4

Learning

In the area of learning, the committee chose learning during sleep and accelerated learning techniques as topics for consideration. The choice of these particular topics relates to the Army's desire to reduce training time. Clearly, benefits would accrue to an organization that is able to use sleeping hours for training and to speed the learning process during waking hours. This chapter investigates these possibilities, drawing on a variety of sources for its conclusions and conveying several interesting insights that may have practical implications.

LEARNING DURING SLEEP

If one simply looks at the best available past research on learning during sleep (see Aarons, 1976, for a remarkably thorough review), it is hard to imagine a more discouraging state of affairs. The learning of verbal materials presented auditorily during sleep appears to take place only to the extent that the presentation of the material triggers alpha-wave activity (an electroencephalographic indicator of arousal or wakefulness) in the learner. When all possible criteria are applied to verify that the learner is truly asleep, there appears to be no evidence of conscious recall or recognition of materials presented during sleep. Since about the mid-1970s, in fact, research activity on sleep learning has nearly expired, at least in this country.

New developments in our knowledge of memory, however, suggest that sleep learning deserves a second look. From an applied perspective, some of the positive demonstrations of sleep learning, dating back many years, possibly deserve an effort at replication. In 1916, for example, L.L. Thurstone was reportedly (Simon and Emmons, 1955) able to shorten the Morse code training of sailors by three weeks by giving additional training during the sleeping period. Such results tend to be dismissed since no EEG recordings were taken to verify sleep, but it may be that the costs of such training during the sleep period—in terms of disrupted sleep and the negative consequences therefrom on later waking efficiency—are minor compared with the benefits of accelerated training. Soviet research on sleep learning (see the background paper by Eric Eich, Appendix B) has apparently been carried out with less concern for whether pure learning during true sleep is possible and more concern for how such training might facilitate ongoing instruction.

From a theoretical perspective, sleep learning also deserves a second look (see Tilley, 1979). Viewed in the current context of research on human memory, one should expect only certain types of learning to take place during true EEG-verified sleep, and one should only expect that learning to show up on certain types of memory tests. The past negative results, in general, were obtained with presentation procedures that were inappropriate and with testing procedures that would be insensitive to any learning that did take place.

In our discussion of learning during sleep, we first reassess the possibility in terms of modern conceptions of human memory; we then look at potential applications of sleep learning, whether pure (during true sleep) or impure (during near sleep); and we conclude with an outline of the types of research projects that merit support. We do not, however, review past research on learning during sleep. As noted above, that research consists almost entirely of two types: (1) earlier research reporting positive results but lacking appropriate controls to verify sleep and (2) later research reporting negative results given verified sleep. The few results we do cite are used as illustrations. For an excellent overview of the current state of research in the field, we direct the reader to the paper prepared for the committee by Eich.

Other Types of Learning Without Awareness

There is an ongoing revolution in how researchers view the storage and retrieval processes that underlie learning. We have come to realize that there are different types of storage that might or might not take place as a consequence of a certain experience and that the presence of any such stored information may or may not influence later memory performance, depending on the way in which the memory is tested. Certain types of learning appear to be data-driven or stimulus-driven, that is, they do not require effort or intention or even awareness on the part of the learner, whereas other types of learning—those more familiar to us—are conceptually driven, that is they *do* require conscious effort, intention to learn, and active interpretation of the material to be learned.

In general, only conceptually driven learning is adequately measured by tests that require an active effort to recall or recognize the target information. Learning of the data-driven type may not show up at all on such tests, or it might show up in a pattern that would lead to the opposite conclusion one would draw from other, more appropriate ways of measuring it. It is learning of the data-driven type, measured in an appropriate way, that one might expect to take place during sleep, but past research on learning during sleep has focused on verbal learning of the conceptually driven variety.

Because some of the current distinctions being made in the human memory field are so critical to a reassessment of sleep learning, it is worth taking time to clarify and illustrate those distinctions in more detail.

Types of Knowledge

Although there are heated arguments about the details and about certain ambiguous cases, it has become common among researchers to distinguish among episodic, semantic, and procedural memories (see, e.g., Tulving, 1985). In brief, *episodic memory* refers to context-specific memory (What did you have for breakfast this morning? What did you do on your trip to Europe?); *semantic memory* refers to knowledge that is independent of context (What do Americans eat for breakfast? What is the capital of Switzerland? How much is 2 × 2?); and *procedural memory* refers to knowledge that underlies motor and cognitive skills, many of them automatized (such as speech, typing, bicycle riding, and possibly certain types of tacit knowledge, such as how a system works or a game is played). The important point is that these different types of memory appear to follow somewhat different rules in terms of the nature of their storage and the ways in which they are accessed. In some circumstances, in fact, there can be a complete dissociation among these types of memories. Amnesic patients, for example, often show "source amnesia," which is an inability to recall episodic information, while showing normal retention of the semantic or procedural knowledge derived from those episodes (see, e.g., Schachter and Tulving, 1982). Thus, an amnesic patient who is given practice every few days in a complex task (such as mirror drawing or solving "Tower of Hanoi" puzzles) may have no memory of the experimenter from one practice session to another, may need to have the task explained every session, but may nonetheless show a normal learning curve across practice sessions in the task itself.

