

A Routledge FreeBook

WHEN MEMORY FAILS



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INTRODUCTION

WHEN MEMORY FAILS

Dear Academic,

Welcome to *When Memory Fails*, from [Routledge Psychology](#). This FreeBook discusses the ways that memory can fail us, starting with neurodegenerative disorders like Alzheimer's disease, to everyday forgetfulness and even looking at false memories and why they matter.

The first chapter is taken from the 3rd Edition of [Memory](#), by Alan Baddeley, Michael W. Eysenck & Michael C. Anderson. The most comprehensive introduction to the study of human memory and its applications in the field. This chapter discusses different memory disorders, from amnesia to Alzheimer's.

Secondly, we have included a chapter from [Human Memory, 4th Edition](#), by Gabriel A. Radvansky. The book highlights the application of memory theory and findings to everyday experience. This chapter considers the experience of forgetting, discussing the widely held idea that this is something bad, to directed forgetting and the influence of interference.

The third chapter is taken from Anne M. Cleary & Bennett L. Schwartz's edited collection, [Memory Quirks](#). This book explores the odd phenomena that challenge and upend our traditional understanding of human memory. The chapter included here considers why we forget, and how acknowledging the quirks of forgetting can help us better use our memory.

The final chapter is taken from, [Current Issues in Memory](#), edited by Jan Rummel. This book brings together some of the best received chapters previously published across the series, highlighting state-of-the-art areas of current and emerging interest and their significance for us all. This chapter discusses false memories, their importance and how they differ from false beliefs.

Some references from the original chapters have not been included in this text. For a fully referenced version of each chapter, including footnotes, bibliographies, and endnotes, please see the published title. Additionally, as you read through this FreeBook, you will notice that some excerpts reference previous chapters and the figure and box numbers aren't in order. Please note that these are references and numbers from the original text and not the FreeBook.

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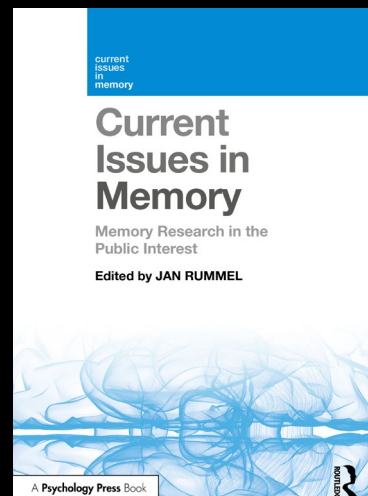
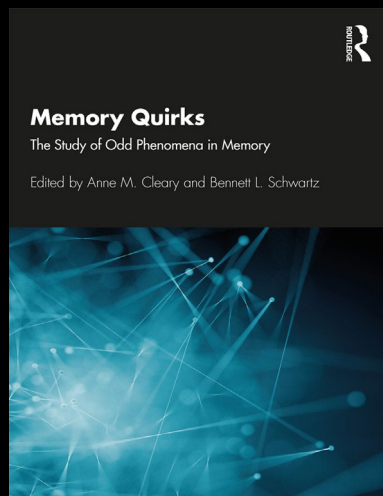
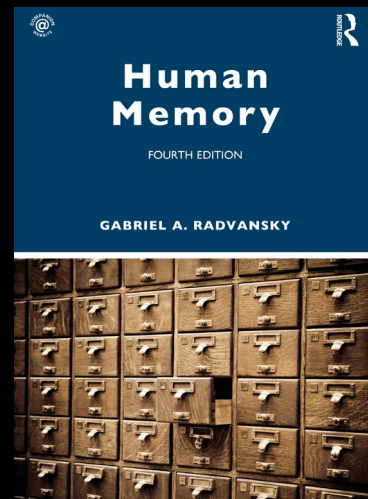
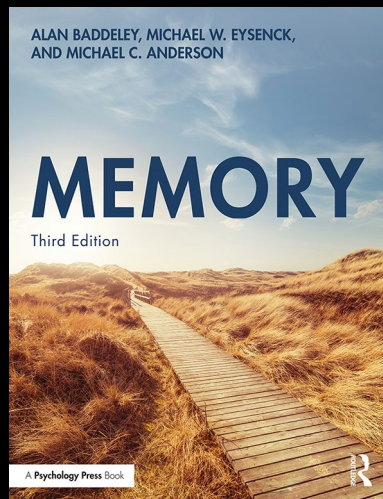
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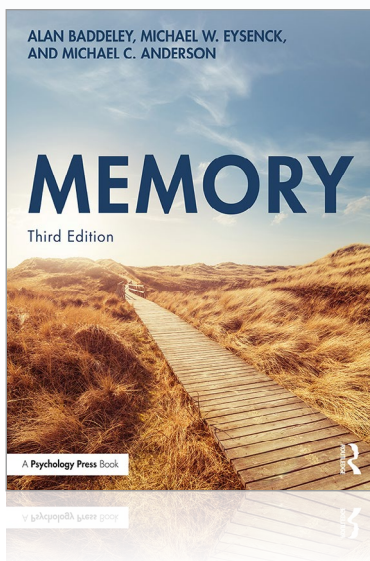


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CHAPTER

1

WHEN MEMORY SYSTEMS FAIL



The following is excerpted from

Memory

By Alan Baddeley, Michael W. Eysenck & Michael C. Anderson.

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We all have memory lapses, some more embarrassing than others. On one occasion, I agreed to talk about memory on a live radio phone-in program, the *Jimmy Mack Show* from Glasgow. As I lived in Cambridge at the time, it was agreed that I would participate from the local radio station. That morning I was reading the newspaper before checking my diary and setting off for work, when I glanced at the TV and radio section, prompting the awful realization that I should at that moment be telling the world about the wonders of memory. I leapt on my bike and arrived just before the end of the program, sheepishly muttering about the terrible traffic in Cambridge, to be asked by the host if I could give the listeners a few hints on how to improve their memory! On another occasion, I turned up to give an important lecture on amnesia, only to discover that I had forgotten my slides.

So we all have bad memories (though perhaps not as bad as mine), but what is it like to have a genuine memory problem— not the devastatingly dense amnesia experienced by Clive Wearing and described in Chapter 1, but the much more common level of memory deficit that accompanies many conditions including stroke, Alzheimer's disease, and traumatic brain injury? A very good account of the problems associated with memory deficit is given by Malcolm Meltzer, a clinical psychologist who experienced memory problems following a heart attack that led to anoxia (Meltzer, 1983). Having given you some idea as to what it is like to experience a serious memory problem, I will move onto a brief account as to the role that cognitive psychology can play in helping to deal with such problems. This will be followed by an account of two of the most frequent causes of memory disruption, Alzheimer's disease (AD), an increasing problem with aging population, and traumatic brain injury (TBI) such as might follow a road traffic accident or a sports injury often occurring in a young population and resulting in a lifetime of cognitive handicap of which memory is a prominent feature.

AMNESIA: THE PATIENT AND THE PSYCHOLOGIST

THE PATIENTS' VIEW

Meltzer's heart attack was followed by a period of coma lasting for six weeks before he finally recovered consciousness, knowing who he was and recognizing his family, but thinking he was 33 years old whereas in fact he was 44. On returning home, he could not remember where things were kept and, unlike a pure amnesic patient, also had problems in remembering skills such as how to set an alarm clock, when bills should be paid, where was a good place to go for a vacation, and how one might get



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there. He also had problems with his working memory:

Organization of thinking was hampered ... I had trouble keeping the facts in mind, which made it difficult to organize them ... comparing things along a number of variables is difficult to do when you cannot retain the variables.

(Meltzer, 1983, p. 4)

Meltzer found it hard work to watch films or TV because of the difficulty in remembering the plot or, in the case of sports, which team was which and which was ahead. He tended to find spatial orientation difficult and even walks in a familiar neighborhood were liable to result in his getting lost. A particular problem was the impact of his amnesia on his capacity to interact with people:

Having conversations could become a trial. Often in talking with people I was acquainted with, I had trouble remembering their names or whether they were married, or what our relationship had been in the past. I worried about asking where someone's wife is and finding out that I had been at her funeral two years before. Often if I didn't have a chance to say immediately what came to mind, it would be forgotten and the conversation would move to another topic. Then there was little for me to talk about. I couldn't remember much about current events or things I read in the paper or saw on TV. Even juicy tit-bits of gossip might be forgotten. So in order to have something to say, I tended to talk about myself and my "condition." My conversation became rather boring.

(Meltzer, 1983, p. 5)

Eventually, with considerable perseverance, Meltzer recovered sufficiently to return to work, and of course to write a paper, providing for carers and therapists a very clear insight into the problems that result from memory deficit.

THE VIEW FROM PSYCHOLOGY

Some years ago, I and a number of cognitive psychologists, interested in what memory deficits could tell us about normal memory, got together for a joint conference with a group of clinical neuropsychologists directly concerned with helping patients. I agreed to give the opening lecture, somewhat ambitiously attempting an overview of the whole of human memory in 55 minutes. The meeting was well attended and, to my relief, I managed my overview, without too many in the



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audience going to sleep and indeed had time for questions. A chap at the back then stood up and asked “How does all this help me when I see my next patient on Monday morning?” A fair question? Perhaps not at that point in the conference, but a question I have continued to bear in mind and use to guide my continuing interest in applying cognitive psychology to clinical questions.

As I hope you will have noticed from previous chapters, the study of patients with memory problems has made a very substantial contribution of our understanding of how memory works. Patient HM convinced people of the need to separate long-term and short-term memory (see Chapter 2, p. 25).

Patients with impaired STM such as PV have played a crucial role in the fractionation of working memory and of the usefulness of the concept of a phonological loop (see Chapter 4, p. 74), while clinical evidence has been crucial in understanding both semantic memory (see Chapter 7) and autobiographical memory (see Chapter 11). In my experience, patients are almost invariably generous in helping us understand the nature of their deficit, even though it is made clear to them that they themselves are unlikely to derive direct benefit. They typically report that if studying them can help others, then they are very happy to take part. But has cognitive psychology been clinically helpful? When and how has it been useful?

I want to try to answer this question by taking you through the various stages whereby a clinician might try to help a patient complaining of memory problems, highlighting the way in which the cognitive psychology of memory can contribute and at the same time telling you something about the disorders that the clinician might encounter. I will illustrate some of the clinical tests commonly used and encourage you to try brief versions, not of the tests themselves, since making them generally available would compromise their clinical value, but using material of a similar type. As you will see, there are often clear links between many such tests and earlier research by cognitive psychologists.

So if you were the clinician, seeing a patient next Monday morning, what would you need to do? You would be likely to begin by assessing the patient allowing you to contribute to diagnosis. In doing so, you would probably identify the patient’s principal problems, leading in due course to treatment and its subsequent evaluation. You would begin by talking to the patient and possibly an accompanying carer about their own views of the problem and what they hope to achieve, tactfully making it clear that a complete restitution of memory is very unlikely. The patient’s account is important but not necessarily reliable; some patients are painfully aware of their difficulties



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while others are not. One of the first amnesic patients I tested responded to each failure to remember with the exclamation “How strange, I pride myself on my memory!”

Assessment is important in a number of ways. It contributes to the diagnosis of the clinical problem underlying the memory deficit, a process that will involve combining such test results with information from a number of other professionals and, if available, from neuroimaging techniques. Standardized test results will allow the patient’s performance to be compared to healthy people using standardized norms, and to be related to the clinician’s experience of others suffering from cognitive impairment. Such data are also important in communicating information about the patient to other professionals in a standardized way, and if the patient is to receive rehabilitation, then their pattern of strengths and weaknesses will be important in planning the treatment program. Finally, if the psychologist is conducting research, then specification of the patient is essential for any subsequent publication.

Assessment tests thus play an important role in treatment, and in addition provide a means whereby new discoveries can begin to influence clinical practice. Assessment is likely to depend ultimately on earlier research, much of it influenced by both concepts and methods that originated in the cognitive laboratory. This is also true of the methods devised to help the patient cope with memory problems. These will be discussed later, although it is important to bear in mind that rehabilitation will need to call on knowledge and expertise that goes well beyond the remit of cognitive psychology.

Unlike many of the patients described in earlier chapters because of their theoretical relevance a typical patient may have a range of perceptual, motor, cognitive, and potentially also emotional problems. All need to be assessed and taken into account in planning further treatment. For present purposes, however, we will focus on memory deficits, referring to other factors only in as far as they interact with problems of memory. We begin with two important and frequent sources of memory problems, Alzheimer’s disease (AD), a problem of old age where memory is likely to deteriorate progressively over time while the other, traumatic brain injury (TBI), often occurs in young people who will probably experience their memory problems throughout a life of normal length. We will then look at what our knowledge of memory can tell us about such deficits, concluding with a discussion of how such patients can be helped to cope with the problem of living with a memory disorder.



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ALZHEIMER'S DISEASE

In 1907, Dr Alois Alzheimer first described the disease that bears his name. It is a devastating disease of the elderly with symptoms that vary but always include an increasingly severe deficit in episodic memory. Alzheimer's disease (AD) is the most prominent but by no means the only cause of senile dementia (see Box 16.2). It does however comprise over 50% of dementia cases and occurs in about 10% of the population over the age of 65 with the rate increasing with age.

BOX 16.2 THE DEMENTIAS

Dementia is an umbrella term describing symptoms that occur when the brain is affected by diseases. They are typically progressive and associated with aging, although earlier forms of dementia also occur. There is a range of types of which the following are more common.

Alzheimer's disease

The most common cause as discussed in the text.

Vascular dementia

Reduced oxygen supply to the brain may lead to cell death. This can occur either suddenly following a stroke, or more gradually through a series of strokes.

Dementia with Lewy bodies

Named from the small spherical structures that develop inside nerve cells leading to degeneration of the main tissue. Initial symptoms tend to be visual rather than memory problems. It is suggested it may be related to dementia that sometimes occurs with Parkinson's disease, for which motor symptoms are most common.

Fronto-temporal dementia

Involves deterioration of neurons in the frontal and/or temporal lobes resulting in changes in behavior and personality, and potentially leading to difficulties with language. Relatively rare.



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Semantic dementia

Progressive loss of semantic memory involves failing comprehension of both words and pictures. Associated with atrophy of the temporal lobes, particularly in the left fronto-temporal region. Relatively rare but important theoretically because of its implication for understanding semantic memory (see Chapter 7).

DIAGNOSIS

Box 16.3 shows 10 potential signs of Alzheimer's disease described in a report by the US Academy of Neurology. Because of the varied range of symptoms, the early stages of AD can be difficult to diagnose; diagnosis requires that there is a memory impairment together with at least two other deficits, which can include problems of language, action control, perception, or executive function. The disease is progressive over time and, ultimately, diagnosis currently depends on a post-mortem examination of the brain tissue, revealing two cardinal signs of AD: amyloid plaques and neurofibrillary tangles. Plaques are created by faulty protein division. This results in the production of beta amyloid, which is toxic to neurons and leads to the formation of the clumps of amyloid that form the plaques. Neurofibrillary tangles occur within the neurons and are based on the microtubules that structure and nourish the cell. Abnormal proteins form, resulting in the twisting and collapse of the microtubules, and ultimately in cell death (St George-Hyslop, 2000).



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BOX 16.3 WARNING SIGNS OF ALZHEIMER'S DISEASE

The American Academy of Neurology proposed the following guidelines (Petersen et al., 2001):

1. Memory loss that affects job skills
2. Difficulty performing familiar tasks
3. Problems with language
4. Disorientation to time and place
5. (getting lost)
6. Poor or decreased judgment
7. Problems with abstract thinking
8. Misplacing things
9. Changes in mood or behavior
10. Changes in personality
11. Loss of initiative

It is suggested that people who show several of these should see their doctor for a thorough examination.

However, while the amyloid hypothesis has dominated the field for many years, it has recently been increasingly questioned. Both plaques and tangles are often found in the normal aging brain, while cases of dementia have been found in the absence of plaques and tangles. A few hours after writing this sentence, it was announced that a major trial involving collaboration between three drug companies based on the amyloid approach had been discontinued, together with an announcement from the Alzheimer's Drug Discovery Foundation that future trials would focus on treatments other than those focused on the amyloid hypothesis. They report that of the 102 drugs currently being tested to treat Alzheimer's disease, 74% focused on targets other than amyloid (Neuro Central news bulletin, July 19, 2019).



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The disease typically develops through a series of stages (Braak & Braak, 1991) beginning in the medial temporal lobes and hippocampus, creating the initial memory problems, and then progressing to the temporal and parietal lobes and to other brain regions. Consistent with this anatomical diversity, a close examination of an extensive sample of well-studied patients indicated a wide and varied pattern of neuropsychological deficits (Baddeley, Della Sala, & Spinnler, 1991). A further extensive analysis of data from 180 patients and over 1,000 normal elderly individuals suggests that despite the potential presence of a varied range of other cognitive deficits, AD is basically characterized by a single overall feature, namely that of defective episodic memory (Salthouse & Becker, 1998). It is important to note, however, that a memory deficit is necessary for diagnosis, so this is perhaps unsurprising.

At the level of the individual patient, the disease can develop from an initial tendency to absentmindedness and memory failure, progressing to increasingly severe and potentially varied cognitive symptoms. These were well illustrated in a case study of the Oxford philosopher and novelist Iris Murdoch, as described by Garrard, Malony, Hodges, and Patterson (2005). They compared the sentence content and structure of one of Murdoch's early novels, *Flight from the Enchanter*, with a middle novel, *The Sea, the Sea*, and her final novel, *Jackson's Dilemma*. They found that her last novel used considerably shorter sentences and more high-frequency words, suggesting that she was adapting to her growing language constraints. As the disease progressed, her linguistic problems increased, including word-finding difficulties, which she avoided by circumlocutions. She showed major problems in word definition, for example describing a bus as "something carried along." Her spelling deteriorated, with a word such as *cruise* being written as *crewes*, and her capacity to name pictures or to generate items from a given semantic category such as animals was increasingly impaired.

Although the decline in cognitive performance in dementia can be very worrying, social and emotional deterioration can be even more distressing, sometimes leading to the feeling of a spouse that "this is not the person I married." In the case of Iris Murdoch, she appeared to maintain a very amiable disposition (Bayley, 1998), but sadly this is by no means always the case. For present purposes, however, we will limit discussion to the effects of AD on memory.



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KEY TERM

Everyday memory: Term applied to a movement within memory to extend the study of memory from the confines of the laboratory to the world outside.

EPISODIC MEMORY

By the time AD has been reliably diagnosed, patients are likely to show a substantial deficit in episodic memory whether measured by recall or recognition, using verbal or visual material or based on measures of **everyday memory** (Greene, Hodges & Baddeley, 1995; Spinnler, Della Sala, Bandera, & Baddeley, 1988). As in the classic amnesic syndrome, the recency effect in free recall is relatively well preserved, although performance on earlier items is grossly impaired. There is evidence that as the disease progresses even recency tends to decline (Miller, 1971).

FORGETTING

Despite the difficulty AD patients have in acquiring new information, once learned it appears to be forgotten no more rapidly than occurs in the normal elderly (Christensen, Kopelman, Stanhope, Lorentz, & Owen, 1998). Kopelman (1985) took advantage of the fact that people tend to be very good at picture recognition, taking care to vary the exposure time so as to equate the performance of normal, AD, and elderly participants when tested after five minutes. He then retested them after a 24-hour delay and found equivalent performance across the groups.

