the time of skin incision. The same format was used for each control participant without anesthesia. The words were repeated in varying sequences 10 times during a 30-min period with 3-s intervals by a male voice. The control participants were asked to count how many times they heard a certain word to ensure that they were listening and to prevent them from rehearsing the words.

Explicit Memory Test. Recall of intraoperative events and dreams was assessed 6 to 8 h later. The explicit memory was tested first, and the implicit memory immediately thereafter. The patients were questioned about their final memories before falling asleep, their initial memory on waking and if they had heard anything in between. They were also asked if they had dreamed.

Implicit Memory Test: Word Stem Completion. Patients and control participants were given a page containing the first three letters (e.g., Kam, Man, Sti, Tau) of the 68 words on the two lists and were asked to complete these stems with the first noun that came to mind containing at least four and at most nine letters. The experimenter (the second author) and the anesthetized patients did not know which of the two tapes was presented to the patients during anesthesia.

Statistical Analysis. The critical comparison regarded the rate with which the previously heard (primed) words were used as completions and the rate with which the 34 unheard (unprimed) words were given as completions. The statistical comparisons were done by a two-way analysis of variance on items with group (patients vs control) and word type (heard vs unheard).

Experiment 2. Presentation of Auditory Stimuli. Two audiotapes, each comprising two different stories, were prepared. On each tape one of the stories was a descriptive yet boring one (low context). The other story had an exciting theme with an unexpected happy ending (high-context; see appendix). We hypothesized that the high-context stories were likely to produce more priming than the low-context stories. With respect to other features such as length of the stories, length and structure of the sentences, number of content (nouns, verbs, adjectives, and adverbs), and function words (prepositions, conjunctions, and articles), all four stories were exactly identical. (The length of each story was 199 words: 78 content words and 121 function words.) The two tapes were thus comparable, only the context of the stories varied. The study and the control patients were exposed randomly to one of the two tapes, so that one half of each group was presented with one of the tapes. This was done in the same manner as in experiment 1. The stories were read in randomized order six times in period of 20 min. Each story lasted approximately 2 min and 30 s.

Explicit Memory Test. The question of explicit memory concerning intraoperative events was conducted in the same way and after the same time course as in experiment 1.

Implicit Memory Test: Reading Speed. For the reading speed task, the four stories were presented on a video monitor, one sentence at a time, in the following manner. Consider, for example, the sentence: Peter went to the zoo.

On the video monitor this sentence would initially appear as

xxxx xxx xx xxx xxx.

By pressing the space bar on a computer keyboard, the participant could reveal one word at a time, for example,

Peter xxx xx xxx xxx.

xxxx went xx xxx xxx.

This type of text presentation, called "the moving window," was introduced by Just et al.25 for neurolinguistic research. They compared several methods to present text and found that the reading time data produced by the "moving window" condition was comparable to eye-fixation data, which was obtained by monitoring the eye-fixations of participants during natural reading.

The patients were asked to read the four short stories of the two tapes aloud as quickly as they could and were told that they had to answer three questions at the end of each story, which also were presented on the computer screen. The four stories (two previously heard, two previously unheard) were presented in randomized order. The experimenter (author I.K.) and the patients did not know which stories he or she had heard before.

Statistical Analysis. The reading time for each word was recorded in a computer file. Reading times were collapsed over all function words and all content words. Data were tested using the Kolmogorov-Smirnov test.
Parametric statistics were used, with P values > 0.10 for patients and control participants. An analysis of variance model was chosen because of its ability to incorporate multifactorial designs. The design consisted of a group (patients vs. controls) as a between-subject factor, and repetition (previously presented vs. unpresented stories), story type (high vs. low context), and word type (function vs. content words) as within-subject factors. We hypothesized that high-context stories would benefit from the more coherent higher level representation of the story concept influencing the reading speed in a top-down manner. With regard to function and content words, we predicted that any decreases in reading speed resulting from postanesthetic effects would be more pronounced for the content words that carry the bulk of the information.

Results

In the postoperative interview, none of the patients reported any recall of words, stories, or intraoperative events. Two of the 60 patients, one from each experimental group, explained that they had indeed dreamed, although the content of their dreams was unrelated to the study items. Hemodynamic parameters remained stable during surgery, and extra boluses of propofol were needed only occasionally (table 2).

Experiment 1: Word Stem Completion Paradigm

Figure 1 shows the results. The controls gave significantly more words from the list that they had previously heard than from the list they had not heard (3.4 vs. 1.5 words of 34; P < 0.001). No such tendency was present in the patient group (1.8 heard, 2.1 not heard), so implicit memory for the words presented during anesthesia was not found. Statistically, the difference between the two groups was reflected in a group by word-type interaction (F(1.67) = 42.09; P < 0.001).