There is evidence of dissociation in normal subjects as well. The spelling of a homophone such as *read* or *fairy* can be biased toward a less frequent interpretation (*reed*, *ferry*) by a question inserted in an earlier phase of the experiment ("Name a musical instrument that employs a reed"), or by a repeated presentation on an unattended auditory channel of an adjective-noun pair ("Catalina ferry"), even when subjects cannot demonstrate that they recognize that such a word occurred in the experiment (Eich, 1984; Jacoby and Witherspoon, 1982). Similarly, prior presentation of a word has been shown to enhance subjects' later ability to identify that word when it is briefly exposed on a tachistoscope, whether or not they recognize the word as one presented earlier (Jacoby and Dallas, 1981). Thus, an event may leave an impact on semantic memory that survives after the episode itself is apparently forgotten.

Measurement of Memory "Strength"

As the foregoing examples demonstrate, one cannot infer the effect of a given experience on memory (or the strength of the resulting memory trace) by any one measure, such as a test of recall or recognition. At least since Ebbinghaus's work in the late nineteenth century, we have known that the different traditional measures of learning (recall, recognition, time savings during relearning) do not always give the same picture of the amount of learning resulting from a given experience, but in recent years dramatic evidence has emerged that certain indirect but sensitive measures of memory may yield a picture that is entirely different than that painted by any of the traditional measures. An event in one's life that cannot itself be recalled or recognized at some later point may nonetheless change one's perceptual thresholds, may bias one's semantic or affective interpretation of a verbal item, may reinforce earlier learning (repetition effects), and may enhance later learning (priming effects).

An example, drawn from an experiment by Jacoby (1983), illustrates how one's conclusions can depend on how one measures prior learning. In the first phase of Jacoby's experiment, target words (such as COLD) were presented in one of three different ways: (1) they were generated by the subject based on a strong associate and a letter cue (HOT C_____), (2) they were simply presented together with the strong associate (HOT COLD), or (3) they were presented without any such associative context (XXX COLD). On a test of later recognition, COLD was best recognized as a word that had occurred earlier if it had been generated, next best if was presented with HOT, and worst if it was presented in the absence of a semantic context. If memory was tested by looking at the effect of prior presentation on subjects' ability to identify words exposed briefly on a tachistoscope, the exact opposite ordering of conditions was obtained. Thus, in Jacoby's experiment more than one type of learning took place when a target item was presented: stimulus-driven activation of the sensory features corresponding to the item in memory and conceptually driven associations of the item with both semantically related items in memory and the experimental context. Recognition performance is sensitive primarily to the latter; perceptual identification is sensitive primarily to the former. Thus, the nature of the original learning determines what type of later test will reveal that learning. For a complete discussion of alternative measures of memory, see Richardson-Klaveher and Bjork (1988).

Remembering With and Without Awareness

The kinds of experiments summarized above illustrate a further important point. As Eich puts it, ". . . it is possible to distinguish the effects of *memory* for prior episodes or experiences on a person's current behavior from the person's *awareness* that he or she is remembering events of the past." Viewed from that perspective, people might learn something from material presented during sleep but not know that such learning took place, either in the sense of being able to recall the target information or to recognize that it had been presented.

Looked at within the conceptual framework outlined above, the failure of past experiments to find evidence for learning during EEG-verified sleep is not surprising. The types of learning one might expect to be possible during EEG-verified sleep are the following:

1. Lowering of perceptual thresholds or improved pronunciation of items presented during sleep, or both.
2. Semantic or affective biasing in postsleep interpretation of verbal items in a direction determined by the semantic or affective context in which those items were embedded when presented during sleep.
3. Repetition effects (i.e., when material studied before sleep is presented again during sleep and postsleep recall of that material is enhanced, even without the learner's being aware that the material was presented again).
4. Priming effects (i.e., when presentation during sleep of material to be learned after sleep increases the rate at which the material is learned, again without the learner's being necessarily aware that the material had ever been presented before).

POTENTIAL APPLICATIONS OF LEARNING DURING SLEEP

From a theoretical perspective, researchers agree that a rigorous demonstration of learning during sleep should have the following properties: (1) prior to sleep subjects should not be informed of the purpose of the procedures to be employed during sleep; (2) the material to be learned should be unique in that it occurs only during the sleep period; and (3) EEG recordings should be taken, both to ensure that presenting the material did not arouse wakefulness and to ensure that the material was not presented when the subject was already in a state of arousal or wakefulness.

From an applied perspective, however, these restrictions eliminate many of the procedures that would seem to hold the most promise for actually using sleep learning in practical contexts. Rather than keep people from knowing the purpose of the procedure to which they are to be subjected, for example, it may be important not only to reveal the purpose, but also to systematically administer some type of presleep training as well. As Eich points out in his review, one may need to learn how to learn during sleep. Procedures analogous to those inducing hypnotic suggestibility may be useful, training early in one's life might lead one to develop the ability to learn during sleep, and so forth. There may be presleep procedures that can prime subsequent learning during sleep. There does not, after all, seem to be much doubt that presleep events and state of mind can bias the nature and content of one's subsequent dreams.

Requirements 2 and 3 above are also, from a practical standpoint, misguided. Rather than have the material to be learned during sleep be unique to the sleep period, most of the potential applications of sleep learning involve its use to enhance the acquisition of material that is part of the waking curriculum. Similarly, the requirement that material presented during the sleep period not disrupt sleep or be presented during periods of wakefulness or arousal may exclude procedures of practical significance, as illustrated in the section below on applications of sleep-disrupted learning.