As noted in the case of Iris Murdoch, semantic memory declines as the disease progresses. Hodges and colleagues devised a battery for measuring semantic memory using a range of different tasks designed to ensure that any deficit observed is general, and not the result of perceptual or linguistic problems. A clear semantic deficit would be reflected in difficulties in naming pictures of objects or animals, in picking the appropriate picture given its name, in describing the characteristic of a named or pictured object, or in answering general questions such as whether an elephant has pricked up or floppy ears. In a series of studies, the Hodges group observed a steady decline in semantic memory in AD patients that was associated with degree of temporal lobe atrophy (Hodges & Patterson, 1995; Hodges, Patterson, & Tyler, 1994). The decline of semantic memory is even more precipitous in semantic dementia, a disease in which episodic memory is relatively well preserved, with atrophy occurring principally in the left temporal lobe rather than the more medial focus that tends to be found in AD (Snowden, Neary, & Mann, 1996).



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IMPLICIT MEMORY

Perhaps unsurprisingly, given that implicit learning and memory can reflect a number of

different systems, the pattern of deficit in AD is somewhat complex. Heindel, Salmon, Shults, Walicke, and Butters (1989) tested patients with AD on the pursuit rotor, which you may recall is a task which requires keeping a stylus in contact with a moving target. The patients performed less well initially, but improved at the same rate as an elderly control group. Similarly, Moscovitch (1982) found little impairment in the rate at which AD patients learned to read mirror-reversed words.

Fleischman, Vaidya, Lange, and Gabrieli (1997) found normal priming in a lexical decision task involving the speed of deciding whether a sequence of letters comprised a real word or not. However, unlike the classic amnesic syndrome, implicit memory was not spared when tested by stem completion, in which patients were shown a word (stamp) and later ask to “guess” a word beginning with st. In general, patients with AD tend to show intact priming on relatively automatic tasks but reduced priming on more complex tasks, for example when recall is primed by presenting associatively related cue words (Salmon & Heindel, 1992; Salmon, Shimamura, Butters, & Smith, 1988).

WORKING MEMORY IN ALZHEIMER'S DISEASE

A working memory deficit occurs but is typically less marked than that of episodic memory, with modest but reliable deficits in both digit span and on the Corsi block tapping test of visuo-spatial memory (Spinnler et al., 1988). Patients are able to maintain small amounts of material over an unfilled delay but, when the delay is filled with articulatory suppression, patients with AD rapidly forget, whereas normal elderly participants show a decline only when the interpolated task is intellectually demanding, counting backwards in threes (Morris, 1986; Morris & Baddeley, 1988). This suggests that maintenance by simple articulation remains, but that more complex or attention-demanding forms of rehearsal are lost.

To test the executive capacity of patients with AD, Baddeley, Logie, Bressi, Della Sala, and Spinnler (1986) devised a series of tasks that combined auditory digit recall, like repeating a telephone number, with a concurrent nonverbal task. In one study, for example, number of digits was adjusted so that AD, elderly, and young participants all performed at the same level of single task accuracy. A similar matching occurred for a secondary tracking task in which participants had to keep



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a stylus in contact with a moving spot of light, with the difficulty modulated by varying the speed of movement of the spot. Having equated the two groups on the individual tasks, they were then required to perform the memory span and tracking tasks simultaneously. Young and normal elderly subjects both showed an equivalent small decrement under the combined condition, whereas the patients with AD showed a marked decline in performance, that became more marked as the disease progressed (Baddeley, Baddeley, Bucks, & Wilcock, 2001). The AD deficit in dual-task performance was not simply due to task difficulty, as young, older, and AD groups responded in a similar way to an increase in difficulty level on a single task, while AD patients but not controls continued to show a dual-task deficit even when each of the combined tasks were very easy (Logie, Cocchini, Della Sala, & Baddeley, 2004). The fact that AD patients but not healthy elderly have difficulty in combining tasks is potentially useful for diagnosis. Memory testing is crucial but can be harder to interpret since performance is also likely to be impaired by a range of other conditions, including of course normal aging (see Chapter 15).

More recently, measures of visual working memory have been studied in AD, yielding a very striking new effect, namely a clear impairment in the capacity to bind features such as color and shape into remembered objects (see Chapter 3, p. 57). A series of studies by Mario Parra of the Edinburgh neuropsychology group has not only demonstrated this (Parra et al., 2009) but has extended his work to a rare genetic form of familial AD found in Colombia in which any family member with the specific gene suffers early-onset AD, typically beginning in their forties. Parra was able to demonstrate the sensitivity of his binding measure to already diagnosed cases, but remarkably, was also able to detect which family members possessed the fatal gene at a time when they appeared to have no other current symptoms of AD (Parra et al., 2010). This task clearly also has the potential, given further development, to serve as an early detector of AD.

Other aspects of attentional control have been less thoroughly studied, but the evidence available suggests that some at least are comparatively spared. For example, the capacity for sustained attention or vigilance does not appear to be particularly compromised (see Perry & Hodges, 1999, for a review).

As we learn more about AD, we are likely to become better at early diagnosis, but then what?



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TREATMENT

In an extensive review of available treatments, Doody et al. (2001) discuss both pharmacological and behavioral attempts to alleviate AD. At that time, they identified three drugs that appeared to have some effect in slowing the course of the disease, namely *donepezil*, *rivastigmine*, and *galantamine*. These operate as inhibitors of cholinesterase, a substance that breaks down the neurotransmitter acetylcholine. Acetylcholine tends to be depleted in AD, hence the value of drugs that resist further depletion. There is a huge interest in this area within the pharmaceutical industry, given that AD is a disease that inflicts enormous cost on society at both a financial and human level. This cost is increasing as the age structure of the population changes from the historic pattern in which the young greatly outnumbered the old, to one in which more and more of the population survive into old age.

Over the past 25 years there has been an intense search for a drug that could arrest the progress of the disease, but currently, as described above, with little obvious progress.

In the meantime, there is growing interest in the need to provide emotional and social support to both the patients and carers in what is inevitably a highly stressful situation in which the magnitude of cognitive disruption may be less important than potential changes in personality—“this is not the person I married!”, or in the potential breakdown of what was already a difficult relationship. This had led to an extensive studies of psychotherapeutic approaches with some limited evidence for their effectiveness (e.g., Benbow & Sharman, 2014; Cheston & Ivanecka, 2017) although whether improvements preserved are sufficient to make them cost effective in a financially limited medical service remains in doubt (Orgeta, Qazi, Spector, & Orrell, 2015; Sogaard et al., 2014).

In the meantime, there is considerable interest in behavioral approaches to individual patients and their carers. It is possible to use some of the methods described in the final section of this chapter to teach skills that will stand the patient in good stead as the disease advances (Clare et al., 2000). For example, patients can be taught to use simple memory aids, such as message boards or calendars, to avoid the need constantly to ask carers the same question, which is one of the most wearing features of supporting a densely amnesic patient. A related approach is to modify the environment in simple but useful ways. Moffat (1989), for example, describes the case of a patient who was constantly mislaying his spectacles and his pipe. His frustration level was reduced by a program training him always to return his spectacles and pipe



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KEY TERM

Reality orientation training

(ROT): A method of treating patients in the latter stages of dementia who have lost their orientation in time and place.

Reminiscence therapy:

A method of helping dementia patients cope with their growing amnesia by using photographs and other reminders of their past life.

to a bright orange bag (hopefully fire proof!). He would not remember where he left them, but could find them easily.

A number of programs have attempted to bring together techniques and skills aimed at helping the patient and the carer to cope as the disease progresses. Spector, Davies, Woods, and Orrell (2000) describe a program that improved performance on the specific areas trained, and tended to reduce levels of depression, although— as in the case of other programs of memory training for the elderly— this did not generalize to other aspects of performance.

As mentioned earlier, the purely cognitive aspects of AD are not typically the most distressing, and there is increasing interest in ways of helping patients and carers to cope with the social and emotional stresses imposed by AD. One disturbing feature of memory loss can be the problem of maintaining a sense of personal identity. This is particularly likely to be a problem for patients who need to move to a care home, and so are separated from their normal home environment and hence are surrounded by new and unfamiliar people. A number of approaches to this problem have been developed. One is **reality orientation training (ROT)**, which involves helping patients maintain orientation in time and place, not necessarily a pleasant prospect given certain realities. An occupational therapist tells the story of an elderly man admitted to a hospital based in a rather grand Victorian building. He was densely amnesic and interpreted his situation as staying in a rather splendid hotel at the seaside. The overenthusiastic therapist carefully taught him to look at the calendar to say the date and to announce the name of the hospital where he was living, which he duly did, only to wink and say “But I know I am really at a grand hotel at the seaside!”

A rather more helpful approach is provided by a technique known as **reminiscence therapy**, which helps patients to maintain a sense of personal identity by recollecting their past (Woods & McKiernan, 2005). This can involve constructing a personal life story book, including photographs and other mementoes from earlier days. This not only has the advantage of reminding patients of their earlier life, but in a group context provides links with other patients who share experience of the past. It also provides things that they can tell the therapist, allowing a more natural interaction than might typically occur. However, although psychological approaches can be helpful, the best hopes for the future must lie with pharmacology, although progress has not been rapid.

In the meantime however there is a great deal that can be done to improve the quality of care of patients by providing adequate training of carers, institutional and in the



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home so as to understand the problems facing the patient, realizing for example that stimulation is not necessarily helpful and finding ways to avoid potential disruptive situations and irritating habits such as continually being asked the same question. Adequate input to carers by trained professionals at this level is likely to be cost effective (Clare, 2017).

TRAUMATIC BRAIN INJURY

A second common potential source of memory problems comes from traumatic brain injury (TBI) when the head perceives a sharp blow or is subject to a sudden acceleration or deceleration as in a car crash. The brain swirls around, resulting in damage from the bony protuberances within the skull, and from the twisting and shearing of fibers within the brain. The potential effects of TBI are extensive and can include social and emotional problems. However, for present purposes we will confine the discussion to cognitive deficits in attention and memory.

A few years ago I was waiting in a line of cars to leave a side road near a sea-coast resort when suddenly a blue figure arced in the air, to the horror and consternation of onlookers. It was a motorcyclist hit by a car turning into the side road, probably resulting in a serious head injury. Such injuries happen mainly to young men, and in the UK over 95% will survive with varying degrees of handicap. Other causes of TBI include falls, sports injuries, and, in the case of war veterans, blast, with an estimated 10–20% of returnees suffering from TBI. Overall, it was estimated that some 5.3 million Americans were currently living with some degree of TBI (Langlois, Rutland-Brown, & Wold, 2006).

So what sort of memory problems might our unfortunate motorcyclist expect? First of all, if the brain injury was severe, he might be expected to be in a coma, sometimes for many weeks. Indeed in the most serious cases, the patient may be left in what is known as a *persistent vegetative state* in which physical functions continue to perform but mental functions do not. This in turn leads to the terrible ethical problem as to how long one should artificially maintain life in such a case. Fortunately, in most cases there will be a gradual recovery, often so gradual that it can be missed by the medical support staff. To optimize this process of monitoring, Shiel, Wilson, McLellan, Horn, and Watson (2000) developed a scale entitled the Wessex Head Injury Matrix Scale (WHIM), which picks up the tiny changes that occur in behavior as the brain slowly recovers from major trauma.



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KEY TERM

Anterograde amnesia:

A problem in encoding, storing, or retrieving information that can be used in the future.

Retrograde amnesia:

A problem accessing events that happened in the past.

Many of the most prevalent cognitive difficulties across a wide range of diseases result from impaired episodic memory. I will therefore begin by describing a pure case of impaired episodic memory as reflected in the classic amnesic syndrome, not because such a pure case is typical, but because it provides a very clear indication of types of problems that are likely to be encountered to a greater or lesser degree, by a wide range of patients.

EPISODIC MEMORY IMPAIRMENT

ANTEROGRADE AMNESIA

A crucial distinction is that between **anterograde amnesia** and **retrograde amnesia**. Anterograde amnesia refers to a problem in encoding, storing, or retrieving ongoing information that can be used in the *future*, hence the prefix *antero*. By contrast, retrograde amnesia refers to loss of access to events that happened in the *past*, typically before the onset of the disease. The densely amnesic patient HM described in Chapter 1 is the classic case of anterograde amnesia because his capacity for new learning was greatly restricted while his ability to recall events from before his operation was relatively preserved. This is in contrast to Clive Wearing, also described in Chapter 1, who showed both dense anterograde amnesia together with retrograde amnesia reflected in his very patchy access to earlier memories. Hence, these two forms of amnesia will be discussed separately. The broad pattern of episodic memory deficit shown by HM has now been replicated many times although pure cases with no evidence of further cognitive impairment are relatively rare. As a reminder of the pattern to be expected, I will describe one case with a particularly clear episodic memory deficit before discussing current interpretations of this syndrome and its theoretical implications.

Keith was a company director who in his 59th year experienced a headache combined with vomiting which continued for several days followed by extreme drowsiness. He seemed disoriented, did not appear to recognize his wife, and could only manage a few words. He was diagnosed with a brain infection, recovering slowly. He began rehabilitation only to relapse some five months after his initial attack, with further evidence of brain infection, accompanied by seizures. His brain infection was brought under control and eventually he was admitted to Rivermead Rehabilitation Centre in Oxford where his cognitive functioning was assessed (Wilson & Baddeley, 1988).

Despite his complex and stormy medical history, Keith proved to have a very pure



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deficit in episodic memory. He was highly intelligent with an IQ of 134. His perceptual and motor skills were excellent and he showed no evidence of executive deficit when tested on standard tests such as the Wisconsin Card Sorting Test, a sorting task which involves switching categories, while his verbal fluency, generating as many words as possible beginning with S and V in 90 seconds, was In contrast his episodic memory performance was grossly impaired. He could recall a prose passage immediately, with an above-average score but failed to recall anything after an hour's delay. Similarly he could copy a complex figure and recall it immediately, but completely failed after 40 minutes and did not even recognize the figure. His verbal free recall showed the classic pattern (Baddeley & Warrington, 1970) of normal recency with grossly impaired retention of earlier items. Keith showed the classic pattern of preserved procedural learning with consistent improvement over trials on pursuit rotor performance indicating good motor learning (Brooks & Baddeley, 1976) together with improvement in reading mirror written script (Cohen & Squire, 1980) and preserved capacity for learning words when prompted by stem completion (Warrington & Weiskrantz, 1970).

In short, Keith showed the classic pattern of results to be expected in any dense but pure amnesic patient. He was functioning intellectually at a high level on all except memory tests, showing grossly impaired performance on tests of episodic memory but with preserved performance on STM tasks and on tests involving procedural learning. Importantly, in Keith's case, semantic memory for events occurring before his brain infection was also preserved as measured not only by performance on vocabulary tests or speed of sentence processing, but also autobiographical memory when tested by semantically oriented questions such as the names of his school teachers, or memory for specific episodes. He could for example recount episodes experienced during the war and when questioned was able to describe the color of the dresses of the bridesmaids at his wedding. In short, Keith had substantial anterograde but preserved retrograde amnesia for events before his illness.

There is general agreement that in its pure form, the amnesic syndrome involves grossly impaired episodic memory together with preserved working memory, semantic memory, implicit memory, and intelligence. In practice, however, although episodic memory deficits are relatively common, they will often be accompanied by other cognitive deficits that need to be taken into account in treating the patient. Nevertheless, the episodic memory deficit is often a central feature of the problems encountered by many patients, reflecting a wide range of diagnoses. Hence understanding its nature is important if the patient is to be helped. Attempts to



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explain the amnesic syndrome can operate at two separate but related levels. One of these concerns the psychological functions that are disturbed, while the other concerns their neurobiological underpinnings. We will begin with explanations of amnesia at the psychological level, moving on later to the role of neurobiology.

Early hypotheses included greater susceptibility to interference leading to a retrieval deficit (Warrington & Weiskrantz, 1970), faster forgetting (Huppert & Piercy, 1979) and an incapacity for deep processing (Cermak, Butters, & Moreines, 1974), although all of these subsequently ran into problems (see Baddeley, 1990, ch. 16 for a discussion). It is, however, too soon to reject the possibility that faster forgetting, and/or susceptibility to interference may play a part in some patients, possibly reflecting further additional deficits. However, whatever the precise mechanism, it seems likely that amnesia disrupts the capacity to associate a *specific* event or episode with its *context*, its location in time and place and that this allows individual specific memories to be retrieved. In a study using rats, Winocur and Mills (1970) observed that animals with hippocampal lesions were particularly bad at making use of environmental context in a spatial learning task, suggesting to Winocur (1978) that a failure to associate memories with context may also apply to human amnesic patients. This was later related to the discovery of specific “place cells” in the hippocampus (O’Keefe, 1976) a discovery that formed the basis for the award of a Nobel prize to John O’Keefe, while others have identified cells that appear to be time-based (Eichenbaum, 2014) making the hippocampus a very appropriate system for encoding contextual cues that can later be used to identify and retrieve specific events distinguishing for example remembering what you did this morning from events happening on many other mornings. This can make it difficult to know what is the origin of a particular memory, a process known as “source memory.” This was demonstrated by Schacter, Harbluk, and McLachlan (1984), using as their material the answers to trivial pursuit questions such as what was the favorite food of the comedian and film star Bob Hope, finding that although amnesic patients may be able to recall the “fact,” they are bad at recalling that they had just been given this information.

You may recall from Chapter 6 (pp. 164, 192), Tulving’s description of episodic memory as a system that allows “mental time travel.” Amnesic patients clearly have problems in traveling to the recent past; what about the future? Amnesic patients may indeed have difficulty in imagining future activities, such as lying on a sandy tropical beach surrounded by palm trees. However, the patients *were* able to imagine the component experiences, but could not integrate them into a whole, a deficit that



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Hassabis, Kumaran, Vann, and Maguire (2007) attribute to the importance of the hippocampus for spatial processing as well as memory.

A SIMPLIFIED MODEL

In an attempt to pull together the overall pattern of data on the amnesic syndrome, I proposed what I termed a modal model of amnesia, a simple interpretation of the amnesic syndrome that appeared to capture most if not all of the evidence (Baddeley, 1990). This accepted a deliberately unspecified consolidation hypothesis, whereby learning in episodic memory involves associating items with their context using some form of “mnemonic glue.” This clearly nontechnical term was deliberately selected so as to indicate that it was *not* based on any sophisticated neurobiological evidence but simply accepted that a neurobiological interpretation of some form seemed necessary. This view is consistent with a contextual hypothesis, on the assumption that the essence of episodic memory is the capacity to “glue” experiences to a specific context, thus providing a contextual tag that allows individual experiences to be retrieved.

This simplified model of amnesia assumed that recall and recognition involve the same underlying storage processes, although they place different constraints on subsequent retrieval. It assumed that semantic memory represents the residue of many episodes. Over time, the capacity to retrieve individual experiences might have been lost through forgetting, but it was assumed that semantic memory, based on those common features that accumulated over repeated episodes, could be retrieved through a separate mechanism based on long-term knowledge. Although this modal model seemed to give a plausible account of the classic amnesic syndrome, it was not clear how to test it and I myself ceased to work on amnesia.

Some years later, however, I was asked to talk about amnesia at a retirement symposium for the distinguished neuropsychologist Elizabeth Warrington. Because of our earlier work together, I agreed. I had not subsequently published anything on my speculative modal model of amnesia and thought it would be a good opportunity to obtain feedback from an expert audience. Despite absent-mindedly leaving my slides on the train en route, the talk seemed to go reasonably well. Then, shortly after the meeting, I was invited by Faraneh Vargha-Khadem, a neuropsychologist from the Institute of Child Health in London, to visit and test a patient, Jon. I accepted. Testing Jon rapidly convinced me that my modal model of amnesia was wrong. The reason was simple; if semantic memory is built up through an accumulation of episodes and Jon has had episodic memory deficits from an early age, then he should have grossly



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impaired semantic memory. He did not. Indeed Jon's amnesia differed from the classic pattern in a number of ways that challenge existing theory. Unlike most amnesic patients, despite having severely impaired recognition, Jon had well-preserved recall memory, again challenging an assumption of my simple modal model (see Figure 16.1).