Experiment 2: Reading Speed Paradigm

Performance of the control participants for the comprehension questions at the end of the stories was virtually perfect and indicated that all had read and comprehended the stories. Figures 2A and 2B show the results. Because high- and low-context stories did not yield different results, these values are omitted. The stories that had been presented before were read more quickly by both groups (both 37 ms/word; F(1,58) = 8.15; P < 0.006). The group by repetition interaction was insignificant (F(1,58) = 0.00008). The control participants were significantly quicker than the patients during story reading (all four stories, controls: 502 ms/word; patients: 746 ms/word; F(1,58) = 16.93; P < 0.0001), indicating a general cognitive slowness of the patients after the operation. As expected from previous results, function words were read more quickly than content words by both groups (main effect of word type: F(1,58) = 66.16; P < 0.0001). However, the benefit of the function words was much more pronounced in the patients (156-ms difference compared with controls with a 49-ms difference), which yielded a group-by-word type of interaction (F(1,58) = 18.07; P < 0.0001). This interaction indicates that patients had disproportionate difficulties in processing content words (i.e., those words that carry the bulk of language information).
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![Graph A](image1)

**Fig. 2.** (A) Mean reading speed per a single word (the brackets show SEM). The previously presented (old) stories were read quicker than the first time presented (new) stories by both groups and reached significance by patients at \( P < 0.1 \) and by controls at \( P < 0.014 \) (analysis of variance [ANOVA]). (B) Mean reading speed for function words (prepositions, conjunctions, articles) and content words (nouns, verbs, adjectives). Function words were read faster than content words by both groups (ANOVA; \( P < 0.0001 \)); the brackets show SEM. The increased reading time of content words was more pronounced by the patients indicating their difficulties in processing the words that carry the bulk of language information.

**Discussion**

In the current study we found a clear effect of implicit memory on the reading speed task and word stem completion task in the control group, but implicit memory for acoustic intraoperative information was detected only on the reading speed measure. All patients were anesthetized with one standardized anesthesia technique for one type of surgery (lumbar disc removal). There were no signs of light anesthesia during surgery, and none of the patients reported any recall of words, stories, conversations, or other intraoperative events.

Our results for the word stem completion task clearly conflict with those reported in previous studies, because only positive results were reported by two groups of investigators for this task.\(^{11-13}\) Both groups found word stem completion to be a sensitive measure of implicit memory during various surgical procedures and anesthesia techniques. Some methodologic differences between our study and the previous investigations may account for our negative result in the word stem completion experiment. First, the tests were conducted in different languages. Although we are not aware of any other results using the word stem completion task in German, there seems to be no *a priori* reason why the lexical features of German should have precluded a positive result. Second, when designing the lists we took great care to enhance the chances of implicit memory by using only low frequency words, and only words that had initial sequences shared with at least five other words.\(^2\) Although implicit memory was demonstrated using these lists in our control group, the anesthetized patients might reveal more priming for common words.\(^{12}\) Third, a modality shift between the study and test phase might have somewhat attenuated an implicit memory effect. However, a modality shift was present also in the study by Block *et al.*,\(^{11}\) who did find a significant priming effect.

Further explanation of the discrepancy between the current and previous results can be found in the different anesthesia techniques. Block *et al.*\(^{13}\) used nitrous oxide (70 vol%) with only opiates or with isoflurane (0.7 vol%) in their first study or nitrous oxide with two concentrations of isoflurane (0.8 vol% or 0.5 vol%) and opiate boluses as needed in their second study during various gynecologic, abdominal, and other unspecified procedures. Anesthetic procedures similar to those included in Block *et al.*’s second study but with lower isoflurane end-tidal concentrations (0.25 to 0.50 vol%) and with atropine as the sole premedication were used during different surgical procedures in two studies by bonebaker *et al.*\(^{12}\) Even if the anesthesia was adequate by clinical standards (no conscious recall, no movements or autonomic sympathetic reflex responses to noxious stimulation), lighter anesthesia episodes might have been possible in the studies by Bonebaker *et al.* and Block *et al.* for two reasons. First, during opiate-based anesthesia the patients were shown to be wakeful.\(^{22}\) Second, nitrous oxide and relatively low concentrations of isoflurane alone or supplemented with opiate boluses might allow moments of arousal at least during

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*Although we are aware of the fact that one study has revealed more priming for common words, the general implicit memory literature (see Schacter* and Richardson-Klavehn and Bjork* for reviews) suggests better priming for lower frequency items.*

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major surgical procedures. The last argument is difficult to prove, because there is no practical tool with the possible exception of the processed electroencephalogram to predict or identify awareness during anesthesia.