It remains to be demonstrated that certain types of stimulus-driven learning are possible during EEG-verified sleep. In the section below, we assume that such learning is possible.

Applications of Learning During Verified Sleep

As should be clear from the foregoing discussion, the type of application that does *not* make sense is to try to produce active postsleep recall of verbal materials presented only during sleep. The real potential of learning during sleep lies in reinforcing the learning that occurs during the waking hours. Such reinforcement would consist in part of re-presenting during sleep material learned earlier and in part of presenting during sleep material to be learned later (priming). The 1916 Morse code experiment discussed earlier is a good case in point. We do not know how much of the materials presented during sleep occurred during verified sleep, but the nighttime presentations no doubt did both of the above, that is, repeated prior learning and primed upcoming learning.

It is worth noting that an important aspect of learning Morse code—learning to recognize units in rapidly presented code—corresponds primarily to stimulus-driven learning. In general, vocabulary learning, broadly conceived (i.e., including coding systems as well as foreign language vocabulary), may be a fruitful domain for the application of learning during sleep. Nighttime presentations could reinforce daytime learning in the two senses specified above and might also facilitate perceptual fluency and speech production. Language learning involves an interaction of stimulus learning—building acoustic units—and conceptual learning—associating those units with semantic representations.

Another domain in which learning during verified sleep might apply is in altering attitudes, affective reactions, or mood. A study carried out by LeShan in 1942 is a good example, although we do not know how much of the learning in LeShan's study occurred during true sleep. The subjects were chronic fingernail biters. For 54 nights, without being informed of the purpose of the study, they were presented with a recording of the phrase "my fingernails taste terribly bitter" 300 times per night. According to LeShan's report, 40 percent of the subjects stopped biting their nails. The apparent change in attitude induced in those subjects is illustrative of the potential that learning during sleep might have in that domain.

Should it prove possible to influence attitudes, emotions, and other types of affective reactions via nighttime recordings, then it is not difficult to think of many applications, although some of them would be inappropriate on moral grounds. It is an intriguing possibility that some learning procedures might be *more* effective in changing subjects' attitudes during sleep than during waking hours; it seems unlikely, for example, that LeShan's procedure would have been as effective had it been carried out on awake subjects.

Applications of Disrupted-Sleep Learning

Should it turn out that learning during true sleep is not possible, there may still be some significant applications of learning procedures carried out during the night. Even if such procedures disrupt the quantity or quality of sleep, their benefits might outweigh their costs. In the Morse code study discussed above, for example, the reported benefits were a three-week reduction in the amount of time the subjects (sailors) took to reach the required level of performance (compared with sailors who did not get the additional Morse code training during sleep). The costs of the sleep-learning procedure, in terms of decreased waking productivity owing to disrupted sleep, may have been minor compared with the benefits.

Looking at sleep-learning procedures from a cost-benefit standpoint suggests potentially significant applications of dynamic sleep-learning procedures. Since an individual goes through cycles of the various stages of sleep (as indexed by the pattern of EEG activity), some of which correspond to semiwakefulness or higher arousal, or both, the presentation of material could be programmed to occur during the natural arousal cycles. Not only would the acquisition of the material to be learned be most effective, in all likelihood at such times the cost in sleep disruption would be minimized because those periods of arousal were not caused by the procedure. Such programming of sleep learning could potentially be carried out automatically. It would seem technically feasible for a single apparatus to monitor a sleeping subject's EEG and to trigger the presentation of material during periods of arousal.

In general, sleep-disrupted learning might be especially effective in terms of enhancing later retrieval of the target information when the subject is exhausted or deprived of sleep, or both. As Eich points out, one of the difficulties of demonstrating learning during sleep is that the learning that takes place may be largely state-specific. Sleep, especially the profound sleep of the deeper stages (stage IV and REM sleep), is a special state both mentally and physically. Learning that takes place in that state may not transfer well, if at all, to states of full alertness and wakefulness. The natural cycles of semiwakefulness during the night, however, must share many properties with the states of drowsiness and semisleep that accompany exhaustion and sleep deprivation. Sleep-disrupted learning might therefore enhance later memory performance in a sleep-deprived waking state. Since cognitive performance deteriorates under sleep deprivation, such potential transfer of training during sleep may help the subject when he or she needs it most. With the technical advances that facilitate nighttime fighting, sleep management and performance under sleep deprivation are going to be ever more significant problems in the round-the-clock military engagements of the future, so the potential of such an application could be quite significant. There is a need to demonstrate, however, that the specific procedural skills critical to nighttime fighting are amenable to enhancement by sleep training.

Direction and Design of Future Research

The committee concludes that sleep learning as a technique to enhance or speed training deserves a second look. An appropriate second look requires both basic research, designed to clarify whether some variety of stimulus-driven learning is possible during EEG-verified sleep, and applied research, designed to explore whether the benefits of sleep-disrupted learning outweigh the costs associated with disrupted sleep.

Research on Stimulus-Driven Learning During EEG-Verified Sleep

In terms of the potential applications of learning during sleep and in terms of what other research options are most fruitful to pursue, it is of central importance to know whether there exists any type of learning during sleep. Toward that end, rigorous research should be carried out incorporating the usual EEG controls to verify that the material to be learned is presented during true sleep (without disrupting that sleep), but with a critical change from earlier experiments (see Tilley, 1979): the measures of learning should have been shown to be sensitive to stimulus-driven learning rather than to active recall or recognition. The appropriate measures are those discussed earlier: priming of postsleep learning, repetition of presleep learning, postsleep perceptual identification of logical items presented during sleep, biasing of postsleep semantic or affective interpretation of items presented in a biasing context during sleep, and so forth.