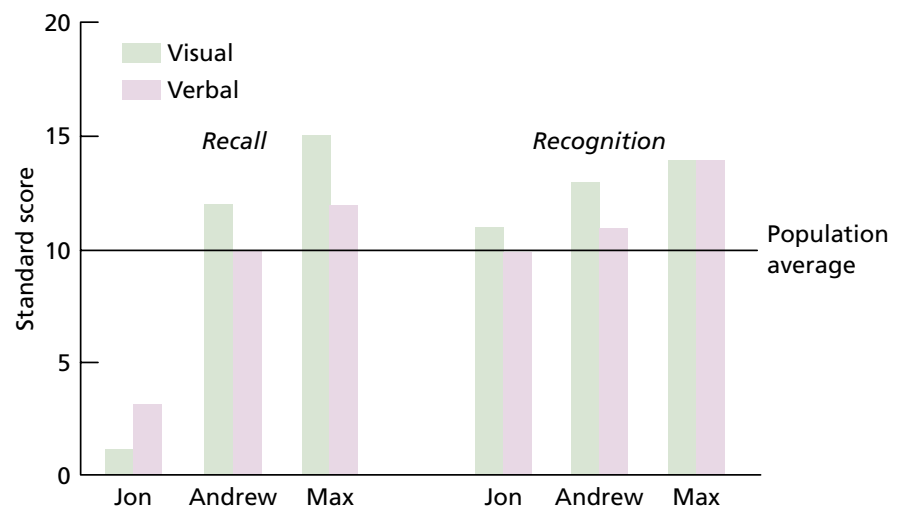


Figure 16.1: Performance on the Doors and People Test of visual and verbal recall by Jon, a developmental amnesic patient, and two controls. Jon is impaired on recall but not recognition. From Baddeley et al. (2001b). Copyright © 2001 MIT Press. Reproduced with permission.

A similar level of relatively preserved recognition performance together with marked recall deficit was found on a wide range of other tests by Vargha-Khadem, Gadian, and Mishkin (2001) and have subsequently been reported for a range of similar developmental cases (Bindschaedler, Peter-Favre, Maeder, Hirsbrunner, & Clarke, 2011; Brizzolara, Casalini, Montanaro, & Posteraro, 2003). However, it was Jon's semantic memory that appeared to create the most crucial problem for my simple modal model. If it is based on the accumulation of episodic memories then Jon's semantic memory should be grossly impaired as should his level of education, vocabulary, and verbal IQ. In fact Jon had relatively high IQ, with good vocabulary, and while his scholastic achievements were less than might be expected given his IQ, they were respectable. Furthermore he could discuss UK politics and could tell you all about the novels of Terry Pratchett and the associated "Discworld." Subsequent research suggests, however, that although Jon's knowledge of the world is excellent, it might take him longer than controls to acquire new facts (Gardiner, Brandt, Baddeley, Vargha-Khadem, & Mishkin, 2008). Finally, if recall and recognition involve



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essentially the same storage process, why, in Jon's case, can recognition be so well preserved and recall so impaired?

A hint as to the answer to this question comes from the previously described distinction between *remembering* and "knowing" (see Chapter 8). You will recall that "remembering" is based on the capacity to recollect an episode, "to travel backwards in time" to re-experience it, in contrast to the capacity to *know* that one has previously encountered an item, in the absence of such recollective experience (see Chapter 8). We attempted to assess Jon's capacity to "remember," but had considerable difficulty teaching him the distinction between remembering and knowing. Eventually, he declared that he understood the distinction and we went ahead. Jon used the remember-and-know categories about as often as controls. However, when control participants made a remember judgment they could describe their recollection, for example *The word "dog" reminded me of my granny's dachshund*. Jon did not. He reported that he tried to form a visual image of the cards on which the words had been presented, and if his image of the word was clear and bright then he categorized this as remembering. In short, he appeared to be using a strength rather than a recollective criterion, a suggestion that is further supported by questioning Jon about how he tried to perform the remember-know discrimination and by the different brain activity associated with these two mental states (Maguire, Vargha-Khadem, & Mishkin, 2001). This gives a possible explanation of Jon's relatively preserved recognition memory, but what about his excellent semantic memory?

A possible way of preserving the modal model's assumption of a common basis for semantic and episodic memory recently resulted from my writing a relatively personal account of my long and intellectually lively friendship with Endel Tulving (Baddeley, in press). Let us suppose that the hippocampus is not principally a structure necessary for learning per se, but is instead responsible for attaching time- and place-based retrieval cues to learning episodes that are created elsewhere within the medial temporal lobes, preserved in Jon but disrupted in most amnesic patients. Episodic retrieval would fail because of the lack of such crucial cues, while cuing using familiarity or pre-existing semantic associations will remain. The idea has survived for long enough to be included as an invited personal contribution to a respected neuropsychological journal, though whether it survives later critical examination remains to be seen.

There is no doubt that Jon is far from typical as an amnesic patient, most of whom are impaired on both recall and recognition tests. He is not however atypical of people



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with developmental amnesia. A recent study (Dzieciol et al., 2017) describes 18 patients who are compared both to matched controls and to populations norms. Their intelligence is well within the normal range as is their working memory, literacy, and numeracy, with above-average scores on both verbal and visually based measures of semantic memory. In contrast, their performance on a range of episodic memory tasks was grossly impaired when compared to the matched control group.

This pattern may however be limited to developmental amnesia. Squire and colleagues have presented data from groups of amnesic patients who appear to have lesions limited to the hippocampus, and who behave in the standard way, with no evidence of preserved recognition memory (Manns & Squire, 1999; Reed & Squire, 1997). Why the difference? One possibility is that Jon acquired his hippocampal damage at a very early age whereas most amnesic patients become amnesic as adults and that the preserved capacity to learn reflects the greater plasticity of the infant brain. Some adult onset cases have however been reported (Aggleton & Brown, 1999; Mayes, Holdstock, Isaac, Hunkin, & Roberts, 2002), but the adult evidence is much less well studied than the developmental group.

We have so far discussed the proposed focal deficit in amnesia, namely the binding of items to their context, and located this deficit principally in the hippocampus. We consider next the process that is necessary for the long-term learning of such bound information, consolidation of the memory trace.

Consolidation

The dominant explanation of both anterograde and retrograde amnesia at a neurobiological level rests on the concept of consolidation, the hypothesis that memory traces are initially fragile and become more resistant to forgetting as time progresses, a view that is at least a century old (Müller & Pilzecker, 1900). This was initially applied to the amnesic syndrome by assuming that consolidation depends crucially on the hippocampus and related areas, and that disruption to this system interferes with the consolidation process.

Evidence in favor of the role of consolidation in learning comes from research on sleep as described in Chapter 5. This shows that when learning is followed by a period of sleep, long-term retention is better than occurs when remaining awake during that time (e.g., Gaskell & Dumay, 2003; Stickgold, James, & Hobson, 2000). Evidence consistent with effects of both consolidation and interference comes from a group directed by Sergio Della Sala in Edinburgh. They report a number of studies



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demonstrating that the retention of information by some amnesic patients was greatly enhanced if learning is immediately followed by removal of the patient to a quiet, dim, interference-free room. In one study, four densely amnesic patients and six controls attempted to remember a story an hour later. When the hour was spent in a darkened room, patients performed almost as well as controls. However, when the hour was filled with the sort of cognitive tasks that would normally constitute patient assessment, the patients remembered virtually nothing (Dewar, Cowan, & Della Sala, 2010). Another study tested patients suffering from mild cognitive impairment (MCI), a condition typically reflecting poor memory and potentially a forerunner of Alzheimer's disease. It showed a similar improvement in retention by the patients when learning was followed by removal to a quiet dark room, whereas this made little difference to the healthy control group. An obvious interpretation of these findings is to suggest that amnesic patients are particularly susceptible to the disruption of the process of consolidation, particularly during the early stages. This was tested directly by Dewar, Fernandez-Garcia, Cowan, and Della Sala (2009) in a study in which MCI patients and controls learned a list of words and were tested after a delay of nine minutes. As shown in Figure 16.2, they found that the patients were much more susceptible and that the earlier the disruption, the greater the forgetting. In addition to its obvious theoretical significance, this finding has considerable potential practical importance if it should prove widely applicable, and the learning observed reasonably robust. The process of hippocampal consolidation over this initial period is presumed to operate at the cellular and subcellular level probably based on the mechanism of long-term potentiation (LTP) described briefly in Chapter 2 (p. 33). However, analysis of the amnesic syndrome at the subcellular level does not yet appear to be well advanced.



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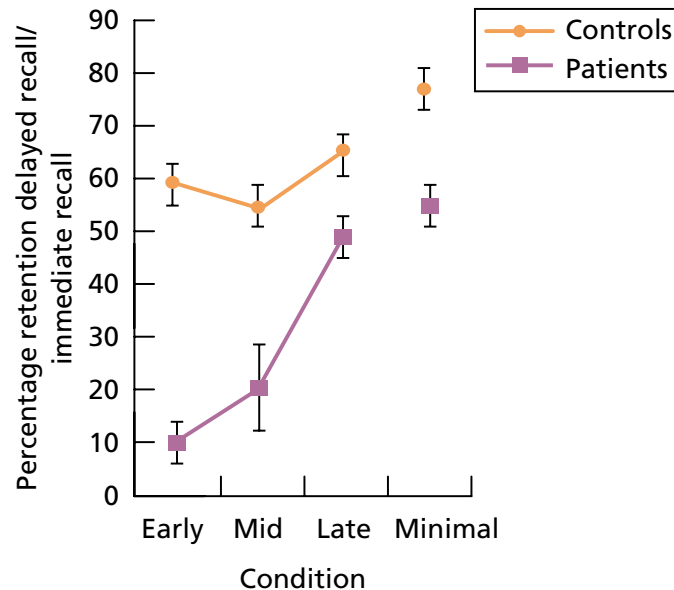


Figure 16.2: Dewar et al.'s (2009) study showed that amnesic patients are very susceptible to the disruption by later activity of the process of consolidation, particularly during its early stages. From Dewar et al. 2009. Copyright © American Psychological Association. Reprinted with permission.

RETROGRADE AMNESIA

Whereas anterograde amnesia refers to the failure to acquire new memories, retrograde amnesia refers to the impaired capacity to retrieve old memories. Patients often suffer from both; however, the severity of anterograde is not highly correlated with degree of retrograde amnesia, suggesting different origins (Greene & Hodges, 1996; Shimamura & Squire, 1991). For example, two patients studied by Baddeley and Wilson (1986) both had dense but pure amnesias with high and well-preserved intelligence, but one (Keith, described earlier) appeared to have excellent retrograde memory and could, for example, talk in great detail about his wartime experiences, whereas the other had at best only a hazy memory of his past. He knew he had been in the Navy and gone to university but could not remember in what order; he knew he had previously broken his arm, but could not recall how.

Measuring the degree of retrograde amnesia presents one problem that is not shared with anterograde amnesia, namely that the tester typically does not have control over the learning of the material to be recalled, as learning might have occurred many years before. An early attempt to quantify degree of retrograde amnesia was made by Sanders and Warrington (1971), who presented their patients with photographs of



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KEY TERM

Personal semantic memory:

Factual knowledge about one's own past.

people who were famous for a limited period at different points in time, finding that their amnesic patients typically performed more poorly on this task than controls. They also observed that earlier memories were better preserved, so-called *Ribot's law*. This asserts that older memories are more durable than those acquired more recently (Ribot, 1882).

A number of similar scales have subsequently been developed using a range of material, including news events, winners of classic horse races, and TV shows that aired for a single season (e.g., Squire, Haist, & Shimamura, 1989). This general method suffers from two practical problems. First, the degree of knowledge of news events or horse races is likely to vary substantially across patients; second, scales of this sort are, of course, continually aging, as the recent events become progressively more remote in time, hence requiring a continuous process of revising and revalidating.

An alternative method is to probe the patient's memory of their earlier life by requesting autobiographical recollections, which can then if necessary be checked through a spouse or carer (Zola-Morgan, Cohen, & Squire, 1983). Unfortunately, this is a somewhat laborious process; patients tend to produce large amounts of material, which must then be transcribed, checked, and evaluated, not a very practical method in a busy clinical context.

In an attempt to reduce these methodological problems, Kopelman, Wilson, and Baddeley (1990) developed the Autobiographical Memory Interview (AMI), which involved asking people to remember specific information selected from a range of time periods. Some were remote, for example the name of their first school, others intermediate, such as their first job, yet others probed more recent events, such as where the patient spent last Christmas. These were essentially factual questions that could be regarded as probing a form of **personal semantic memory**. In addition, for each life period, participants were asked to recollect a *specific* personal event. An example from childhood might be winning a race at school. These episodic recollections were then rated in terms of amount and specificity of information retrieved.

The test was validated using both healthy people and a range of patients and was found to be sensitive and reliable. Even patients with Korsakoff syndrome, who are commonly believed to be inclined to confabulate, produced either accurate recall, as validated by relatives, or simply said they could not remember (Kopelman et al., 1990). This and related scales have been used increasingly widely in line with the



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increased interest in autobiographical memory and its disorders (see Chapter 11). Retrograde amnesia generally leads to impairment in autobiographical memory on both the personal and the semantic scales. However, cases who show differential impairment do occur. De Renzi, Liotti, and Nichelli (1987) describe an Italian woman who could remember events of her personal life very well, but recalled virtually no public events, neither the war which she had lived through, for example, nor the assassination of the Italian prime minister. The only public event that she seemed to remember was the wedding in England of Prince Charles to Lady Diana Spencer, who she described as a scheming girl just like the one that married her own son; a public event that she had personalized. Other studies have reported the opposite pattern. Dalla Barba, Cipolotti, and Denes (1990) describe a patient with alcoholic Korsakoff syndrome and a severe episodic memory deficit who was good at recalling famous people and events but could not remember aspects of personal autobiography.

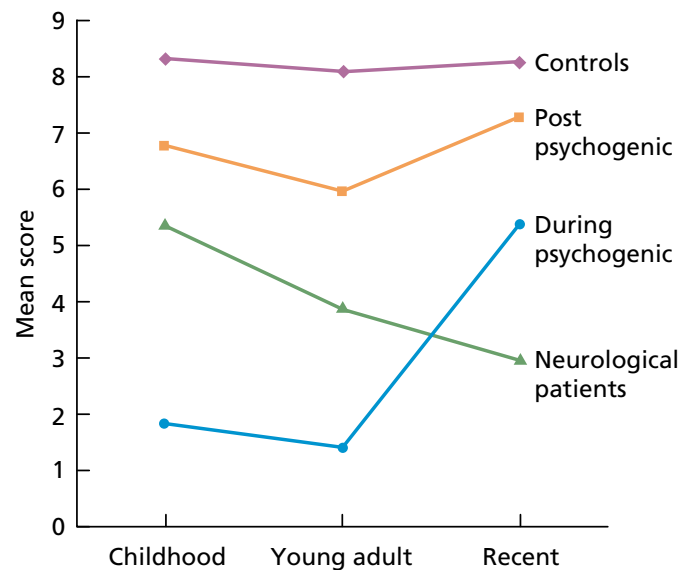


Figure 16.3: Recall of autobiographical events by patients suffering from psychogenic amnesia and neurological memory-disordered patients. The psychogenic group show particularly marked loss of memory from childhood and young adulthood during the amnesic episode, but show a much more normal pattern on recovery. Neurological patients remember earlier incidents better. Data from Harrison et al. (2017).



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It is important to distinguish between retrograde amnesia resulting from neurological damage and psychogenic amnesia that is typically a temporary state associated with emotional stress (see Chapter 10, pp. 318, 331). Figure 16.3 shows the pattern of retrograde amnesia as measured using the autobiographical episodes component of the Kopelman et al. (1990) test, given both during and after memory recovery (Harrison et al., 2017). During the psychogenic amnesic phase more distant memories are less likely to be recalled, a pattern that disappears following recovery. The opposite pattern is shown by the neurological patients, a pattern that tends to persist over time.

Confabulation

Confabulation occurs when the reported autobiographical information is false but not intentionally misleading. A distinction can be made between spontaneous and provoked confabulation. Provoked confabulation can occur as a result of an amnesic patient's attempt to fill in a gap in knowledge, so as to avoid embarrassment. In one sense this is not too different from normal behavior, when we might produce a reasonably accurate account but include detail beyond what we can really remember, perhaps to make a better story. Spontaneous confabulation tends to be much more florid, is less common, and tends to be linked to frontal lobe damage.

Consider, for example, patient RR mentioned in Chapter 4, who had extensive bilateral damage to his frontal lobes following a driving accident (Baddeley & Wilson, 1988). When asked about the accident, he happily provided a detailed account that involved his getting out of his car and carrying out a polite but extremely repetitive conversation with the driver of the lorry that had hit him, with each apologizing to the other multiple times. He had in fact been unconscious for a lengthy period following the accident and could almost certainly not remember it. He was no longer capable of driving and gave a totally implausible account of how he had subsequently driven himself to the rehabilitation center, giving a lift to a fellow patient he rather ungallantly described as "a fat piece." Confabulation can also result in action. On one occasion, RR was found heading along the road outside the center pushing a fellow patient in a wheelchair to show his friend a sewage farm he was working on as an engineer. He had in fact worked on such a project, but it was many years ago and a good distance away.

Confabulation is typically found in patients with a dysexecutive syndrome, disruption to the operation of the central executive component of working memory (see Chapter 4, p. 82), resulting from damage, typically to both frontal lobes. This probably



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interferes with autobiographical memory in two ways. First, such patients have difficulty in setting up appropriate retrieval cues. The previously described patient RR, for example, was very poor at generating items from semantic categories. Given the category *animals*, for example, he produced *dog ... animals ... there must be thousands of them! ... Did I say dog?* However, given appropriate retrieval cues, *an Australian animal that hops*, for example, he readily came up with the right answer.

A second problem is that of evaluating the outcome of a memory search, with the result that information that would clearly be implausible to most normal or indeed most brain-damaged people is accepted and elaborated. RR responded in an autobiographical memory study to the cue word *letter*. He described sending a letter to an aunt recounting the death of his brother Martin. When he was reminded that Martin visited him regularly, he accepted this, claiming falsely that his mother had had a later son, also called Martin (Baddeley & Wilson, 1986).

Explaining retrograde amnesia

There have been fewer studies of retrograde than anterograde amnesia, and less extensive theoretical analysis. This has begun to change in recent years with a number of models proposed, often accompanied by computer simulations to check that they are indeed able to predict the results claimed. Three of these models—those of Alvarez and Squire (1994); McClelland, McNaughton, and O'Reilly (1995); and Murre (1996)—differ in detail, but all assume that the hippocampus and surrounding regions play a crucial role in memory consolidation. They typically assume two types of consolidation. The first, *hippocampal consolidation*, a relatively rapid process, operates at the cellular and subcellular level and involves the initial encoding of new information within the hippocampus. A second more long-term process termed *systems consolidation* is subsequently involved in gradually transferring information from the hippocampus to other brain regions for more long-term storage. These two types of consolidation are not, of course, mutually exclusive, although failure to consolidate at a cellular level will presumably interfere with any subsequent system consolidation.