Our anesthesia technique differed from the previous ones in two ways. All patients received oral premedication of 7.5 mg midazolam, which might have been sufficient to suppress implicit memory in the word stem completion task but not in the reading speed task. Implicit memory has been shown to be impaired by an intramuscular dose of 0.1 mg/kg as premedication and as a single agent of 0.05 and 0.1 mg/kg given intravenously in healthy volunteers. On the other hand, other investigators observed unimpaired implicit memory using midazolam as a sedation for dental surgery in boluses of 0.1 mg/kg given intravenously or as infusions in healthy volunteers. Together, the implicit memory effects of midazolam are unclear. The other difference was that not only the hypnotic agent (propofol) but also the analgetic agent (alfentanil) was given via continuous infusions, which might be more effective in preventing episodes of arousal caused by surgical stimulation. In fact, investigators recently showed that the propofol concentrations required for loss of consciousness are markedly reduced by a concomitant opiate infusion. Other groups of researchers, which have used similar total intravenous anesthesia techniques, have reported a low incidence of awareness. Nevertheless, only a few studies of implicit memory have been conducted using propofol infusions. In the absence of explicit memory, implicit memory was spared in patients after coronary bypass surgery, after surgical procedures with local or regional anesthesia, and in healthy volunteers. In these studies, relatively low infusion rates (1.27 to 3 mg·kg⁻¹·h⁻¹) were used mostly as a single anesthetic agent, which may contribute in part to the positive results. However, whether propofol and alfentanil can suppress implicit memory, and at which concentrations, is unknown and must be determined by future research.

Propofol, alfentanil, and nitrous oxide anesthesia may have a differential effect on the two measures of implicit memory. Although our anesthetic procedure effectively suppressed implicit memory on word priming, residual memory traces could be shown using the reading speed paradigm. This test has been used to demonstrate implicit memory to a far lesser extent than has the word stem completion test. Moscovitch et al. reported decreased reading times for previously presented sentences in young and elderly persons and in patients with memory disorders. Because only the first two groups could distinguish old from new sentences, the patients must have relied on implicit memory for their performance increment. Similar to the previous studies in persons with amnesia, we found an increased reading speed of previously presented material in patient and control groups. Richardson-Clavehn and Bjork have argued that we should distinguish between the measures of implicit memory and implicit memory per se. Different tasks can reveal different aspects of implicit memory, and dissociations similar to the one in our study have been reported elsewhere.

With respect to future research into implicit memory in anesthetized patients, not only the parameters concerning the implicit memory testing (number of stimulus presentations, stimulus-test modality, interval between presentation and the test, and so forth) should be standardized but also the anesthesia technique and, as far as possible, surgical stimulation. Because the interaction between these two factors may lead to episodes of awareness, even in the absence of hemodynamic or other clinical signs, it might be advisable to use target-controlled infusion pumps for total intravenous anesthesia techniques. These allow, at least theoretically, an individual titration of intravenous anesthetics to concentrations that are needed for surgery and loss of consciousness. Even if the pharmacokinetic and pharmacodynamic aspects of intravenous agents cannot be determined as precisely as that of inhalation agents, the wide clinical use and acceptance of intravenous anesthetic techniques justifies, in our opinion, their use in implicit memory studies as well.

We cannot explain, at this state of our research, why reading time, rather than word completion, showed priming for verbal information during anesthesia. Because the implicit memory research is so sensitive to a myriad of still unclear factors, further study to confirm our results of reading speed is needed. Furthermore, using the reading speed method, it will be possible to investigate further implicit memory by manipulating the verbal material.

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From the anesthetist's perspective, research on implicit memory in anesthesia should take advantage of the most sensitive measure available to tackle the more difficult and unsolved question in this field: What are the emotional and cognitive consequences of implicit memories for postoperative outcome?

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Appendix 1: The High-Context Story

Chris was not this anxious during the last robbery attempt. His mind was simply dimmed by the thoughts of the unimaginable amount of money and the life of paradise that would await him afterward. He had firmly decided to continue this dog's life no longer. He deserved a better standard of living and, if nobody was willing to give it to him, then he had to put it right on his own. Everything had been so simple. Only the horror on people's faces, a true tear of death, that Chris had never seen in this civilized country, had left a strong impression in his mind. On one hand, for the first time in his life, he had a feeling of power, yet on the other hand a feeling of compassion as well as bitterness tore at his insides. These thoughts dominated in Chris's head as his companion turned off the motor in the backyard of the bank. "Get out!" said his accomplice impatiently. They loaded their weapons, kept a lookout for the police, and moved toward the bank. The tension in the air stole their breath away. Suddenly, Chris stopped. His accomplice laughed: "You are scared?" Chris looked at him seriously, "I can't go any further."