Should it prove possible to achieve such stimulus-driven learning without the subject's awareness, then a whole new domain of possible applications and additional basic research questions will arise. For example, can attitudes be altered by sleep-learning procedures? Is bone conduction a better vehicle than air conduction for presenting auditory information during sleep? (Eich suggests that it may be, because bone conduction "has the curious effect of shifting the phenomenal source of speech from the outside to the inside of one's head.") These and a variety of other questions, many of them outlined in Eich's paper, become important questions should it be possible to achieve stimulus-driven learning during verified sleep.

Research on Sleep-Disrupted Learning

Even if the outcome of the basic research recommended above were to be negative, it may be important to test the feasibility of certain applications of sleep-disrupted learning. Does sleep-disrupted learning transfer in positive ways to postsleep states of exhaustion and sleep deprivation? Can sleep-learning repetition or priming of information that is part of the normal training of a soldier facilitate that training to the extent that it offsets any detrimental effects of the sleep-learning procedure? Is it technically feasible to build an apparatus that would both monitor a soldier's sleep-state EEG and present, possibly via bone conduction, information to be learned when a certain specified EEG pattern is registered?

If one focuses not on the theoretical possibility of learning during true sleep but on the practical purposes it may serve to use the hours a subject is asleep (whether superficial or not) to achieve learning, then the foregoing questions and a variety of related questions merit research. The committee feels that it is important to conclude on a note of caution. The kinds of EEG-verified sleep learning that may be possible may have limited applicability to the kinds of learning that are important to the Army, and the costs of disrupted-sleep learning may outweigh the benefits. A substantial commitment of funds to an actual sleep-learning program should await clear positive results from the kinds of research programs we suggest above.

Sources of Information

In addition to drawing on the relevant knowledge of its members, the subcommittee on sleep learning commissioned a review paper by Eric Eich, arranged a special briefing by LaVerne Johnson, chief scientist at the Naval Health Research Center in San Diego, and benefited from presentations given by military officers at Fort Benning, Georgia. Eich's paper provided a useful interpretation of sleep learning within the context of present-day theories of human information processing and memory. Johnson's talk provided a historical context for the research by tracing its development from the earliest known studies by Thurstone in 1916 to the present. And exposure to the varieties of training at Fort Benning alerted the committee to the special demands placed on soldiers to perform important jobs while in states of exhaustion and sleep deprivation.

ACCELERATED LEARNING

With respect to the goal of accelerating the learning process, that is, increasing the rate or depth, or both, of learning beyond that characteristic of typical training in a given task, three types of research are relevant. First, basic research on human beings as learners is crucial: knowing the basic characteristics of human attention, of the storage and retrieval processes that underlie human memory, and of the representation of knowledge and procedural skills in long-term memory provides a framework for examining practical techniques that are or are not likely to accelerate learning.

The other two areas of research are related to each other: research on the characteristics of effective instruction, and research on effective learning strategies on the part of the learner. The first of these more applied research domains focuses on the skills, techniques, and knowledge the instructor can bring to the training situation; the second focuses on the strategies the learner can bring to the training situation to accelerate the learning process. The fact that efficient learning strategies may be transmitted from the instructor to the learner is only one of the ways in which these two research domains are related.

We focus in this section on accelerated learning programs that attempt to provide a system for addressing instructor and student variables together. It is a working assumption of such programs that one must look at teacher-learner dynamics as a whole. The paper written for the committee by Robert E. Slavin, "Principles of Effective Instruction," is a good characterization of research on the instructor's contribution to the learning process, and a recent chapter by Weinstein (1986), "Assessment and Training of Student Learning Strategies," is a good treatment of the potential contribution of the learner. Textbooks such as Anderson (1981) and Glass and Holyoak (1986) do a good job of capturing the current status of basic research on human beings as processors of information.

Packaged Programs for Accelerated Learning

Accelerated learning methods are a class of techniques using unusual methods of instruction with the intent of substantially increasing the speed of learning. The techniques are referred to by the names Suggestive Accelerative Learning and Teaching Techniques (SALTT), Suggestopedia, and Superlearning. The approach employs a combination of physical relaxation exercises, guided imagery, a suggestion of efficient learning, a belief in tapping mental reserves, and an alternation of active and passive review (generally with baroque music). The techniques have been popularized in the press in *Psychology Today* (August 1977), *Parade* magazine (March 12, 1978), and a popular paperback, *SuperLearning*, by Ostrander and Schroeder (1979). Schuster and Gritton (1986) provide a textbook for SALTT procedures that includes a review of studies supporting the approach. There is an international society (Society for Accelerative Learning and Teaching), which holds an annual meeting that draws about 500 participants. The society publishes a journal, the *Journal of the Society for Accelerative Learning and Teaching*, which was begun in 1975. The journal contains testimonials, evaluation studies, and reviews of SALTT techniques and research.