The above three models differ in detail but all assume that the hippocampus and associated regions act as an intermediary, detecting and storing novel information at a relatively rapid rate, then holding it while it is gradually transferred to more cortical areas. Unlike hippocampal storage, which is relatively rapid but temporary, links within the cortex are assumed to take longer to set up, but are more durable. This



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consolidation process continues to progress within the neocortex after traces have been lost from the hippocampus, with the result that memory traces that have been in the brain for many years will be particularly robust, thus accounting for Ribot's law, the greater durability of early memory traces. The extent to which this process is consistent with my recent view of the hippocampus as a system for attaching retrieval cues rather than a basic learning system remains to be explored.

An alternative model is offered by the Multiple Trace Hypothesis, proposed by Nadel and Moscovitch (1997, 1998). They argue for the role of the hippocampus in *retrieval*, as well as encoding. They accept a version of the model just described, which they refer to as the "standard model," but assume that the process of long-term consolidation sets up recorded traces of experience within the hippocampal complex, leading to multiple replicas of earlier experiences. However, while this explains why retrieving memories is an effective method of learning as shown by Karpicke and Roediger (2008; see Chapter 5, p. 127), this does not explain why some densely amnesic patients have good long-term autobiographical memory while others do not (Baddeley & Wilson, 1988). The question of whether this or one of the more standard models gives the better account of retrograde amnesia remains an open question.

The study of relative "pure" memory disorders and their links to clearly specified areas of the brain has proved enormously useful in developing both our theories of memory and our knowledge of brain function. However, the typical clinician is likely to encounter many more patients for whom a serious memory deficit is only one of a range of symptoms, and where the association between the deficit and its anatomical localization is often unclear. From the patient's viewpoint, however, regardless of its origin, a memory deficit can be a crippling affliction. It is therefore important to study memory performance in diseases of this type, and to try to develop methods of helping patients to cope with the associated memory problems.

POST-TRAUMATIC AMNESIA AND CONSOLIDATION

On recovering consciousness, a patient with TBI from a severe fall, for example, is likely to move into a state of **post-traumatic amnesia (PTA)**, in which attention can be disturbed and the capacity for new learning grossly impaired. Once again, it is important to be able to monitor this gradual recovery, and to do so a number of scales have been devised (Levin & Hanten, 2002). A study by High, Levin, and Gary (1990) monitored the progress through PTA of 84 patients whose brain injury



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KEY TERM

Post-traumatic amnesia

(PTA): Patients have difficulty forming new memories. Often follows a severe concussive head injury and tends to improve with time.

was sufficient to lead to coma. They typically first recovered *personal knowledge*, who they were; followed by *place*, where they were; and finally *temporal orientation*. The estimated current date was typically displaced backwards, especially in more severe cases, where there could be an error of up to five years. As the patients recovered, the degree of error reduced, reflecting a shrinkage of their retrograde amnesia.

Length of time in PTA can vary considerably, and provides a rough, although not infallible, guide to level of probable recovery (Levin, O'Donnell, & Grossman, 1979). Having recovered from PTA, the patient is likely to be left with a degree of retrograde amnesia. This might initially be quite extensive, but will shrink over time, as in the classic case described below.

*A green-keeper, aged 22, was thrown from his motorcycle in August 1933. There was a bruise in the left frontal region and slight bleeding from the left ear but no fracture was seen on X-ray examination. A week after the accident he was able to converse sensibly and the nursing staff considered that he had fully recovered consciousness. When questioned, however, he said that the date was February 1922, and that he was a school boy. He had no recollection of 5 years spent in Australia and 2 years in the UK working on a golf course. Two weeks after the injury he remembered the 5 years spent in Australia and remembered returning to the UK; the past 2 years were, however, a complete blank as far as his memory was concerned. Three weeks after the injury, he returned to the village where he had been working for 2 years. Everything looked strange and he had no recollection of ever having been there before. He lost his way on more than one occasion. Still feeling a stranger to the district he returned to work; he was able to do his work satisfactorily but had difficulty in remembering what he had actually done during the day. About 10 weeks after the accident the events of the past 2 years were gradually recollected and finally he was able to remember everything up to within a few minutes of the accident.
[Russell, 1959, pp. 69–70]*

The shrinkage in degree of retrograde amnesia is variable and typically less dramatic than that shown by our Australian green-keeper. The dense period of continuing amnesia immediately preceding the TBI is, however, very characteristic. Is the



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problem one of registering the experience in the first place, or consolidation of the memory trace? Light is thrown on this issue by a study by Yarnell and Lynch (1970) of American football players who have been “dinged.” As they were led off, the investigator asked the name of the play that had led to the collision (e.g., Pop 22). Typically, the player could remember it immediately, but not when questioned later. Although other interpretations are possible, this certainly is consistent with a lack of early neural consolidation of the memory trace.

There has, in recent years, been a growing interest in the long-term effects of playing high-contact games like American football. Gina Geffen, an Australian neuropsychologist, was asked to examine an Australian-rules football player who had sustained a head injury. To obtain a comparison group, she tested a number of his colleagues using a test of speed of semantic processing developed by Baddeley, Emslie, and Nimmo-Smith (1992). This involves the patient in reading a series of brief sentences that are either obviously true or obviously false. Typical positive sentences are *Nuns have religious beliefs* and *Shoes are sold in pairs*. Negative sentences are created by recombining positive instances, as in *Shoes have religious beliefs* and *Nuns are sold in pairs*. Go to Box 15.3 (p. 485) to try the test yourself.

Geffen found that not only her patient but also his team-mates in this extremely vigorous sport were somewhat slowed on this sensitive speed test of semantic processing (Hinton-Bayre, Geffen, & McFarland, 1997). Others have found similar results in other high-contact sports players, and regular testing has now become an important feature within American football and increasingly in other sports (Sahler & Greenwald, 2012). This residual deficit is of course much less severe than that found in PTA, and in American college football players typically appears to resolve within a few days (McCrea et al., 2003), although a too speedy return to playing can increase the chance of a further incident and lead to slower recovery particularly in the immature brain when it can prove fatal.

Cognition may typically recover from a mild head injury in 1–3 weeks, with a recovery rate of 1–3 months for a moderate to high TBI (Schretlen & Shapiro, 2003), although the effects tend to be cumulative meaning that players who suffer repeated head injuries should certainly retire. An important reason for this is the association between TBI and later dementia where a recent study by Fann et al. (2018) using an extensive Danish population study found that people reporting TBI during their twenties were 63% more likely to suffer from AD during the next 30 years. As someone who has experienced a couple of instances of mild TBI playing rugby



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however I am glad to point out that the actual incidence of such early dementia is still quite low, 5.3% versus a baseline of 4.7% of this Danish sample population. However, a recent study of professional American football players by Randolph, Karantzoulis, and Guskiewicz (2013) involving 513 retired NFL players aged 50 or older, found preliminary evidence that some 35% showed signs of mild cognitive impairment (MCI) a condition that is predictive of progression to dementia. This is already giving rise to law suits in the US, and internationally to an increasing concern regarding sports-based concussive injuries, notably in Rugby Union where the laws of the game have been changed in an attempt to reduce contact with the head.

REHABILITATION OF PATIENTS WITH MEMORY PROBLEMS

As discussed earlier, attempting to enhance memory function in dementia is an uphill struggle, given the progressive nature of the disease and its tendency to impact on an increasingly wide range of cognitive, social, and emotional capacities. Fortunately, many memory problems are not progressive, and here, the psychologist can certainly help, not to restore memory function, but to enable the patient to make full use of remaining skills and capacities. Consider for example the biker I described in the TBI section. He would be expected to have a normal life expectancy accompanied by memory problems. How might a psychologist help him, and others suffering memory deficits from stroke or encephalitis or alcoholic Korsakoff syndrome? This will of course depend on the individual patient, their age, the severity of their memory deficit, and importantly what specific aspects of their life are most important to them. The therapist cannot bring back their memory but may be able to help them solve at least some of the everyday problems they face.

Let us begin with the biker mentioned earlier. Although there is likely to be some spontaneous recovery of cognitive function, full recovery of episodic memory after serious TBI is unlikely. Our own study of everyday memory in TBI found no difference in memory performance between patients tested a few months after injury and those whose injury had occurred several years before (Sunderland, Harris, & Baddeley, 1983). However, it is certainly possible to help the biker to make the most of his remaining memory capacity. An important aspect of any treatment is its evaluation, monitoring to check whether treatment is actually leading to an improvement over and above any recovery that might have spontaneously occurred over time. What treatments are possible and how could they be evaluated?



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EXTERNAL AIDS

For most patients, the main way of supplementing their impaired memory is through external aids, changing the environment in a way that helps them remember. Typical strategies for severe deficits such as occur in Alzheimer's disease might, as discussed earlier, involve labeling cupboards, drawers, and doors, perhaps providing signposts from one room to the next. More generally, patients with severe memory problems benefit from building in a consistent routine, whereby objects are always kept in the same place, and everyday tasks always done in the same order. In all of these cases, of course, learning is necessary and the patient may well need considerable help from the psychologist, occupational therapist, and most importantly from a carer.

Fortunately, however, most patients subsequently develop at least some coping strategies independently or with the help of carers, although for patients with dense amnesia these are usually not enough to live independently, although there are occasional exceptions. One such case is that of JC, who was a first-year law student at Cambridge University when he experienced an epileptic seizure during a tutorial caused by a brain hemorrhage. This left him with a very pure but dense amnesia, but otherwise intellectually unimpaired. In due course he underwent rehabilitation, being taught to use external aids, mnemonics, and rehearsal strategies. He made very good use of both a diary and a notebook and in due course recovered sufficiently to help in his father's shop. This potentially caused problems when he had to leave the counter and fetch a particular article for the customer. He coped here by subvocally verbalizing the item and a brief description of the customer, for example, "blue tights for Mrs Pointy Nose."

He went on subsequently to develop what he described as "The Grand Plan" which involved a weekly sheet on his desk, a daily sheet with details from the weekly sheet and one of appointments from his diary, using a Filofax with different colored sheets for different activities and different individuals. He supplements this using a Dictaphone on which he records events as they occur, carefully transferring them every evening. This is an abbreviated account of an extremely carefully devised and complex system that JC followed rigorously and remarkably successfully. Using it he was able to live independently, and to take a course in furniture renovation that allows him to support himself (Wilson & Watson, 1996).

While the case of JC demonstrates that it is possible to live an independent and full life despite an extremely severe amnesia, he is clearly quite atypical in his



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intelligence, determination, and preparedness to organize his life in extreme detail. What about the rest of us?

Help has come from the increasingly sophisticated development of electronic devices such as pagers and mobile phones. While these are used widely, there is often little effort to assess their usefulness. A valuable exception to this came from a study of NeuroPage, a system developed by a neuropsychologist and an engineer who is the father of a young man who sustained a severe TBI (Hersh & Treadgold, 1994). Wilson, Evans, Emslie, and Malinek (1997) sought to evaluate the system in the United Kingdom, initially starting with 15 patients with memory/or planning problems. Each client selected a behavior they wanted to remember each day (e.g., “Take your tablets”; “Prepare your packed lunch”). Over a six-week baseline, relatives monitored whether or not the targets had been achieved. The patients were then provided with the reminder system NeuroPage for a period of 12 weeks. NeuroPage is a simple paging device that can be set up to ring or buzz at prespecified times, at which one press of a button will present a message. The pager increased target behaviors from an average of 37% correct at baseline to over 85% during treatment. A major advantage of this approach is that it is usable by a wide range of patients varying in their neurological problems and in their cognitive capacity. It is now of course possible to deliver a similar service by a mobile phone, although the simplicity of the original NeuroPage device is likely to make it easier to use for older patients.

So does this remove the need for the psychologist? Certainly not, since the NeuroPage experience showed that its effectiveness depended crucially on first of all establishing exactly *what* is important for the patient, programming it accordingly and ensuring that the patient actually uses the system, which is not as straightforward as it might seem. It is important to recognize that almost any system for improving a patient’s everyday memory will require some degree of new learning. So how can this be achieved?

INTERNAL AIDS

This term refers to ways in which a patient can be helped by acquiring new habits or strategies, a task that becomes more difficult the more severe the amnesia, and the more extensive the accompanying problems. However, in practice, almost all patients have some preservation of episodic memory with truly dense amnesia being rare, so it is important to make full use of any residual memory capacity. Learning is likely to be difficult, and hence it is important to focus it on specific problems that particularly concern the individual patient, trying to ensure that steady progress is made, and for



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motivational reasons, that this is visible to the learner. As different patients will have different priorities and different preserved capacities, group evaluation is often not practical. However, a series of single-case methods originally derived from Skinnerian approaches to learning have been fruitfully adapted for clinical use.

All single-case treatment methods involve beginning with a measure of *baseline performance* across a series of trials before treatment is introduced. This baseline is used to determine whether genuine progress has been made by noting if improvement begins or greatly accelerates *only* after treatment has begun. It may however be possible to treat several problems at the same time, in which case it is sensible to introduce the different treatments at different points, to ensure that the patients are not simply showing a period of spontaneous recovery in overall cognition.

One such study is described by Wilson (1987) who attempted to teach amnesic patient TB, a 43-year-old man with Korsakoff syndrome, three relevant activities. The first activity involved finding his way around the rehabilitation center. This improved spontaneously and hence needed no further treatment. The second, reading and remembering a news story, applied a system known as PQRSST to reading and remembering, in this case using as an example a newspaper paragraph. PQRSST is an acronym for *Preview, Question, Read, State, and Test*. Learning to apply this approach greatly improved performance. The third task of face-name learning was based on the use of imagery, for example remembering the name of a therapist called Stephanie might be remembered by imagining her sitting on a step and clutching her knee, a method which, in this case, proved highly effective. Not all strategies suit all patients, however; the use of imagery can be too demanding for some patients, while another patient who was entirely capable of using it rejected it on the grounds that it was “silly.”

Visual imagery can however often be helpful for name learning, as shown in Figure 16.4. This uses another variant of single-case design, in this example by using the same imagery-based strategy but applying it to several patients, always establishing a flat baseline before subsequently introducing the imagery strategy. Note that in each case, improvement occurs only after the strategy is introduced, making clear its causal role in the improvement observed.

We have described two methods of enhancing learning, and in general, approaches that facilitate learning in healthy people such as those described in Chapters 11 and 17 are also likely to be potentially useful for patients, although progress is likely to be slower. There is however one important exception to this. The retrieval practice effect described in Chapter 5 (p. 126) which proves so powerful for healthy learners can



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create problems for amnesic patients. Repeated attempts at retrieval may enhance learning in healthy young college students, but are not advisable for amnesic patients for whom errors made at retrieval can be particularly persistent and disruptive. This conclusion stems directly from the application of the results of basic research in cognitive psychology.

You will recall from Chapter 5 (p. 143) that a distinction can be made between explicit and implicit memory, with explicit episodic memory being impaired in amnesic patients, while a range of implicit learning tasks are preserved. We were tantalized by the question of whether these preserved capacities could be used to help the patient.

Reflecting on the characteristics of the preserved tasks, it seemed to us that many were either procedural tasks in which time rather than errors was the mark of success, or as in the case of classical conditioning in which the conditioned response is evoked automatically by the conditioned stimulus. In contrast, typical episodic memory tasks are measured in terms of error reduction. Could it be that the absence of episodic memory might make it particularly difficult for amnesic patients to remember their earlier performance and use this to avoid future errors? We decided to test this by contrasting a learning situation in which people were encouraged to guess if uncertain, a strategy often encouraged by therapists, with one that minimized errors. Errorless learning had previously been shown in pigeons by Terrace (1963) and for a time was applied to assist learning-disabled people (Sidman & Stoddard, 1967). By this time however it appeared to have been abandoned clinically, or recommended as a final strategy only if normal learning had failed, by which time disruptive errors would of course already have become established.

Our own approach to errorless learning began with a task based on stem completion and involved presenting a series of five-letter words, cued by presenting the first two letters. Words were selected so that when given the first two letters there were several potential completions, for example *quote*, *quiet queen*, and *quite*. In the errorful condition participants were encouraged to guess the answer both initially and during learning. People in the errorless condition were told the answer each time, for example "I am thinking of a five-letter word beginning with QU and the word is QUOTE, please write it down."

We compared three groups, amnesic patients, elderly controls, and young controls. They were tested over nine trials with rest points in between each group of three trials (Baddeley & Wilson, 1994). Results showed little difference between the two



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learning conditions for the young or normal elderly group, who seemed to have no difficulty in dealing with earlier guesses, while the errorless learning condition was substantially better for the amnesic patients.

It could of course be argued that we had used a very artificial task that might not generalize. We therefore moved on to a subsequent study using single-case treatment designs, in each case comparing errorless learning to the standard error correction approach. We studied a number of patients on several practically relevant learning tasks (Wilson, Baddeley, Evans, & Shiel, 1994). One task involved learning to use an electronic device; our amnesic patient succeeded using the errorless approach but failed completely to learn an equivalent task using an error-prone approach. Other patients showed a clear errorless advantage in tasks such as learning the names of staff, acquiring general knowledge, and orienting themselves in time and location. Barbara Wilson immediately changed her clinical practice which had previously been to encourage patients to guess if unsure.

The method has subsequently been widely used, not only with amnesic patients (Kessels & de Haan, 2003) but also with aphasic (Fillingham, Hodgson, Sage, & Lambon-Ralph, 2003) and schizophrenic patients (O'Carroll, Russell, Lawrie, & Johnstone, 1999). It is now widely used in memory rehabilitation, not because it guarantees learning but because it is a patient-friendly approach that facilitates learning by optimizing the use of implicit memory and minimizing a major source of difficulty and frustration in memory-impaired patients (Middleton & Schwartz, 2012).

CONCLUSION

Our understanding of human memory has benefitted greatly from the study of patients with memory deficits, particularly in those cases where the deficit was limited to a specific memory system. This knowledge has fed back into the memory clinic, helping in the assessment, diagnosis, understanding, and in the treatment of the patient's memory problems. As such the cognitive study of memory provides one component of the array of clinical knowledge and skills available to the clinical neuropsychologist. Unfortunately, these will not "cure" the memory deficit, but they can maximize the capacity of patients to cope with their affliction.



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SUMMARY

- Many kinds of disruption of normal brain function result in problems of learning and memory.
- These can be very severe and tend not to be reversible.
- Memory problems are a principal feature of Alzheimer's disease.
- The disease is progressive with increasing disruption of other aspects of cognition.
- With an aging population, dementia is a growing problem.
- Alzheimer's disease is its most common form involving a memory deficit of increasing severity.
- Traumatic brain injury (TBI) is nonprogressive and may occur at a young age and persist over a lifetime.
- Episodic memory is particularly vulnerable and disabling across a wide range of causes of memory disorders.
- It is found in its purest form in the amnesic syndrome.
- Its principal feature is anterograde amnesia, failure to lay down new episodic memories.
- Implicit learning and memory are typically preserved.
- Anterograde amnesia is thought to result from failure to associate experiences with their context or location in time and space.
- This in turn is commonly thought to result from impaired consolidation of the episodic memory trace.
- Retrograde amnesia involves failure to access earlier memories including those acquired before the onset of amnesia.
- There is typically a gradient with items acquired earlier in life being better preserved.



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- Traumatic brain injury occurs when a blow or sudden deceleration cause damage to the white matter through sheering or twisting.
- In severe cases, a period of coma may be followed by post-traumatic amnesia during which attention and new learning is disturbed.
- Both retrograde and anterograde amnesia will typically follow but become less severe over time.
- While organic memory deficits cannot be reversed, patients can be helped to cope.
- External aids such as diaries, reminders, and pagers offer the most extensive help.
- Patients still need to be trained to use these and to acquire other information; methods of achieving this are discussed.