The SALTT approach developed as an outgrowth of presentations and writings by Georgi Lozanov of Bulgaria. His dissertation and public presentations attracted attention in America in the early 1970s (see

Bancroft, 1976). Lozanov describes himself as a psychotherapist who was known as a hypnotist for 10 to 15 years and who has a strong interest in pedagogy. His techniques have been applied in several Eastern bloc countries. Many Western advocates of accelerated learning have studied with Lozanov and have adopted his methods of instruction.

Some proponents of the SALTT approach make wide-ranging claims of extraordinary learning rates. Lozanov (1978:27) claims "memorization in learning by the suggestopedic method is accelerated 25 times over that in learning by conventional methods." Ostrander and Schroeder (1979:15) report claims that Suggestopedia increases learning:

> . . . from five to fifty times, increases retention, requires virtually no effort on the part of students, reaches retarded and brilliant, young and old alike, and requires no special equipment. And people testified not only had they learned a whole language in a month, or a semester of history in a few weeks, they rebalanced their health and awakened creative and intuitive abilities while they were learning their facts.

In a discussion of techniques, Wenger (1983:89) claims "the first dozen methods [of accelerated learning] consistently yielded a rate of apparent acquisition of conceptual learning several hundred times greater than that found from conventional methods."

With such strong endorsements, one would hope to find many studies showing impressive learning gains. However, after ten years of informal research, there is little scientific support for even the mild claims of two- to threefold improvements made by some of the more pragmatic proponents (Schuster and Gritton, 1986). Lozanov's empirical studies reported only a 20 percent improvement. In controlled experiments using the same teacher with extended study utilizing SALTT procedures, modest improvements are reported relative to controls, for example, 10 percent improvement in learning German (Gasser-Roberts and Brislan, 1984); 25 percent improvement in learning English as a second language (Zeiss, 1984). A number of quasi experiments report that students can learn comparable information in one-third the time (see Schuster and Gritton, 1986); however, most of these demonstrations suffer from a number of confounding factors (see below).

SALTT procedures exploit a number of traditional (e.g., spacing repetitions) and nontraditional (e.g., review with music) procedures in a conglomeration of techniques to improve learning. SALTT provides a packaged program with specific techniques to deal with student motivation, instructor motivation, instructor training, and presentation of material. By dealing with the multiple aspects of instruction, SALTT techniques may enhance the instructor's ability to keep students motivated to perform, to remain engaged in the task, and to provide material at an appropriate level. In his background paper, Slavin faults many traditional instruction procedures (e.g., computer-based instruction, self-study) for emphasizing presentation of material at the appropriate level while ignoring the factors of motivation, engaged time, and instructional quality. The conglomeration of techniques typical in any SALTT experiment, however, makes it difficult to distinguish between essential and nonessential aspects of SALTT.

SALTT seeks to change instructors' attitudes, expectations, and behaviors to produce better instruction. In general, it is difficult to change the behavior of practicing instructors, although the suggestion-sales techniques employed by SALTT instructors may motivate some of them to alter their teaching behavior for the better.

THE SALTT CLASSROOM

A SALTT classroom includes features that are not present in the traditional classroom. The environment is a pleasant living room–lounge atmosphere with comfortable chairs rather than rows of desks. This setting is intended to provide a relaxed, comfortable, and nonthreatening learning environment. The instructor encourages the interaction of the entire class through the use of positive reinforcement, relaxation, and confidence-building techniques.

Schuster and Gritton (1986) provide a detailed account of the components of a SALTT class session. A session includes three major components: preliminaries, presentation, and practice. Rather than focusing on content material for an entire session, a significant period of time is spent performing relaxation, suggestion, and restimulation exercises.

The preliminary phase (about 10 percent of the class time) relaxes the students and prepares them to absorb new material. This involves mild physical relaxation exercises such as stretching. Next, students perform a mental relaxation task (e.g., watching their breathing) to take their minds off their day-to-day problems and attend to the teacher. Thereafter teachers perform a "suggestive setup" to convince students that the learning will be fun, easy, efficient, and long-lasting. Students use guided imagery to recall a pleasant learning experience (e.g., Remember how you felt on your best-ever English test? Who was the teacher? How did your stomach feel?). These procedures might take three to ten minutes of an hour-long session, with more time required for the first two sessions.

The presentation phase (about 40 percent of the lesson) presents the material in a dramatic, dynamic way and then reviews it passively with background music. This phase has three components. The first, preview, gives the student the big picture, providing advanced organizers as to how the current lesson fits into the entire course and the specific behavior objectives of the lesson (Ausubel, 1960). The preview typically requires only a few minutes. The second component, dramatic presentation, presents the material in a dynamic way. Students are strongly encouraged to make vivid images relating to the material to be learned. They generate images on their own and actively deal with the material. For example, to learn programming, they imagine themselves as a computer sequentially executing instructions. This component might take 20 minutes of a class. The third component involves passive review with music. The instructor rhythmically repeats key material while playing baroque music in the background. The rhythm of the words and the sound of the music are assumed to produce a special mental condition that accelerates learning. This might encompass 15 minutes of an hour-long session.

The third phase of a SALTT session is practice, which entails 50 percent of the lesson. There are three components. The first, activation of the knowledge, involves using the knowledge described in the presentation phase. For example, in a foreign language class, there might be a choral reading of the material. The second component is elaboration, which involves having the student use the material in new and different ways. In a foreign language class, students are given foreign language names and perform interactive procedures such as ordering a meal in the new language. Error correction is often indirect (e.g., the teacher does not say that a foreign phrase was wrong but rather immediately uses the phrase correctly). The third component is the use of frequent quizzes. The questions generally assess information that has been presented several times. The students are provided the answers to the quizzes and scores are generally not used to determine class grades.

THE EVIDENCE

Assumed Theoretical Support

A variety of physiological and clinical phenomena are cited as support for SALTT (see Lozanov, 1978; Schuster and Gritton, 1986). There is an assumption that whole-brain learning produces integrated brain activity coordinating left brain, right brain, and subcortical activity. The hemispheric specialization is cited to suggest that the whole brain should be used to increase learning. Evidence is also cited that music and subjects' mental activities alter EEG activity. There is no direct evidence, however, that these brain phenomena can substantially enhance learning. Relaxation is also assumed to produce better learning; however, the psychological evidence on this is weak and better supports the view that optimal levels of relaxation occur when the subject is in a normal state (e.g., tense individuals learn better in normal tense states—Schuster and Martin, 1980). The research on expectancy effects is cited as evidence for the use of suggestion techniques. In their paper prepared for the committee, Monica J. Harris and Robert Rosenthal show that positive expectations to learn can result in more positive assessments of performance. One must be cautious, however, in assuming that these placebo techniques will work in situations in which subjects receive extended exposure to positive expectations.

Support for Traditional Instructional Components

The majority of the time in a SALTT classroom is spent in activities that are typical in the classrooms of expert teachers and have substantial psychological support. Although 10 minutes of a SALTT class session may be occupied with nontraditional tasks (relaxation exercises and review with music), perhaps 50 minutes are spent engaged in component tasks (elaboration, generation, imagery, repetition, and frequent testing) that clearly benefit instruction in standard laboratory experiments.

Generation and Elaboration. A SALTT class session typically presents fewer instructor-generated elaborations of the material and encourages more student-generated elaborations. Research in reading comprehension indicates that students benefit little from author-generated elaborations, and such elaborations may even impede the learning of facts. In contrast, student-generated elaborations enhance learning (see Reder, Charney, and Morgan, 1986). For example, in ten studies Reder and Anderson (1980, 1982) found that students who read author-elaborated chapters from college textbooks did consistently worse than students who read only the chapter summaries, which were one-fifth as long. From this perspective, the SALTT strategy of presenting a short preview, dramatic presentations and review (during the presentation phase), followed by an extensive practice phase involving student-generated images and elaborations is likely to be superior to a single presentation by the instructor with extensive instructor-generated elaborations. Study of the "generation effect" (e.g., Slamecka and Graf, 1978) has shown that students learn far more by actively generating answers (e.g., solving simple anagrams) than by passively reading or listening to material.

Spacing of Repetitions. SALTT lessons repeat material more frequently and with substantial spacing relative to typical college courses. Critical material is presented during the presentation, review, activation, elaboration, and test phases of the experiment. The literature on spacing and repetition effects (e.g., Crowder, 1976, Chapter 9; Landauer and Bjork, 1978) shows that long-term memory can be greatly increased by repeating the material under optimal spacing conditions rather than presenting it once or under massed conditions.

Imagery. SALTT procedures emphasize the use of imagery. Imagery has long been employed by mnemonists (Luria, 1969) and can generally improve long-term memory for concrete objects (Paivio, 1971; Paivio and Desrochers, 1979).

Songs and Rhythm as Mnemonic Devices. The use of song and rhythm has been shown to improve recall. In a SALTT foreign language class for lawyers, students sing the elements of a contract (Stockwell, 1986). The rhyming information embedded in such songs provides an extra cue that may facilitate learning.

Cooperative Learning. SALTT classes frequently break up into groups in which students cooperatively utilize the material. Cooperative teaching has been shown to be effective in enhancing instruction in the educational literature (Danserean, 1986; Slavin, 1983, and the paper prepared for the committee).

Advanced Organizers. SALTT instructors are encouraged to present "advanced organizers" to give students an overview of how the material to be learned relates to previous material. Advanced organizers have been shown to enhance the learning of reading material (Mayer, 1979).

Tests as Motivational Devices and Learning Events. SALTT instructors employ daily quizzes. Frequent testing has long been recognized as a factor in maintaining subject effort in animals and humans (e.g., Adams, 1980). But SALTT procedures do not overdo testing, as is frequently done with programmed instruction. When tested too often, students are encouraged to read passively, forfeiting the benefits of generation and elaboration.

Review of the SALTT Learning Literature

There is an extensive published literature on accelerated learning techniques (at least three major books and over 2,800 pages of journal articles). Unfortunately, the majority of the work involves testimonials with little quantitative data (e.g., in a review of the field, L.L. Palmer, 1985, found that only about half the studies report statistics). Testimonials can be useful to identify hypotheses, but any hypothesis must be viewed as tentative until it is verified with experimental procedures employing control groups with random assignment of subjects. The history of the use of bloodletting in early medicine illustrates the danger of accepting testimonial evidence (see also Chapter 9 and the paper prepared for the committee by Griffin).