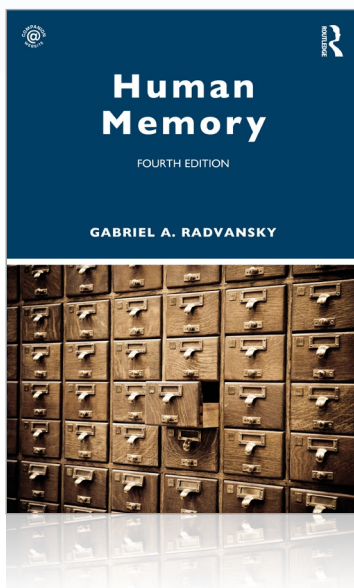
POINTS FOR DISCUSSION

1. Why is amnesia so disruptive of everyday life?
2. What are the central cognitive problems for patients with Alzheimer's disease?
3. How can they be helped?
4. How might the practical memory problems for a young person with TBI differ from those of an older AD patient?
5. What are the similarities and differences between anterograde and retrograde amnesia?
6. How might the autobiographical memory profile differ between a patient with a pure amnesia and one with an emotionally based functional amnesia?
7. How might this influence their personal life?
8. What are the strengths and weaknesses of single-case treatment designs?

CHAPTER

2

FORGETTING



The following is excerpted from

Human Memory

By by Gabriel A. Radvansky.

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FORGETTING

By Gabriel A. Radvansky

Excerpted from *Human Memory*

When our memories are working well and we can retrieve the knowledge that we need, we do not typically notice it. However, when our memory fails us, and we forget things, we are much more aware of its limitations. In general, when people take an interest in memory, the focus is not on remembering, but on the failure to remember, namely forgetting and how to avoid it. The type of forgetting that is of concern here is the normal, standard, everyday kind of forgetting that we experience in our lives. When the loss of information in memory exceeds this expected amount, it is no longer normal forgetting, and it crosses over into a catastrophic memory loss that is amnesia, which is the topic of Chapter 10. Often that kind of forgetting is due to some sort of trauma. Normal forgetting is not due to something wrong with the mind or brain but, instead, is a consequence of the normal operation of memory and how it manages information.

In our consideration of forgetting, and the idea that forgetting is something bad, we begin with Schacter's Seven Sins of Memory, along with a consideration of why these sins may actually be virtues. This is followed by coverage of the viability of decay, or the passage of time, as a mechanism of forgetting. After that, we consider one of the primary mechanisms of forgetting, namely interference. This is followed by a discussion of inhibition, which is used to regulate the influence of interference. After this we consider when people deliberately seek to forget information with directed forgetting and the management of knowledge that has been explicitly retracted. Then, we consider two aspects of experience that can influence the rate of forgetting, namely the collaborative forgetting that can occur when you try to remember things along with other people, and the influence of drugs and alcohol on forgetting.

THE SEVEN SINS OF MEMORY

In his book *The Seven Sins of Memory*, Schacter (2001) laid out memory problems as if they were seven sins. His seven sins of memory are: (1) transience, (2) absent-mindedness, (3) blocking, (4) misattribution, (5) suggestibility, (6) bias, and (7) persistence. An overview of each of these is presented here, followed by reasons why these seven sins may be virtues. Keep these in mind when you consider both parts of this chapter and other parts of this book.

TRANSIENCE

The first sin of memory is transience. This is the idea that memories are forgotten with the passage of time. This is reflected in the Ebbinghaus forgetting curve



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introduced in Chapter 3. As a reminder, the more time that passes, the more likely that information is forgotten, with forgetting being more rapid early on and then slowing down as time progresses. Keep in mind that not all aspects of a memory are forgotten at once. Memories may still be present but become fragmented. The gaps in these memory fragments may be filled in with general knowledge (see Chapter 9). Thus, memory can go from being reproductive, in which the prior knowledge is brought back into working memory, to being reconstructive, in which people fill in the gaps that are created by forgetting. Alternatively, people may remember different features of objects or events but not remember to which they belong (Utochkin & Brady, 2020). For example, people may remember seeing two boxes and that one was open, but not remember which.

ABSENT-MINDEDNESS

The second sin of memory is absent-mindedness. This is the idea that people are not paying attention when information is first encountered (and so it is never encoded into memory). As an example, Henkel (2014) had students at Fairfield University visit a museum. While there, they just looked at some objects and took photos of others. What she found was that when people took photographs, they remembered less than when they simply looked at the object. This happened because the act of taking a picture takes your attention away from what is going on, so you remember it less well.

Alternatively, absent-mindedness could occur if information makes it into memory, but people somehow fail to retrieve it. This reflects the distinction between availability and accessibility. Availability is whether a trace is even present somewhere in memory. It may not be available either because it was never encoded, or it was permanently lost. In comparison, accessibility is the idea that the trace is somewhere in memory, but the issue is whether people can successfully get to it. Sometimes forgetting occurs when a memory is available, but not accessible. Failure of accessibility can sometimes be overcome, as with cuing, or with the phenomena of reminiscence and hypermnesia, discussed in Chapter 3, in which previously forgotten information is remembered later. These memories were available but not accessible until later.

Another issue that absent-mindedness is relevant for is how does having attention divided among multiple tasks then influence later memory? Divided attention during learning clearly disrupts encoding, so we will not go too much into that here. Of more interest is whether dividing attention during retrieval disrupts performance (Baddeley



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et al., 1984; Rohrer & Pashler, 2003). Distraction during retrieval can slow the rate at which information is remembered, but overall accuracy is less affected, if at all. That said, divided attention can disrupt memory retrieval when the distracting task uses the same cognitive/neural systems (Fernandes & Moscovitch, 2000); for example, if you were trying to recall a list of words while at the same time listening to another set of words to assess whether any were repeated three times in a row. There may actually be some benefits for divided attention during retrieval. Kessler et al. (2014) found that dividing attention at retrieval can boost later memory, particularly if there is a 24-hour delay between learning and the first memory test. The effort needed to compensate for the retrieval difficulty on the first test boosts the memory, making it better retained and remembered.

BLOCKING

The third sin of memory is blocking. This is the idea that people have trouble accessing a desired memory because others get in the way. That is, these other memories block access to the desired one. For example, you may try to think of a person's name, but other, similar names keep popping up in your mind. This is the sin of memory that gets the most attention in this chapter when we discuss interference and inhibition. An idea that fits well with the blocking principle is the concept of cue overload in which the more things that are associated with a memory cue (i.e., the more memory traces that share that element), the less effective that cue is. The more memory traces associated with a cue, the more these other traces interfere with or block access to the desired memory. This harkens back to the idea discussed in Chapter 7 that the best memory cues are the ones that are most diagnostic. Diagnostic cues have low cue overload.

MISATTRIBUTION

The fourth sin of memory is misattribution. This is the idea that people can remember something but misattribute where it came from. This is a forgetting of the nature of a memory, not its content. For example, you may mistakenly remember something about President Lincoln from a textbook you read, when in fact it was in a fictional movie that you saw. Misattribution can be striking, such as a feeling of déjà vu, or the more mundane experience of simply thinking that you remember information coming from one source, when in fact it came from somewhere else. Issues of source monitoring are covered in detail in Chapter 13. Moreover, Chapter 14 covers how misattribution can influence legal issues.



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SUGGESTIBILITY

The fifth sin of memory is suggestibility. This is when memories are implanted from outside sources, possibly causing correct information to be forgotten. This incorrect information may be introduced either explicitly or implicitly and may be done intentionally or unintentionally. Regardless of the circumstances, incorrect knowledge disrupts the memory. Issues of suggestibility are discussed in Chapter 13 where issues of memory and reality are brought into focus, as well as Chapter 14 in terms of incorrect information being suggested to witnesses.

BIAS

The sixth sin of memory is bias. This is the idea that memory can be distorted toward what is currently known. For example, bias occurs if there is a forgetting of events or knowledge of your prior mental states, as a function of what is currently known. This was briefly covered in Chapter 3's discussion of the hindsight bias, and these memory biases are discussed in more detail in Chapter 15.

PERSISTENCE

The seventh sin of memory is persistence. This is when memory is compromised by incorrect knowledge that should be forgotten, but it is not. In other words, a failure to forget can be a problem. This incorrect information continues to infiltrate our stream of thought and distort memory, decision making, and thinking in general. The avoidance of persistence is covered in this chapter in the sections on directed forgetting and retraction.

THE VIRTUES OF FORGETTING

The seven sins of memory can also be virtues. They occur for a reason and have some adaptive value. Transience and absent-mindedness are helpful because information that is not needed over long periods of time, perhaps because it is no longer relevant, falls out of accessible memory and does not clutter up processing. The shift from reproductive to reconstructive processes is helpful when we need to abstract generalities across a wide range of situations, rather than dealing with each new event from scratch. While blocking can occur because we may know so much and have so many experiences, the inhibition that can follow from the management of it helps streamline our thought and makes it more effective and efficient.

Misattribution and suggestibility are consequences of general memory processes



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that are clearly beneficial. While some things in the world are stable and consistent, others are in flux and change. This process allows these needed memory changes to be made. Alternatively, if we learn that our understanding of the world is incorrect, we need to modify our memory. For example, as a young child (like many children) you may have known that the Earth is round but thought that it is round like a plate. Or, perhaps, you knew that it is round like a ball but thought that we live on the inside of the ball. What you needed to do was alter your memory to contain the newer, correct information to update and improve your understanding. These processes are helpful. However, they are problematic when we update memory with information that is incorrect. Finally, the persistence of memories reflects the otherwise desired ability to hold onto information that might be useful in the future. This is only a problem when we retain information that is troubling or incorrect.

As you will see, one benefit of forgetting is that it causes memories that produce interference to be taken out of the current stream of processing, and thereby be less disruptive. Thus, while the inhibition of memories may seem like a negative consequence, it can actually be a benefit (Storm, 2011). Forgetting has also been suggested by Nørby (2015) to be helpful and adaptive for emotion regulation (it keeps us from dwelling on experiences that swing our emotions too far to the extremes), helping us to be more positive and forgiving. It also allows us to abstract away from the details to conceive of generalities, and it helps us disengage from the past, allowing us to focus on the present and the future.

STOP AND REVIEW

Forgetting is a big challenge to memory. Schacter has outlined his seven sins of memory, namely transience, absent-mindedness, blocking, misattribution, suggestibility, bias, and persistence. While these are described as sins, they also reflect more general memory processes that serve as virtues. Overall, forgetting likely exists because it is more efficient to lose some information rather than maintain all of it all, most of which may become irrelevant or inappropriate.

THE FORGETTING CURVE

As described in Chapter 3, importantly Ebbinghaus (1885) showed that memory changes over time, and this change is a regular negatively accelerating function (see Figure 3.8). Forgetting curves can help identify neurological disorders. For example, forgetting is more rapid in people who have neurological diseases, such as



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Alzheimer's Dementia, epilepsy, and traumatic brain injury (van der Werf et al., 2016). This rapid loss of memories, known as accelerated long-term forgetting, involves cases in which memory appears similar in impaired and normal people soon after learning, but differences emerge over time (e.g., weeks or months) (Elliott et al., 2014).

The negatively accelerating forgetting pattern has been widely observed (Rubin & Wenzel, 1996). However, Fisher and Radvansky (2019) reported that under some circumstances the pattern of forgetting is linear. To illustrate this difference, Figure 8.1 shows Ebbinghaus's data (top) plotted with a linear scale (left) and a logarithmic scale (right). The Fisher and Radvansky data (below) are similarly plotted. As you can see, a negatively accelerating pattern does not capture all the data very well. This is important because while a negatively accelerating pattern conveys a constant loss in the proportion of memories over time, a linear pattern of forgetting conveys a constant loss in the amount of information. That is, there is an increase in the proportion lost over time.

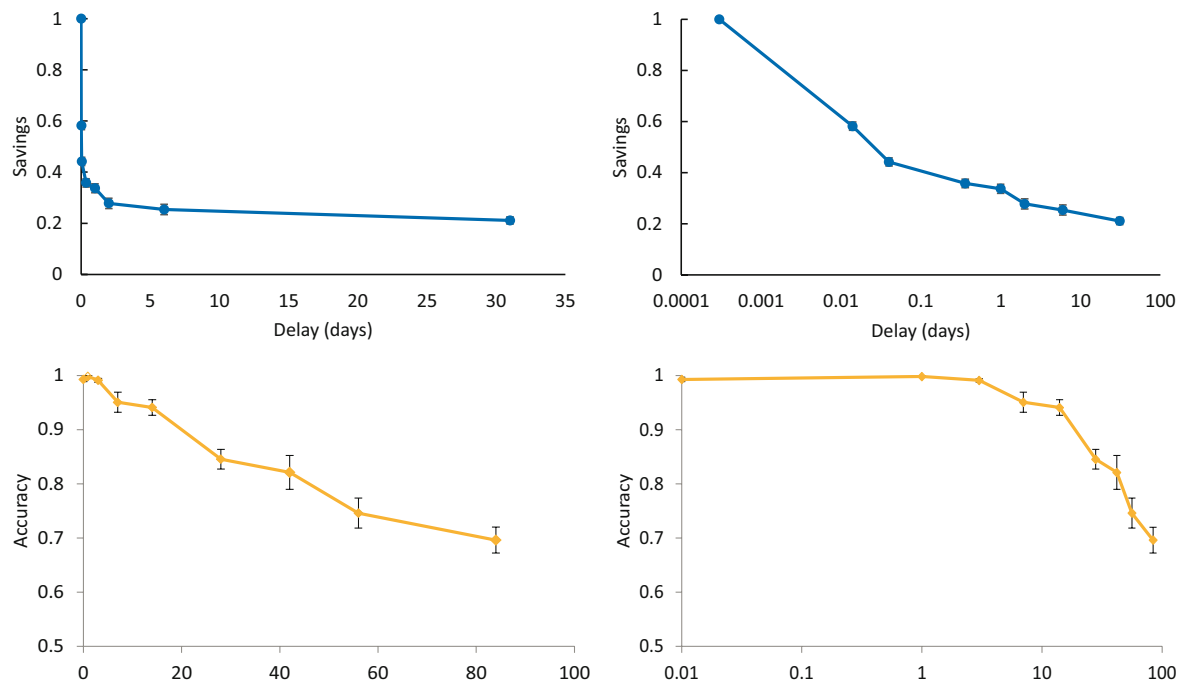


Figure 8.1: Results of the Ebbinghaus (1885) (top) and Fisher and Radvansky (2019) Studies (Below). These Data Are Plotted with a Linear X-Axis (Left) and a Logarithmic X-Axis (Right) Source: created from data reported in Ebbinghaus, H. (1885/1964). *Memory: A Contribution to Experimental Psychology*. Translated by H. A. & C. Bussenius. New York: Dover; and Fisher, J. S., & Radvansky, G. A. (2019). Linear forgetting. *Journal of Memory and Language*, 108, 104035



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Why does linear forgetting occur? For Fisher and Radvansky (2019), this occurs if some criteria are met. First, the memories have many components or features. These features are forgotten following a standard Ebbinghaus pattern. Thus, during retrieval, there is only partial information available. However, we can reconstruct memories from these partial traces, and then give an accurate response, provided a sufficient portion of the memory is still accessible. Linear forgetting reflects a kind of averaging across traces along with memory reconstruction. Linear forgetting is more likely to be observed for complex memories (e.g., mental models) where there are many parts to a memory, allowing reconstruction to be more successful.

STOP AND REVIEW

The pattern of forgetting can be regular and stable. Science should allow us to predict what will be remembered in the future, to a reasonable degree. By knowing the pattern of forgetting, we can predict how much a person will likely remember after a given period of time.

FORGETTING THROUGH DECAY AND DISUSE

An intuitive account of forgetting is that as more time passes without a memory being used, it decays away and is eventually forgotten. This is the Law of Disuse (Thorndike, 1914). Although this idea is accepted by some neuroscientists (e.g., Hardt et al., 2013), the idea of forgetting caused by decay and disuse was rejected by psychologists after a brutal critique by McGeoch (1932). McGeoch argued that the passage of time causes nothing by itself. There must be some process that is correlated with time to cause forgetting. An analogy used by McGeoch is the phenomenon of rust. While the amount of rust increases with time, the mere passage of time does not cause rust. Instead it is the oxidation of the metal over time that causes rust. Thus, the idea that forgetting is a loss of memories over time explains nothing. It is only a description of the phenomenon. For McGeoch, events that occur between learning and testing (i.e., interference) are what causes forgetting. These processes are discussed in detail later.

NEW THEORY OF DISUSE

After languishing for decades, the idea that decay and disuse play a role in forgetting was reconsidered in the New Theory of Disuse (Bjork & Bjork, 1992; 2006). This view does not assume that memories simply decay over time. It acknowledges that the more time that has passed since information was used, the less accessible it becomes, presumably because it is no longer needed. For example, if you move, your



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previous address becomes harder to remember, even though it was very well-known at one point.

An important distinction for the New Theory of Disuse is between storage strength and retrieval strength. Storage strength is how well a memory is encoded. The more practice you have with information, the greater the storage strength. In comparison, retrieval strength is the ease with which information is retrieved from memory. This distinction between storage strength and retrieval strength is analogous to the concepts of habit strength and reaction potential in the behaviorist literature (Hull, 1943). Retrieval strength is strongest just after learning and can increase with practice. However, it weakens as new information is encountered, interfering with it. Thus, this is not a decay process, but a reflection of disuse. The passage of time corresponds to encountering other information, and the ability to access well-known but unused memories declines.

One study supporting the New Theory of Disuse was by Smith and Handy (2014). They had students at Texas A & M University memorize materials with either a constant context or varied contexts. They then gave memory tests immediately and days later. While immediate memory was worse in the varied context condition, it was better days later. Why? The explanation was that with varied contexts, this mismatch (following the encoding specificity principle) impairs the ability to develop retrieval strength because each experience is different. Thus, memories are not effectively cued early on, and performance was worse. However, each experience adds to the storage strength. These more challenging learning conditions give storage strength a boost, improving performance days later. This lends further support to the idea that when you study, it is to your benefit to do so in different places at different times of the day.

This view readily explains some memory phenomena. As one example, if people have acquired a skill to a high degree, such as a golf swing, and then learn a new swing, the newer learning will initially overpower the original and dominate performance. However, if the new skill is not continually practiced, the old one will re-emerge, causing a regression to prior ways of behaving. When you try to change a bad habit, you may be successful immediately, but over time, if you do not continue to focus on changing your ways, the old habit will re-emerge. As a more memory-based example, when people learn new information, this can produce retroactive interference (detailed below) in which the new memories impede the retrieval of older memories. However, retroactive interference weakens over time and the older memories play a larger role. Proactive interference effects, in which the older memories disrupt access to the newer ones, grow stronger (Briggs, 1954; Postman et al., 1968). The



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storage strength of an older, well-engrained memory is greater than that for a new memory. As the retrieval strength of newer memories weakens, the greater storage strength of older memories comes to dominate.

STOP AND REVIEW

Early ideas about forgetting suggested that memory traces decay over time. However, this has been rejected in favor of mechanisms of interference and inhibition. The New Theory of Disuse preserves the idea that disuse leads to poorer performance and couches this in a framework that incorporates interference and inhibition.

FORGETTING THROUGH INTERFERENCE

Each experience we have alters memory. Even the act of remembering alters memory because the experience of remembering gets stored. One consequence of this is that memories compete with one another. This competition is interference. Interference is a primary mechanism of forgetting. When two or more traces have overlapping information, and you only want one of them, interference occurs. Suppose you are trying to remember your friend Mary's phone number. You remember getting the number from Mary when you met her for lunch, but Susan was there, too, and you also got her number. These two memories compete because they both contain phone numbers and the element of having lunch, thereby producing interference. Here, several kinds of interference are covered, including proactive interference, retroactive interference, associative interference, and general interference.

PROACTIVE INTERFERENCE

Proactive interference occurs when older memories impair the retrieval of newer memories (Underwood, 1957). For example, if people study psychology and then study sociology, there is greater forgetting and worse performance on a subsequent sociology test. The degree of proactive interference experienced depends on the overlap between sets of information, not on how much was learned (Postman & Keppel, 1977). If it is difficult to differentiate between memory traces because of their content, then proactive interference is experienced. This is why sociology and psychology interfere with one another. Any effort that you can make to distinguish and differentiate sets of information reduces interference, and memory improves. Proactive interference is resolved by processes in the left lateral prefrontal cortex (BA 46), although the right dorsolateral prefrontal cortex (BA 8) and parietal regions (BA 7) may also be involved (Nee & Jonides, 2008).



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The influence of trace relatedness on proactive interference has been studied extensively. When too much information of a similar type is encountered close in time, more proactive interference is experienced. When there is a break in similar types of information, memory improves, and there is a release from proactive interference. An example of release from proactive interference is a study by Wickens (1970; 1972) in which people were given lists of words to remember (see Table 8.1). The words in the first three lists were all fruits. If the fourth list were fruits again, then memory continued to decline, as shown in Figure 8.2. However, if the words belonged to a new category, release from proactive interference occurred. Moreover, the greater the difference, the greater the release. For example, vegetables are different from fruits, but they still have some features in common, whereas professions are quite distinct from fruits. The build-up and release from proactive interference occurs for real-world materials, such as televised new stories (Gunter et al., 1980). As people read more stories on a topic (e.g., politics), memory for each one declines, until there is a switch to a different topic (e.g., sports).

Condition	Trial 1	Trial 2	Trial 3	Trial 4
Fruits (control)	banana	plum	melon	orange
	peach	apricot	lemon	cherry
	apple	lime	grape	pineapple
Vegetables	banana	plum	melon	onion
	peach	apricot	lemon	radish
	apple	lime	grape	potato
Flowers	banana	plum	melon	daisy
	peach	apricot	lemon	violet
	apple	lime	grape	tulip
Meats	banana	plum	melon	salami
	peach	apricot	lemon	bacon
	apple	lime	grape	hamburger
Professions	banana	plum	melon	doctor
	peach	apricot	lemon	teacher
	apple	lime	grape	lawyer

Table 8.1: Stimulus Lists from Proactive Interference Study. Source: Wickens, 1972



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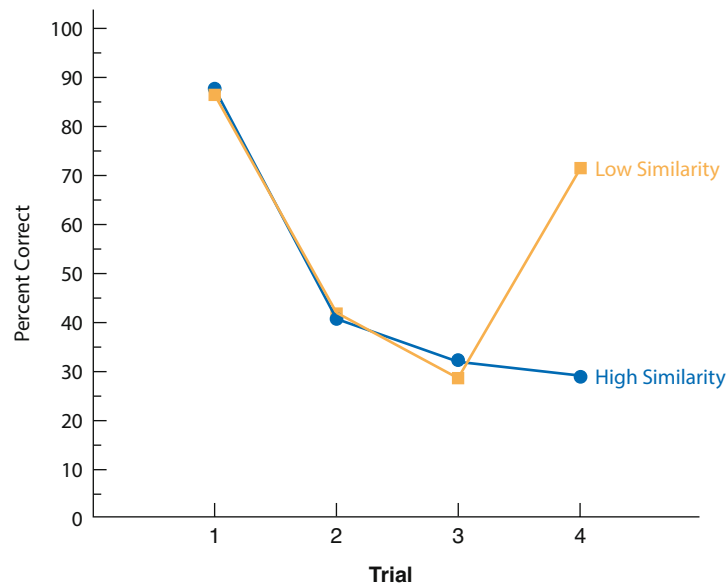


Figure 8.2: Results from a Study of Release from Proactive Interference Source: adapted from Wickens, D. D. (1972). Characteristics of word encoding. In A. W. Melton & E. Martin (Eds.) *Coding Processes in Human Memory*, pp. 191–215. New York: Wiley

The build-up in proactive interference can be because of the continued, unsegmented learning of similar types of information. If people get information with topics interleaved, rather than in blocks of related knowledge, then less proactive interference occurs (Del Missier et al., 2018). This difference between blocked and interleaved presentation is shown in Figure 8.3, along with some hypothetical data. Thus, given this, you may want to break up your studying from time to time to boost your retention.

Another way to segregate information, leading to a release from proactive interference, is by testing people prior to learning new information (Szpunar et al., 2008). Testing causes a shift in the perceived context, which leads to less interference (Pastötter et al., 2011), either because the memories may become more integrated, resulting in fewer competitor traces, reducing interference (Wahlheim, 2015), or because we are better able to monitor what we report as being part of the most recent information set (Pierce et al., 2017).

Proactive interference is also reduced by sleep. Abel and Bäuml (2014) had people learn two sets of information that overlapped in content and which produced proactive interference. This was evident for people tested immediately after learning. However, when tested 12 hours later, people who slept (learning in the evening,



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testing the next morning) exhibited less proactive interference compared to another group that was awake during the 12 hours (learning in the morning, testing later that evening). Consolidation served to separate out and distinguish the memory traces from one another, thereby reducing proactive interference.

Blocked Presentation

Category A Items	Category A Items	Category A Items	Category B Items	Category B Items	Category B Items	Category C Items	Category C Items	Category C Items
------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------

Interleaved Presentation

Category A Items	Category B Items	Category C Items	Category A Items	Category B Items	Category C Items	Category A Items	Category B Items	Category C Items
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Hypothetical Memory

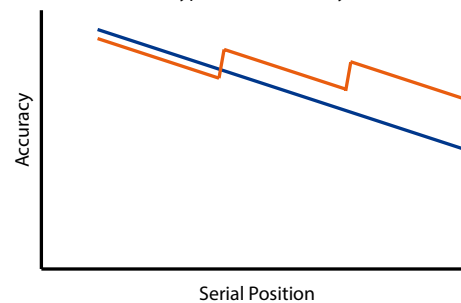


Figure 8.3: Difference between Clock and Interleaved Presentation, along with a Hypothetical Pattern of Data Source: adapted from Del Missier, F., Sassano, A., Coni, V., Salomonsson, M., & Mäntylä, T. (2018). Blocked vs. interleaved presentation and proactive interference in episodic memory. *Memory*, 26(5), 697–711

TRY IT OUT

To illustrate proactive interference, and the subsequent release from it, we use the example illustrated in Table 8.1. For this project you should have at least 12 people in each group.

Give two or more groups of people the lists of fruit names. Have them recall the words at the end of each list. For all groups, the first three lists should be the same. However, on the fourth list, vary the nature of the list depending on what condition people are in. For one group, give them another list of fruit names. However, for other groups, give them lists of words that are further and further



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removed from fruits, namely vegetables, flowers, meats, and professions. You do not need all of these groups to do this demonstration, but you need at least the first group and one other.

After people finish recalling, collect their responses and tabulate the number of correct recalls for each list. You should find that everyone gets worse from list 1 to 3, and that at list 4, the fruit group continues to get worse, but the other groups get better, with the amount of improvement being related to how different the words are from fruits.

RETROACTIVE INTERFERENCE

Retroactive interference is when newer memories make it harder to remember older memories (Melton & Irwin, 1940). A classic demonstration of this is a study by Jenkins and Dallenbach (1924) in which students at Cornell University learned lists of ten nonsense syllables. They were then tested one, two, four, and eight hours later. What is important is what they did during these intervals. They were given the lists either early in the day, so they were awake the whole time, or at night, so they were asleep during the retention period. The results in Figure 8.4 show less forgetting when the students slept than when they were awake. When we are awake, there is a continuous stream of new information (including thoughts). This produces retroactive interference, making the older information harder to remember. However, if we sleep, there is not as much new information, so there is less retroactive interference and forgetting. The degree to which retroactive interference benefits from sleep is like that observed with proactive interference (Abel & Bäuml, 2014).

With retroactive interference, newer experiences make it harder to remember older, similar experiences (Postman & Stark, 1969). For example, if you study psychology and then study sociology, you forget some of the psychology because the newer sociology memories interfere with the retrieval of older psychology knowledge. Retroactive interference is more pronounced with recall than with recognition. During recall people try to sort through many competing memory traces, allowing interference to occur. However, during recognition there are fewer traces involved because a more direct match can be made between the recognition probe and a memory trace. Thus, less interference occurs.



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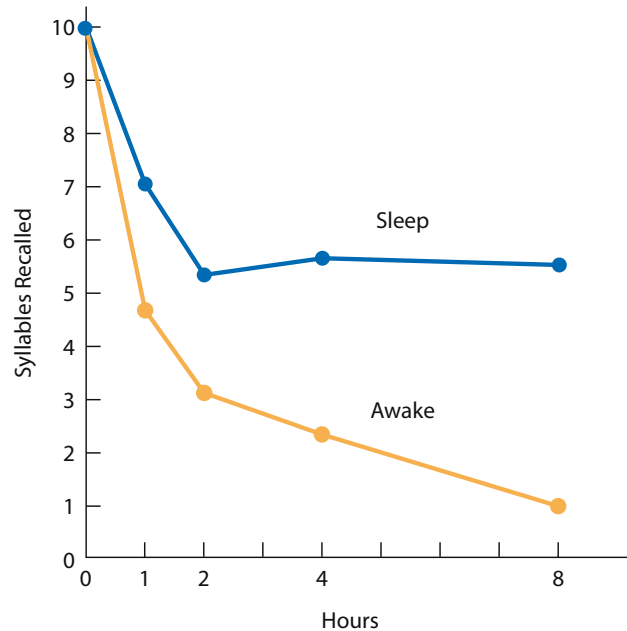


Figure 8.4: Results from a Study of Long-Term Memory Interference

Source: Created from data reported in Jenkins, J. G., & Dallenbach, K. M. (1924). Oblivescence during sleep and waking. *American Journal of Psychology*, 35, 605–622

In the verbal learning era, retroactive interference was thought of as a form of extinction, known as the unlearning of prior associations (Barnes & Underwood, 1959; Melton & Irwin, 1940). The idea was that new information causes older information to be lost or disrupted. However, this “unlearning” idea is not completely correct. Retroactive interference can subsequently be reduced or eliminated, suggesting that the original memories are still there, even if they are difficult to access. Thus, retroactive interference may only involve a disruption of the retrieval, not storage. If people are given the appropriate cues, retroactive interference is attenuated or eliminated (Tulving & Psotka, 1971).

ASSOCIATIVE INTERFERENCE

Associative interference reflects the complexity of newly learned information. The disruption of memory is not based on temporal order (as it is with proactive and retroactive interference), but on the number of associations with a concept. For example, if you have just learned five things about Jenny, you will be slower to verify any one of these than if you had learned only one thing. Associative interference can be described in terms of the fan effect. The term fan effect assumes that information



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is stored in a propositional memory network with nodes representing individual concepts and links representing the associations among them (see Chapter 18). During retrieval, the more links “fanning” off of a concept, the greater the interference from the competing associations, and retrieval time increases accordingly.

In one study, Anderson (1974) gave students at Stanford University lists of sentences to memorize, such as “The doctor is in the park” or “The lawyer is in the museum.” The number of associations with the person and location concepts (e.g., doctor or park) was varied from one to three. Thus, there were one to three places that a person could be in and one to three people in a location. After memorization, a recognition test was given. The results, shown in Figure 8.5, were that as the number of associations with a concept increased, response time also increased.

A worrisome implication is that the more you know, the harder it should be to remember. However, experts have more information than novices with no deficit in the speed of remembering. This is the “the paradox of the expert” (Smith et al., 1978). A way out of this is to use chunking. Information that is integrated into a common memory trace reduces the amount of interference because there are fewer traces to compete with one another (Radvansky & Zacks, 1991).

Let us look at chunking in more detail. Suppose people memorize sentences about objects in locations. For some sentences, one object is in several locations, such as “The potted palm is in the hotel,” “The potted palm is in the barbershop,” and “The potted palm is in the airport.” In these cases, multiple mental models are created, because each sentence refers to a different situation. Thus, there are three memory traces that can compete at retrieval. In contrast, for other sentences, multiple objects are in one location, such as “The pay phone is in the laundromat,” “The oak counter is in the laundromat,” and “The ceiling fan is in the laundromat.” Here, a single mental model can include all this information because it all refers to a single event. As such, there is only one memory trace, and thus no interference (Radvansky & Zacks, 1991). These differential fan effects are shown in Figure 8.6, and this basic pattern of memory retrieval persists, even weeks later (Radvansky et al., 2017).



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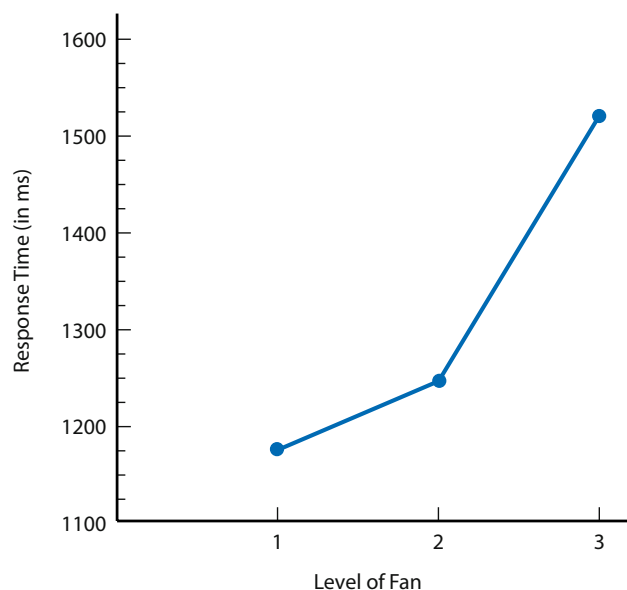


Figure 8.5: Results from a Study of Associative Interference Producing a Fan Effect

Source: created from data reported in Anderson, J. R. (1974). Retrieval of propositional information from long-term memory. *Cognitive Psychology*, 6, 451–474

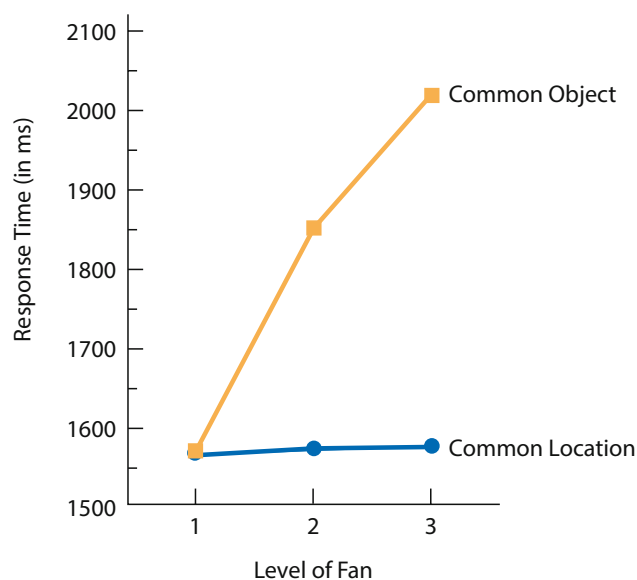


Figure 8.6: Differential Interference Effects When Information Can and Cannot Be Integrated into Mental Models

Source: Radvansky, G. A., Spieler, D. H., & Zacks, R. T. (1993). Mental model organization. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 19, 95–114



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WALKING THROUGH DOORWAYS CAUSES FORGETTING

Forgetting and interference not only come from knowledge stored in memory, but also come from our interaction with events. When we move from one event to another, in the real or a fictional world, there is an event boundary (Radvansky & Zacks, 2011). This can be a change in location, a jump in time, a change in activity, and so on. Encountering an event boundary leads us to set up a mental model of the new event. Importantly, the mental model for the old event is moved out of working memory to make way for the new one. This is supported by research showing that when event boundaries are encountered, hippocampal and related brain areas respond to these changes with increased activity (Brunec et al., 2018). This results in a remapping of cells to accommodate the new event. Event boundaries are regularly and easily identified by people (Newton, 1973; Zacks et al., 2009). The organization of information into mental models has consequences for memory. To ease exposition, we focus on changes in spatial location.

When mental models are stored in memory, and they have shared elements, such as an object, if people need to retrieve one of them then the related but irrelevant models produce interference (cf. differential fan effects). This interference does not need to involve memorizing lists of sentences. Just walking through doorways can cause forgetting. Radvansky and Copeland (2006; Pettijohn & Radvansky, 2018) had people move from room to room in a virtual environment, moving objects from one place to the next. When people walked from one room to another, memory for the objects they were carrying was worse compared to if they had just walked across a large room. In other words, the event boundary disrupted memory. This is also observed with real and imagined environments (Lawrence & Peterson, 2016; Radvansky et al., 2010) and disrupts both relational and item information (Horner et al., 2016). In general, when there have been shifts from one event to another, people have difficulty accessing information in memory that is tied to prior events (Swallow et al., 2009; Zwaan, 1996).

At first blush this might seem like a context effect; an instance of encoding specificity (see Chapter 7). When the encoding context does not match the retrieval context, memory is worse. However, there is more going on here. If it were, then when people return to a prior room, memory should improve, but it does not. Moreover, if people walk through two doorways, then memory is even worse (Radvansky et al., 2011). The explanation is that each room people are in is a different event memory. When people pick up an object and move across a room, the object is in just one mental model, so



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there is no interference. However, when they walk into a new room, the object is now in two mental models. These memories compete during retrieval, producing interference. When people walk through two doorways there are three mental models, and things are even worse.

GENERAL INTERFERENCE AND CONSOLIDATION

As noted earlier, the more information overlaps in content, the greater the interference. However, there is more to interference than just overlapping content. Think back to the study by Jenkins and Dallenbach (1924). When people were awake, they experienced more interference. However, the information they learned was nonsense syllables. It is unlikely that they encountered many other nonsense syllables during the day. What is going on is that there is general interference that occurs when people process lots of different types of information in their daily activities.

Memories are first held in a limited memory system, such as the hippocampus. When new information is learned, this results in the formation of new memories, which displaces some older ones. This is why there is less retroactive interference following sleep. In general, the older a memory is, the more consolidated it is, and the less likely it will be susceptible to general interference. If the formation of new memories is prevented, retroactive facilitation can occur in which older memories are remembered better.

AVOIDING INTERFERENCE THROUGH RESTING

As you have seen, encountering information prior to, after, or overlapping with a memory trace you want to retrieve can produce interference. Also, sleep can often aid in segregating information during consolidation, thereby reducing interference. That said, one does not need to sleep to reduce interference. Taking some time to simply rest after learning can also accomplish this. For example, a study by Dewar et al. (2012; see also Martini et al., 2018) found that resting ten minutes in between reading two narrative texts boosted memory, both immediately and a week later.