Testimonial Evidence. Testimonial evidence is often cited to show that SALTT procedures can overcome learning barriers (Schuster and Gritton, 1986). Klockner (1984) cites as an example teaching adult Vietnamese women to learn English as a second language. In Vietnamese culture, elderly women are given a position of respect and are expected to show wisdom in their actions; they are not expected to make errors. To learn a new language, however, one *must* make errors. An unwillingness to make errors is a serious barrier to learning a language. Bringing Vietnamese women into a strange environment (e.g., relaxation exercises, classical music, performing skits, having different names) reduces the barriers, allowing the apprehensive student to practice, and through that practice, to learn the language. Musical suggestive techniques may be helpful in counteracting certain phobias (e.g., math or computer anxieties) that inhibit learning in problem populations. An individual with a strong phobia may learn little in a traditional class; treating the phobia may greatly accelerate his or her learning. Klockner reports a fivefold improvement in learning for her students. Given that a student may be unwilling to practice in a traditional classroom, and hence learning may be near zero, proportionally large improvements may occur.

Confounding Factors. Almost all the experimental studies of SALTT are confounded by the motivated teacher effect. An extensive study by Schuster and Prichard (1978) illustrates this. An experimental group of 16 teachers had enrolled in a SALTT teacher improvement workshop that required up to 120 hours of class time. The control instructors were selected from comparable (matching procedure unspecified) instructors in similar classes that did not sign up for teacher training workshops. At this point the study was already flawed. Instructors who volunteer for 120 hours of instruction are already likely to be more motivated to teach well. At the end of the first year of classroom teaching, three of the instructors did significantly better than their controls; three did worse. It is surprising and disappointing that any teacher training program involving so much instruction did not improve performance in the first year. In the second year, six of the instructors were dropped from the study, primarily because they were unwilling to put in the full effort to execute a SALTT lesson. At this point, seven of the ten remaining SALTT instructors showed significantly better teaching performance than did their controls. However, given the selection effect, one cannot attribute these results to the use of SALTT procedures.

The motivated instructor effect is also a problem when the same individual teaches with and without SALTT (e.g., Gasser-Roberts, 1985), if the instructor believes that the SALTT procedure is superior. The belief alone can produce better teaching (see the Pygmalion effect discussed by Rosenthal and Jacobson, 1968).

Studies of SALTT are also difficult to interpret because of the possibility of a Hawthorne effect, that is, when people realize that they have been chosen for observation, they typically perform better. The Hawthorne effect refers to results of a study conducted at the Hawthorne Plant of General Electric, where engineers tried to find the optimal light level for maximizing productivity. It was found that increasing the light level, decreasing the light level, or just measuring it improved performance. A study by Knibbeler (1982) suggests that the Hawthorne effect may be a confounding variable. He had seven instructors teach using either Suggestopedia or the silent way. (The silent way is almost the opposite of SALTT: students are presented the language with little chance for verbalization and few repetitions in a tense environment in which learning is expected to be hard work.) Both methods improved instruction equally, and only the instructor variable was significant.

Weak Designs and Questionable Interpretations. SALTT proponents frequently claim to have demonstrated more efficient learning by shortening class time and showing comparable performance. For example, Schuster (1976*a*) taught students with two hours of lectures per week compared with six hours in the control conditions. He found that the groups were not significantly different. One must be very cautious in interpreting such studies. First, the comparisons did not include nonclass study time, which, if equivalent (at the rate of two hours per original course hour), might reduce the ratio from 3:1 to 1.3:1. Second, almost all human learning is negatively accelerated, that is, the marginal utility of additional study time is reduced with practice (e.g., Newell and Rosenbloom, 1981). Hence reducing study time by 50 percent is expected to reduce performance by less than 50 percent. Third, most performance tests do not represent ratio or even interval scale data (e.g., it is generally easier to learn enough to go from 0 percent to 10 percent correct than to go from 90 percent to 100 percent correct). Hence a reduction in learning time may not be proportionately reflected in performance scores. Fourth, when trying to show no difference in learning, one must be careful to use a statistical test with sufficient power. With very few subjects or high variability, no learning manipulation will cause a significant difference. Schuster (1976*a*) interpreted his findings as nonsignificant. The results actually showed a strong trend in the opposite direction, namely, that the SALTT students performed substantially worse (t = 1.96, df = 49, $p < .06$ level in a two-tailed test; $p < .05$ in a one-tailed test). It would be prudent to assume that, had additional subjects been run, the effect would have been significant; hence the interpretation of nonsignificant differences is inappropriate.

One must be careful when extrapolating short-duration studies to long-duration training programs. For example, in a 15-minute learning study, Borden and Schuster (1976) found that SALTT-taught students recalled 2.5 times as many paired associates as controls. The experiment used students in an introductory psychology subject pool, who are required to spend several hours as subjects in order to satisfy a course requirement. They are often poorly motivated to perform well in an experiment. Unusual procedures such as SALTT can motivate them to perform well for short periods of time. However, if the same procedures are employed over many hours, as in a normal classroom, they may not maintain this superiority. In a study examining SALTT over multiple sessions, Schuster and Wardell (1978) found no benefit of Suggestopedic features after the first hour, suggesting that gains may be short-lived.