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IMPROVE YOUR MEMORY

There is no question that interference is a major contributor to forgetting in memory. Anything that can minimize interference helps in reducing forgetting. One way to do this is to make information more distinct in some way, such as using bizarre imagery, different contexts, and so on. Many of these ideas were suggested in Chapter 7. As noted here, and hinted at in other chapters, interference and disruptions of memory that can lead to forgetting is less of an issue for memories that are more consolidated. Anything that can be done to facilitate consolidation should reduce forgetting. This is why taking breaks from studying and doing some quiet resting can improve memory. These rest periods allow knowledge that you have learned to be consolidated, causing forgetting from interference to be reduced.

STOP AND REVIEW

Some forgetting is caused by interference from competing memory traces. This interference may come in the form of proactive interference in which older memories impair the ability to access newer memories, or retroactive interference in which new memories impair the ability to access older memories. Interference can also be defined in terms of a general overlap among memory traces, as with associative interference. If memories are given time to consolidate, perhaps through a period of quiet resting, there is reduced forgetting from retrieval interference.

FORGETTING AND INHIBITION

Interference in memory is a problem if you want to remember accurately and quickly. One way to reduce and control interference is by using inhibition to actively reduce the activation of interfering memories. There are several examples of inhibition influences on memory (Anderson, 2003). That said, inhibiting related but irrelevant memories can also bring about forgetting.

PART-SET CUING

As you learned in Chapter 7, retrieval cues can aid memory. However, there are exceptions. If we try to remember a set of things, such as the names of sports teams, the probability of recalling any one of them is higher if a simple recall test is used



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than if some of the names are given as cues to help us get started. This counterintuitive finding of poorer memory when provided with partial information is part-set cuing (Slamecka, 1968). This effect is generally greater when people are given items that they were more likely to recall than forget (Kroeger et al., 2019). There are three mechanisms that can influence part-set cuing (Bäuml & Aslan, 2006; Kroeger, et al., 2019). One is that giving people part of the set disrupts their retrieval plan (Basden et al., 1977), similar to the collaborative inhibition discussed later in this chapter.

A second mechanism is retrieval competition (Rundus, 1973). When people are given part-set cues, the activation level of those memories becomes higher. As a result, they are more likely to be accessed during a memory search. This then serves to reduce or block the retrieval of the other, noncued memories.

Another mechanism involves inhibition (Aslan et al., 2007). When people recall an item from a set, it has a higher activation than the rest. As a result, it blocks access to the others (Roediger et al., 1977). To reduce the interference, they are inhibited (Anderson & Neely, 1996). As people get further and further into the set, the unrecalled traces get more and more inhibited, making it harder to remember them (Oswald et al., 2006). Thus, for part-set cuing, providing people with part of a set leads them to inhibit memories that might otherwise be more available.

TRY IT OUT

A forgetting phenomenon that you can demonstrate is part-set cuing. For this you need two groups of at least 12 people each. First, for both groups, read everyone a list of 20 words. These words should be read at a rate of about one word per second. Then, after reading all the words, have people recall them. For the control group, just have the people try to recall all 20 words. However, for the experimental group, first give these people ten of the words from the original list. Then have them try to recall the other ten. When you are done, collect the response sheets, and score the recall performance of both groups only for the ten words that were not provided to the experimental group. What you should find is that the rate of recalling these ten words will be worse for the experimental group than the control group.



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NEGATIVE PRIMING

Inhibition is also observed with associative interference. By focusing on memories that compete and produce interference, we can assess inhibition. If people are probed for interfering memories immediately after they have been inhibited, the memories are less available (Radvansky, 1999). The decreased availability of memory traces that were recently inhibited is negative priming. It is the opposite of normal (positive) priming, in which related information becomes more available. This is a case of retrieval-induced forgetting because remembering one thing makes remembering related things harder. In other words, remembering causes forgetting.

RETRIEVAL PRACTICE

Finally, inhibition occurs when people repeatedly retrieve part of a set of items (Anderson et al., 1994; but see Jonker et al., 2013). Repeated retrieval causes competing but unretrieved traces to be inhibited. As a result, the probability of recalling those nonpracticed memories decreases (Tulving & Hastie, 1972) and people forget that information faster. This retrieval-induced forgetting for related but unpracticed memories is the retrieval practice effect (Anderson & Spellman, 1995; see Murayama et al., 2014, for a meta-analysis). The study of the retrieval practice effect is detailed in the Study In Depth box.

STUDY IN DEPTH

The retrieval practice paradigm is a method for assessing retrieval inhibition. To better understand this paradigm, let us look at a study by Anderson and Spellman (1995). For this work each person received eight lists of words. Four of these were experimental lists, and four were untested filler lists. Each experimental list had six words in it, and all of the words in a list were members of the same category. For example, one person might see words in the categories listed below. Note that some of the items from one category could also be placed in another category. For example, there are some things that are both red and food. The categorized nature of these lists is important here.



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RED	FOOD	FLY	LOUD
blood	bread	kite	thunder
fire	crackers	glider	yell
sunburn	peas	frisbee	traffic
apple	ketchup	butterfly	lawnmower
cherry	radish	eagle	sandblaster
tomato	strawberry	ladybug	compressor

For this study, 48 students from the University of California Los Angeles were tested. At the beginning there was an initial learning phase, in which people were shown all of the words in all of the lists. These lists were presented one category-word pair at a time, such as RED-blood, for five seconds each. The point was to set up the category-word associations in memory.

After the initial learning phase, the experiment went into the retrieval practice phase. Here, people were given a cued recall test in which they saw a category name and the first two letters of the target word, such as RED-bl_____. The task was to complete the target word. People were given ten seconds for each word. Importantly, not all of the categories were tested. Moreover, only half of the items from a practice category were actually practiced. Thus, there were only six items from the list of 24 that actually received retrieval practice, and these items were practiced twice. In addition, all of the words from the four filler lists were practiced once.

To better understand the logic of the retrieval practice phase, use Figure 8.7 as a guide. There were four conditions in the study. Assume that people practiced the first three words in the RED category and three from the FLY category. Those practiced items, such as RED-blood, are the **RP+ items**. These were words from a category that was practiced, and these were the words that were actually practiced. The words that were from the same category as the practice words, but were *not* actually ever practiced, such as “tomato,” were the **RP-items**. That is, these were words from the category that was practiced, but the specific words were never actually practiced. The third condition were words from a non-practiced category that overlapped words in the practice category, such as “strawberry,” the **NRP-similar items**, were words from a non-practiced category



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that overlapped words in the practice category, such as “strawberry.” That is, these items were from a category that was not practiced, but were similar to items from a category that was practiced. Finally, for the fourth condition, words from a non-practiced category that did not overlap with a practiced category, such as “crackers” were the **NRP-dissimilar items**. These items served as the control condition to assess the influences of retrieval practice and inhibition.

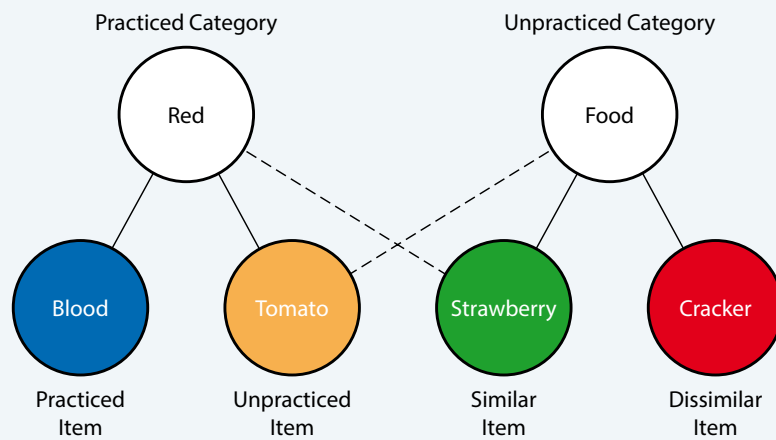


Figure 8.7: Operation of Retrieval-Induced Inhibition in a Repeated Practice Paradigm
Source: Anderson, M. C., & Spellman, B. A. (1995). On the status of inhibitory mechanisms in cognition: Memory retrieval as a model case. *Psychological Review*, 102, 68–100

The logic behind the study is that, first, words that were practiced will be recalled more later. This is hardly surprising. If you spend more time practicing something, you are going to remember it better. Second, and of primary importance, is what happens with the RP-items. Because they are in the same category as the practice items, they are related and irrelevant. Thus, they are sources of interference at retrieval during retrieval practice, and so are actively inhibited. They will be recalled less often later. That is, people will have worse memories because they were inhibited. Third, and of secondary importance, is what happens to the NRP-similar items. Because they are from a non-practiced category, memory for them is worse than for those that were actually practiced. However, because they are also similar to the practiced category, there is some spill-over inhibition to these items, and they are remembered worse than the control items.



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After going through retrieval practice, people were given a distractor task for 20 minutes to encourage some forgetting (we would not learn much if people recalled most or all of the words). After this distractor task, people took a cued recall test. For each category, they were given the category names (e.g., RED) and were to recall as many members of that category as they could. They were given 30 seconds for each category. The results, shown in Figure 8.8, show that, relative to the NRP-dissimilar condition, recalled words more often in the RP+ condition, consistent with the idea that practice improves memory. Importantly, for the RP-condition, people recalled those words at a *lower* rate, consistent with the idea that they were inhibited, making their retrieval more difficult. Finally, also, for the NRP-similar condition, people recalled these words less often, again showing evidence of retrieval inhibition.

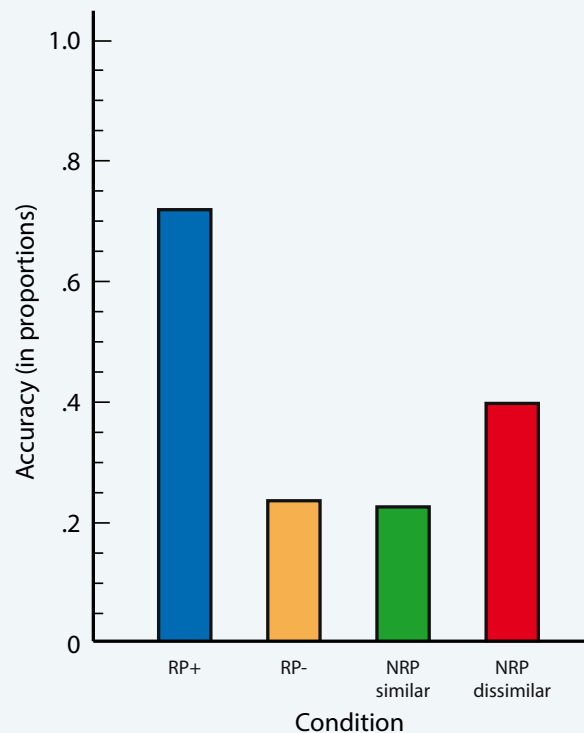


Figure 8.8: Pattern of Recall Rates in Anderson and Spellman's (1995) Retrieval Practice Paradigm
Source: created from data reported in Anderson, M. C., & Spellman, B. A. (1995). On the status of inhibitory mechanisms in cognition: Memory retrieval as a model case. *Psychological Review*, 102, 68–100



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The repeated practice effect is observed with both recall and recognition (Hicks & Starns 2004), as well as indirect memory tests (Camp et al., 2005). It not only occurs for categorized lists of words, but also for sentences with similar concepts (Anderson & Bell, 2001), experienced events (Cinel et al., 2018), autobiographical memories via episodic future thinking (Ditta & Storm, 2016) and prospective memory (Utsumi & Saito, 2016), or even elements of prose (Saunders & MacLeod, 2006). Thus, it is pervasive.

It is important to keep in mind that the retrieval practice effect occurs only when there is some interference present during retrieval for the inhibition to counteract (Anderson et al., 2000). Merely exposing people to information is insufficient (Ciranni & Shimamura, 1999). This is supported by neuroimaging data that shows an increase in theta band activity in EEG recordings in cases where there is retrieval interference during a retrieval practice resulting in inhibition (Staudigl et al., 2010).

The retrieval practice effect can be modified depending on how people think about information. If we can integrate a set of information, then the effect is reduced or eliminated (Anderson & McCulloch, 1999). This is because there are fewer competitors, no interference, and therefore no need for inhibition. Alternatively, if memory traces are more distinct from one another, this can also reduce the effect by reducing interference (Anderson et al., 2000). Finally, consistent with the idea that inhibition is only temporarily used to manage retrieval interference, retrieval practice effects are reduced or eliminated after delays (e.g., a day later) when the inhibition has dissipated (Abel & Bäuml, 2012).

STOP AND REVIEW

Interference experienced during retrieval disrupts memory. Interference is reduced through inhibition, thereby facilitating the retrieval of target memories. However, this also makes the retrieval of inhibited memories harder. This is retrieval-induced forgetting. This is seen in part-set cuing, in which people who are given part of a set of information find it harder to retrieve the rest of the set, compared to if no cue is provided. Similarly, with negative priming, memories that were just previously sources of interference are responded to more slowly. Finally, the retrieval practice paradigm shows that repeatedly retrieving part of a set of items can make the rest of a set harder to recall later.



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INTENTIONAL FORGETTING

Most studies of forgetting focus on how we forget things that we want to remember. However, there are times when we want to forget. An everyday example of this would be if someone were telling you their phone number and then realized they gave you the wrong one and said, “Oh, wait, that’s not the number, the number is ...” Clearly you would want to forget the incorrect information. Here we cover two lines of research involving intentional forgetting: directed forgetting and retraction.

DIRECTED FORGETTING

The first type of intentional forgetting is when people are told to forget some things and to remember others. This is directed forgetting (Bjork, 1970). The effectiveness of directed forgetting is assessed on a final memory test in which people are told to retrieve all of the prior information, both things that they were told to remember, as well as the things that they were told to forget. There are two hallmarks of directed forgetting (relative to a control condition in which people are told to remember everything). The first is that the to-be-forgotten (TBF) information is remembered worse. The second is that the to-be-remembered (TBR) information is remembered better. There are three methods for studying directed forgetting: the item, list, and selective directed forgetting methods. Each of these is considered in turn.

For item method directed forgetting people are given a set of items, and after each one, they are explicitly told either to remember (TBR) or forget it (TBF). An everyday example of this is when we offload information, such as making a note, or saving a bookmark on a computer. When we do this, we do not feel a need to commit the information to memory. The consequences of this are like directed forgetting (Sparrow et al., 2011).

The explanation for forgetting here is that when people are told to forget an item, they stop rehearsing it, thus it is not stored in memory. In the absence of rehearsal, fewer TBF items are retrieved on a final memory test relative to the TBR items that were rehearsed more (Basden et al., 1993; Fawcett et al., 2016). It has been found that people look away from the spatial location of an item after a forget cue, and the iris expands, indicating some element of mental effort (Lee, 2018). This mental effort can be disrupted if TMS is applied to the dorsolateral prefrontal cortex (Xie et al., 2020).

For list method directed forgetting people are given a list of items. Then, they are either told to remember (control) or to forget (experimental) the list. Afterward, people are given a second list. Here, people need to rehearse all the first list items



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prior to the forget instruction, because they do not know that they will be told to forget it. Then people inhibit the TBF information in memory (Basden et al., 1993; Bjork, 1989). This inhibition is effortful. If people are disrupted by a secondary task, the inhibition of TBF information is reduced or eliminated (Conway et al., 2000). Moreover, like item method directed forgetting, this can be disrupted if TMS is applied to the dorsolateral prefrontal cortex (Hanslmayr, et al., 2012).

List-based directed forgetting is alleviated by a night's sleep (Abel & Bäuml, 2012) or even wakeful resting (Schlichting & Bäuml, 2017). Memory consolidation during sleep causes a lifting of the inhibition of memory traces. Also, forgetting is hindered if people have engaged in retrieval practice during learning (as opposed to simply studying) (Abel & Bäuml, 2016).

The inhibition of the TBF information is pervasive. It occurs both for direct memory tests, like recognition and recall, as well as indirect tests, like word fragment completion (MacCleod, 1989). Directed forgetting can occur for your autobiographical memories (Barnier et al., 2007). Directed forgetting is reduced if TBF items are meaningfully (semantically) related to the TBR items (Conway et al., 2000). Presumably, the automatic priming of TBF items by TBR items keeps them from being effectively forgotten.

Note that while the inhibition account is the dominant explanation, directed forgetting can also be brought about by changes in (mental) context (Sahakyan & Kelley, 2002; but see Abel & Bäuml, 2017b). When you are told to forget something, this sets up a change in the mental context. This mismatch in mental context impairs the ability to access information in memory, much as is seen with encoding specificity (see Chapter 7).

For selective directed forgetting people are given a set of information and then are told to forget only part of it based on some criterion. For example, you might be told a bunch of facts about Tom and Bill in a random order. Then you are told to forget everything about Bill. After this, you then learn a bunch of facts about Steve. This is selective directed forgetting because people are not told to selectively edit memory based on some common concept, such as a person.

Selective directed forgetting is absent if the materials are highly integrated, perhaps because the various components of the materials continue to prime and activate information that was marked as TBF. As a result, materials continue to be remembered rather than forgotten (Delaney et al., 2009). It should be noted that



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selective directed forgetting is difficult to replicate (Akan & Sahakyan, 2018; Storm et al., 2013). Thus, while selective directed forgetting seems like it should be possible, and feels like something we do regularly, our understanding of how we actually go about it is not well understood at this time.

RETRACTION

Related to directed forgetting is the idea that sometimes we learn things and then we later find out that those things are incorrect. Information that we encounter is first treated as accurate until we have motivation to think otherwise (Gilbert et al., 1990). When information is then marked as incorrect it is said to be retracted. In general, while retraction does influence memory, people do have some difficulty altering their knowledge and understanding.

In an early study by Kay (1955) students at Cambridgeshire Technical College were given two stories to read for later recall. They then recalled the stories immediately and then five more times over the next four months. Importantly, people were given an opportunity to reread the stories after each recall attempt. What was striking was that when people made an error in the recall of the story, the error often persisted throughout the additional attempts, even though there was an opportunity to correct the mistake after each rereading. Given this resistance to modifying our understanding, it is best to try to understand something correctly the first time, to as great a degree as possible. This reflects the memory sin of persistence and is the general principle of memory. Even well-learned semantic knowledge held by experts shows some resistance to change. For example, even experts in astronomy are slower to verify the statement “The Earth revolves around the Sun” than “The Moon revolves around the Earth.” This is because the first is inconsistent with our early held understanding of everyday experience, where the latter is not, even when people know very well that these statements are true (Shtulman & Valcarcel, 2012). An interesting thing about retracted information is that it continues to influence our thinking. Thus, it is called the continued influence effect (CIE) (Wilkes & Leatherbarrow, 1988). For example, if people are told that a traffic accident involved older adults, and later this information is retracted, people may continue to make age-related inferences about the injured, such as suggesting that the family members who would need to be contacted would be their children (with no mention of other possibilities, such as parents). As a real-world example, during the 2003 Iraq War misinformation was sometimes reported by news outlets, such as a report that Iraqi forces were executing coalition prisoners of war. Afterward this misinformation



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was denied or corrected by news agencies. However, some people continued to use it (Lewandowsky et al., 2005). As another example, Greitemeyer (2014) found that some scientists continue to believe results that had been retracted (e.g., if it was found that someone faked the data).

The CIE is robust. It not influenced by whether the retraction is given immediately or after a short delay (Johnson & Seifert, 1994). That said, the CIE does require that the retracted information be part of the larger event. It is not observed if it was merely mentioned in passing (Johnson & Seifert, 1994). Further, the magnitude of the CIE can be reduced if people are given an alternative causal explanation (Ecker et al., 2011), such as being told that the injured in an accident were not older adults, but were patients at a local rehabilitation center. That said, it may also be the case that people will not believe and accept the correction (O'Rear & Radvansky, 2020), and there may even be a backfire effect in which they cling more strongly to the original, incorrect information (Nyhan & Reifler, 2010).