The evidence of benefits from the nontraditional components of SALTT procedure is weak. A number of experiments in which the specialized SALTT procedures were deleted showed little performance change (see reviews by Alexander, 1982; Schuster and Gritton, 1986). Schuster and Wardell (1978) removed the suggestive positive atmosphere, recall of a positive learning experience, dramatic presentation and relaxation, and imagery components of the task: only the elimination of imagery reduced performance. Lozanov (1978) has claimed that accelerated learning does not require physical relaxation. His own data show memorization is not enhanced by background music. Recent studies have found little effect of music (Alexander, 1982) or the elimination of dramatic presentation and music (Schuster, 1985). It should be noted that earlier short-duration studies (three minutes' learning time per music segment) did show an advantage for music of 15 to 24 percent during vocabulary learning (Schuster and Mouzon, 1982). Although the use of suggestion can modify the EEG activity to increase the generation of alpha activity, this does not appear to enhance learning (Schuster, 1976*b*). Reducing stress, relative to normal classroom levels, does not enhance learning in general; rather, it helps low-stress (baseline) individuals and hinders high-stress (baseline) individuals (Schuster and Martin, 1980).

Independent Evaluations

There are few independent evaluations of accelerated learning, and these do not support claims that SALTT substantially enhances performance of normal students. The SALTT Society instills in its practitioners a belief that they will change the world (this comment was frequently made by attendees of the 1986 annual meeting), and many practitioners have a commercial interest in promoting the techniques. Such zeal can bias the execution, evaluation, and reporting of results. Scientists accept results more readily when they are obtained by neutral or even skeptical investigators.

One study by non-SALTT proponents was carried out by the Army Research Institute at the Defense Language Institute Foreign Language Center (DLIFLC) (Bush, 1985). Forty students were randomly assigned to either a Suggestopedia or a traditional instructional class to learn Russian. The Suggestopedia section was taught by a Suggestopedia instructor from a commercial firm, the standard class by DLIFLC instructors. The Suggestopedia section met for 10 weeks, whereas the traditional section met for 15 weeks. The Suggestopedia group performed significantly worse on written (45 percent) and speaking (20 percent) tasks, with a weighted score that was 40 percent less than the control subjects.

In another study published by non-SALTT practitioners, Wagner and Tilney (1983) examined learning in a traditional classroom using a SuperLearning tape, with the instructor varying voice quality as suggested by SuperLearning (Ostrander and Schroeder, 1979). Students learned a 300-word German vocabulary over a five-week period. They found the SuperLearning group learned 50 percent less material than the standard classroom group, even though they had comparable class time. Schuster and Gritton (1986:40) fault this study for not utilizing all the elements of SALTT to see the interactive effects. This is a valid critique, although it is discouraging that the most unique component of SALTT (the music review) produced such poor acquisition. One must be cautious in evaluating negative instances of SALTT procedures used in SALTT experiments, for the negative results are generally also confounded by factors such as the instructor effect.

Direction and Design of Future Research

Accelerated learning procedures provide packaged educational programs that incorporate traditional and nontraditional instructional elements. There is little evidence that the modest empirical benefits of SALTT instruction are derived from the nontraditional elements. Accelerated learning approaches deal with multiple aspects of instruction, including teacher motivation, student motivation, material presentation, elaboration, and assessment. This attempt to deal with the whole range of instructional issues is not typical for most instructional interventions (e.g., computer-assisted instruction).

The evidence available, however, does not suggest that the application of packaged accelerated learning programs will greatly benefit Army training. The nontraditional elements (e.g., relaxed environment with very positive instruction) are somewhat at odds with traditional instructional styles.

The Army can, however, distill components of cognitive psychology and accelerated learning to apply them to Army training. It should monitor and support research to identify procedures that reliably enhance learning. Additional basic research is needed to produce guidelines for instruction (e.g., how often should a component skill be practiced, with what spacing and elaboration, to be useful a year after the training course ends?). It is important that new procedures evaluate the interaction of quality of instruction, practice, study time, motivation of the learner, and matching of the training paradigm to the job demands. In addition, the Army should evaluate its own training programs to identify the transferrable elements of effective instruction to other instructors and training procedures.

The formal evaluation of competing training programs is an expensive procedure and should generally not be undertaken unless: (1) there is reliable laboratory evidence that the new techniques produce a benefit; (2) the techniques can be taught to Army instructional personnel; (3) there is reason to believe the techniques can be cost-effective; and (4) the evaluation is done with sufficient care to either significantly enhance our understanding of the approach or provide decision makers information that allows them to determine the applicability of the approach based on the new data. Nonlaboratory evaluations should be carried out by researchers who are not promoters of the techniques. The relative effectiveness and benefits of new training techniques should be made available to the providers of instructional material and to instructors.

This information should be presented in a manner that can directly influence training activities (e.g., guidelines for different types of lessons, computer procedures that can directly influence pedagogy, spacing, and repetition of new material).

It is unlikely that new techniques will increase learning rates by a factor of ten, as some approaches suggest, but careful application and extension of cognitive science and instructional principles could bring about a substantial enhancement of training effectiveness.

Sources of Information

The subcommittee on accelerated learning focused its work largely on a particular learning package referred to as Suggestive Accelerative Learning and Teaching Techniques (SALTT). Our conclusions are based on reviews of the SALTT literature (published in the *Journal of the Society for Accelerative Learning and Teaching*) and on basic research in the area of effective instruction. Additional information about SALTT was obtained from practitioners and researchers at the annual meeting of the Society for Accelerative Learning and Teaching in April 1986. Two papers prepared for the committee (see Appendix B) were very useful: Slavin provided a thorough review of literature on the teacher's contribution to effective instruction, and Harris and Rosenthal provided an evaluation of the likely contribution of expectations to learning in a SALTT environment.