One theory of memory change in the face of explicit refutation is the Knowledge Revision Components framework (KReC) (Kendeou & O'Brien, 2014). This theory assumes that there are five mental processes that can affect memory change. The first is that information that is encoded into long-term memory is permanent regardless of whether it was later corrected. The second is that memories are passively activated when new, related information is encountered as a result of our trying to understand the events that we come across. This is a form of implicit priming. The third is that in order for a misunderstanding to be corrected, people need to reactivate the older incorrect memory along with the newer correct information. This is related to the idea of reconsolidation where older memories can be changed if they are reactivated. The fourth is that the new knowledge is integrated with older knowledge of the incorrect information. Again, this is part of a reconsolidation process. Finally, over time, as people retrieve and remember the newer correct information, it gains memory strength and dominates thinking over the older incorrect knowledge. Thus, over time, and with some appropriate effort, our misunderstandings can be corrected.

STOP AND REVIEW

Not all types of forgetting are bad. Sometimes we have good reason to forget. For directed forgetting, people are told to forget things, and they do so. This can also increase memory for other information. This can be done on either an item-by-item basis, resulting in differential rehearsal, or on a list-based basis, resulting in the



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inhibition of to-be-forgotten information. We also seem to have the ability to selectively forget information, but how this is done is not well understood. Other times, we need to forget things that turn out to be wrong and were retracted, but we are only partially successful at doing this.

SOCIAL INFLUENCES

Many of the studies discussed here have a person largely remembering alone. However, in our everyday lives, we are often in social situations, interacting with others. These other people can influence our memory. For example, people remember events differently depending on who they are with (who they are telling their story to), which can then bias later memories (Tversky & Marsh, 2000). Moreover, people who work with high-performing individuals recall more than people who work with low-performing individuals (Reysen, 2003). Finally, people remember information better if they think it comes from another person as compared to a computer (Reysen & Adair, 2008). Even how well we remember someone's face depends on social influences. People remember faces better when the person in the picture is looking at them versus when they are looking away (Mason et al., 2004). Thus, memory is influenced by other people. Here we look at how interacting with other people can cause forgetting, as well as some evidence that it can have the opposite effect.

COLLABORATIVE INHIBITION

When people in groups try to recall something, they typically recall less than if they were separated, asked to recall information, and had their individual efforts pooled (Weldon & Bellinger, 1997). This decline in memory when working in a group is collaborative inhibition. In other words, overall, people are recalling less in a group than as individuals. This occurs for both retrospective and prospective memory tasks (Browning et al., 2018).

Collaborative inhibition is not a result of social loafing. Instead, people are encountering different ways that others have structured the information. Each person's recall is based on his or her own retrieval plan. When confronted with an organization that is different from one's own retrieval plan, recall becomes disrupted, and performance declines (Weldon et al., 2000). This is related to the part-set cuing phenomenon (but see Kelley et al., 2014). Not only is some information forgotten when it is recalled in groups, but a shared memory of an event becomes more



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homogeneous across the group members, both in terms of its content and its organization (Congleton & Rajaram, 2014).

People can insulate themselves against collaborative inhibition if they first retrieve information on their own, prior to being in a group setting. That is, the testing effect (Chapter 7) may guard against collaborative inhibition (Congleton & Rajaram, 2011). It should be noted that although people recall more alone than in groups, group recall does increase the accuracy of what is actually recalled (Harris et al., 2012; Vollrath et al., 1989). It should also be noted that the collaborative inhibition effect dissipates over time (such as a day later) (Abel & Bäuml, 2017a). After forgetting occurs, hearing other people recall information may then serve as a trigger for remembering otherwise forgotten information.

When people recall events together, this can result in the inhibition of unrecalled memories. In other words, this is a retrieval practice effect both for the people who originally spoke, as well as the people who were only listening (Cuc et al., 2007). Thus, the same memory processes that lead to forgetting in an individual can be triggered just by listening to other people.

Collaborative inhibition not only applies when we try to retrieve information either alone or in a group, it can also occur when we learn information (Barber et al., 2010). This is even true if the same people are present at learning and retrieval (so, it is not poorer memory because of a change in social context). Different people create and use different retrieval cues from each other. When people study together, they do not develop retrieval cues that would be most helpful for their recall of the information. This is also the reason why we do not learn as well by using other people's class notes (Annis & Davis, 1975). That said, it should also be noted that it is possible for collaborative encoding to mitigate effects of collaborative inhibition at retrieval; in some sense shifting where the memory problems are originating from (Harris et al., 2012).

COLLABORATIVE FACILITATION

Working with groups is not all bad and does not always lead to forgetting. Although recall memory is worse in groups than alone, the opposite is true for recognition (Vollrath et al., 1989). This is collaborative facilitation. In recall, the retrieval plan plays an important role in performance. In contrast, for recognition there is no retrieval plan. Memory only requires that something seem familiar, and anything more is a bonus. When people do recognition in groups, they can pool their resources



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to arrive at a consensus about what happened, although this is more effective at accepting old items than rejecting new ones (Clark et al., 2000).

OTHER PEOPLE'S MEMORIES

From time to time we may be asked to evaluate the quality of other people's memories. While we can do this to some degree, there are some biases that can creep up. One is the consensus bias (Ross et al., 1977), which is the idea that we often assume that other people know what we know. Thus, if we have an idea, we implicitly expect other people to know this as well.

Another bias is that people expect others to do better when the pressure is on to remember. While motivation to remember can help when we first encode something, it does not help much, if at all, during retrieval. However, we often expect other people to remember more when they are motivated at retrieval (Kassam et al., 2009). Imagine a high-profile court case in which people are strongly motivated to remember something accurately. If they were trying to commit things to memory at the time the event occurred, then memory is better. However, if they were only motivated in hindsight to retrieve something that did not seem particularly important at the time, then memory is relatively poor regardless of the desire to remember. Despite this, we often expect other people to remember better because of a lack of insight we have into how memory works.

STOP AND REVIEW

Interacting with other people can also cause forgetting. This collaborative inhibition occurs when people recall less in groups. This may be a result of retrieval plan disruptions and the inhibition caused by socially induced retrieval practice. That said, collaborative facilitation can happen, as with recognition. Another problem that can arise is our blindness to other people's memories. People often cannot remember more just by trying harder, even at our (incorrect) insistence.

DRUGS AND ALCOHOL

Forgetting can also occur as a result of chemicals that we put into our bodies. In this section we look at the influence of drugs and alcohol and how they change memory and forgetting.



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DRUGS

One class of drugs that has a strong influence on memory is benzodiazepines (e.g., Valium and Halcion), which are depressants. These drugs influence memory by increasing GABA-related processes, which inhibit neural firing. Because of this suppressed neural activity, people taking these drugs have difficulty acquiring new memories. In a sense, this is a drug-induced form of anterograde amnesia, similar to what is seen in Korsakoff's patients (Curran, 1991). In other words, these drugs cause forgetting by impairing the ability to encode new knowledge. In addition, although memory is typically better for emotional information, people taking benzodiazepines do not show this benefit, suggesting that the drugs are also disrupting amygdala processing (Buchanan et al., 2003).

Benzodiazepines primarily compromise declarative rather than nondeclarative memory (Reder et al., 2006), with PET scans in one study showing suppressed processing in the right prefrontal cortex (BA 9), left parahippocampal gyrus (BA 35), and left anterior cingulate cortex (BA 32) (Mintzer et al., 2006).

A beneficial consequence of drug-induced anterograde amnesia is that retroactive interference effects are diminished. Memory for information learned prior to taking the drug is better than it would be otherwise (Fillmore et al., 2001). Because new memories are not created, they cannot interfere backward in time to cause retroactive interference. The better memory is retroactive facilitation.

ALCOHOL

Another substance that can influence memory is alcohol. While alcohol can have several effects, the focus here is on the consequences of individual episodes of drinking. In general, memory is worse for things learned under the influence of alcohol, although this may be primarily for peripheral and secondary information (Schreiber et al., 2011). Alcohol affects a broad range of memory processes (Maylor & Rabbitt, 1993), including executive working memory function (Saults et al., 2007), prospective memory (Leitz et al., 2009), and producing overconfidence in metamemory judgments (Nelson et al., 1986). Work using the process dissociation procedure has shown that alcohol's influence is more pronounced for explicit, declarative knowledge than for implicit, nondeclarative knowledge (e.g., Kirchner & Sayette, 2003). Part of the problem is that alcohol, as EEG recordings show, disrupts event-related synchronization and desynchronization (see Chapter 2) in the cortex in the theta and alpha band levels (Krause et al., 2002). Thus, the brain cannot



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coordinate processing as effectively after alcohol consumption. At high enough levels, people can experience blackouts during which there is no memory for any of the events of that time. This is a sign of a serious drinking problem.

In addition to the negative effects of alcohol on memory, there are some positive effects as well. Specifically, information is remembered better if people consume alcohol immediately afterward than if they do not (Moulton et al., 2005). This is another example of retroactive facilitation. Because information is so poorly encoded when one is under the influence of alcohol there are fewer new memory traces to produce retroactive interference. Also, alcohol may facilitate consolidation of the earlier memory traces, perhaps because of increased glucose levels (Scholey & Fowles, 2002).

Alcohol can even influence memory when it is not actually present, but it is just suggested to people that they have consumed alcohol. Assefi and Garry (2003) had students at Victoria University of Wellington watch a slide show of a man shoplifting at a bookstore. Later, people were given misleading post-event information (see Chapter 14). Even though all the students drank tonic water, half of them were told that it also contained vodka (the glasses were rimmed with vodka). Students who thought that they drank alcohol were more susceptible to misleading information and were more confident in their responses. This is a pattern consistent with actual alcohol consumption. Thus, just the thought of drinking alcohol can influence how people use their memories and what they forget.

STOP AND REVIEW

Forgetting can be caused by external influences. Some drugs, such as benzodiazepines, block normal operations of the nervous system resulting in a drug-induced amnesia. Alcohol can also disrupt the formation of new memories. In both cases, the blocked formation of new memories reduces retroactive interference, allowing for retroactive facilitation.

PUTTING IT ALL TOGETHER

The opposite of remembering is forgetting. Forgetting is often viewed negatively, almost like a sin. Forgetting is more likely when there is competition among memories, producing interference during retrieval. This can happen proactively, retroactively, associatively, and generally. Inference can cause you further difficulties when the process of inhibition is involved, causing some memories to be even harder



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to retrieve than before as they are pushed below their prior levels of accessibility. This is seen with part-set cuing, negative priming, and retrieval practice effects.

However, forgetting also allows some control over your thoughts, keeping them from being clogged with irrelevant information. In this case, a sin may be a virtue. When knowledge ceases to be relevant, forgetting causes it to become extinct through disuse. Here, forgetting comes about as interference keeps old and unwanted information at bay. While interfering memories that have been inhibited are harder to access, this inhibition is helpful in controlling the negative effects of interference. Inhibition can be deliberately used to keep incorrect and irrelevant knowledge out of mind, as with directed forgetting and retraction. The net result is that forgetting keeps out unwanted knowledge and promotes the remembering of wanted knowledge. Forgetting is everywhere, taking out the garbage and keeping things fresh.

Most of the forgetting considered here derives from the normal use of memory. Forgetting is just something that happens. However, forgetting can also happen when you interact with other people, as with collaborative inhibition, and when you take certain drugs and alcohol. Even walking through a doorway can cause forgetting. Overall, forgetting is not just a part of yourself, but is also part of how you interact with the world.

STUDY QUESTIONS

1. What are Schacter's seven sins of memory? How might these actually be virtues?
2. How does the passage of time influence forgetting? What is the Law of Disuse?
3. What is Bjork's New Theory of Disuse, and what are its core principles?
4. What is proactive interference, and how is it an interference theory of forgetting? How does proactive interference differ from negative transfer?
5. What is the release from proactive interference, and how can it be brought about?
6. What is retroactive interference, and how is it an interference theory of forgetting?
7. What is associative interference, and how does it produce the fan effect? How does the integration of information in memory cause a reduction in associative interference?



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8. What is the role of inhibition in memory retrieval? How does this manage interference? How does this cause forgetting?
9. What are some of the effects that are produced by the operation of inhibition?
10. Under what circumstances do people intentionally forget information?
11. What is directed forgetting? What are the different ways of bringing this about? What is the cause of directed forgetting in each of these circumstances?
12. What does it mean for information to be retracted, and how well does memory handle retracted information?
13. What are ways in which social settings can promote forgetting? What are ways in which it promotes remembering? How well do we understand other people's memories?
14. What are the influences of drugs, such as benzodiazepines and alcohol, on remembering and forgetting?

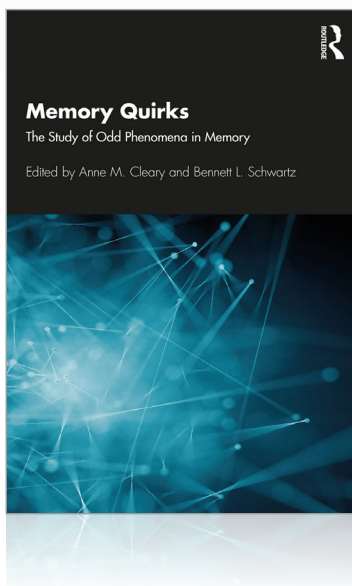
KEY TERMS

- absent-mindedness
- accelerated long-term forgetting
- accessibility
- alcohol
- associative interference
- availability
- benzodiazepines
- bias
- blocking
- collaborative facilitation
- collaborative inhibition
- continued influence effect (CIE)
- cue overload
- directed forgetting
- event boundary
- event model
- fan effect
- forgetting
- inhibition
- interference
- item method directed forgetting
- Jost's Law
- Knowledge Revision Components framework (KReC)
- Law of Disuse
- list method directed forgetting
- misattribution
- negative priming
- New Theory of Disuse
- NRP-dissimilar items
- NRP-similar items persistence
- part-set cuing, persistence
- proactive interference
- reconstructive
- release from proactive interference
- reproductive
- retracted
- retrieval-induced forgetting
- retrieval practice effect
- retrieval strength
- retrieval-induced forgetting
- retroactive facilitation
- retroactive interference
- RP+ items, RP- items
- selective directed forgetting
- seven sins of memory
- storage strength
- suggestibility
- transience
- unlearning

CHAPTER

3

WHEN AND WHY WE (SOMETIMES) FORGET REALLY IMPORTANT THINGS



The following is excerpted from

Memory Quirks

Edited by Anne M. Cleary & Bennett L. Schwartz.

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WHEN AND WHY WE (SOMETIMES) FORGET REALLY IMPORTANT THINGS

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Excerpted from *Memory Quirks*

Alan D. Castel and Matthew G. Rhodes

INTRODUCTION

Both authors have frequently had the following experience. We are on a flight and start talking to the person sitting next to us. Inevitably, the question is posed: “What do you do for a living?” Experience suggests that answering “I’m a psychologist” leads to assumptions about therapeutic expertise or a comment like, “so you must be reading my mind right now,” insight and skills that neither of us possess. Instead, a more precise answer that eliminates those assumptions is to respond “I study memory.” When comparing our experiences, we realized that the response to this description of our occupation seems to elicit a common reply. Often our seatmate will lean in and state “Oh, I’m just terrible at names and am always forgetting them.” While other information is forgotten (state capitals, plots to movies, parking spaces, keys, phones), these memory missteps are rarely recalled with the same level of frustration that accompanies people’s observations about forgetting names.

Fortunately (or unfortunately), the experience of forgetting names is a collective challenge that appears to plague most of us. This challenge may be one of the most frustrating quirks of memory and our awareness of the struggle illustrates how we attend to our memory failures. Indeed, we think about memory most when it fails us. These failures can range from the mundane (forgetting a name), to the embarrassing (forgetting an anniversary), to the horribly devastating (forgetting an infant in a hot car for hours). In this chapter, we review why people’s awareness of memory (metamemory) is critical and how it is sometimes poorly tuned to predicting our own memory successes and follies. For example, we think we will remember details of things we have encountered many times, such as the Apple logo, the American flag, the location of a fire extinguisher, emergency instructions on an airplane, WARNINGS IN LARGE LETTERS, secret passwords and where we have hidden a special object. Only later do we realize that we don’t quite remember things as well as we think.

Although people often describe how they are prone to forgetting, people also think their memory is fairly stable over time (Koriat, Bjork, Sheffer, & Bar, 2004; Kornell & Bjork, 2009). Thus, assessments of forgetting introduce a paradox: individuals frequently decry their isolated memory failures but, in many experiments, make predictions assuming that they will forget very little. Other work (e.g., Castel, Rhodes, McCabe, Soderstrom, & Loaiza, 2012; Rhodes, Witherby, Castel, & Murayama, 2017) suggests that when we do forget we may exhibit a predictable tendency to devalue that information. In addition to these tendencies, our perceptions of memory may



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change across the lifespan. For instance, aging may heighten awareness of memory success and failures, possibly because older adults have experienced more memory errors and, as a result of experience (and perhaps the anxiety associated with past failures), know what to focus on to remember. Noticing what we remember and forget may be the best way to improve memory across the lifespan, if we can use this knowledge to guide future memory efforts in our often- distracted state and world of information. Thus, understanding the quirks of forgetting may be a valuable method that allows us all to be better users of our memory abilities.

THE NATURE OF FORGETTING

No exploration of forgetting would be complete without some comment on its form (see Roediger et al., 2010; Wixted, 2004, for splendid reviews). In general, the form of forgetting appears to hew to patterns first reported by Herman Ebbinghaus (1885) in his seminal studies of his own memory. In particular, after a bout of learning, forgetting appears to proceed rapidly and then slow, reaching asymptotic stability, and is likely best characterized by a power law (see Wixted, 2004; Wixted & Carpenter, 2007). Theories of forgetting abound, positing mechanisms and processes ranging from the interference wrought by other information (Crowder, 1976; McGeoch, 1932), to the utility of cues or hints available (e.g., Watkins & Watkins, 1976), to competition between responses (Anderson, Bjork, & Bjork, 1994), to a host of physiological processes (Wixted, 2004).

In the midst of cataloging explanations and the form of forgetting, an equally valuable question considers its function. We may decry slips of memory in conversations in a social gathering but is there a greater, beneficial function to forgetting? One primary function of forgetting, noted by a number of investigators (e.g., Anderson et al., 1994), is that it ensures that memory is less subject to the minutia or detritus of our experiences and more attuned to important information (Castel, 2008). For instance, it is of little value to remember what one ordered for lunch 9 weeks ago or where parking was secured on a trip to the supermarket 2 years ago, but it will be important to recall a daughter's birthday, the correct dosage of a medicine crucial to heart health, plans for retirement, etc. Thus, forgetting might be usefully considered a type of mental thresher, separating the wheat of the most important information we need from the chaff of the less valuable knowledge, experiences, and day- to- day details. Admittedly, although it often functions superbly, this mental thresher is decidedly imperfect and admits some chaff and loses some wheat, perhaps giving rise to our complaints about forgetting.



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Is forgetting really the enemy of learning or does it serve an important role? Bjork and Bjork (1992; see also Bjork, 1989, 2011; Bjork & Bjork, 2019) have long made the case that we should welcome forgetting and regard it as a friend rather than a foe. Indeed, many activities that appear to result in substantial initial levels of forgetting may forge superior learning in the long run, despite the initial impression that forgetting hurts performance.

Consider, for example, math instruction. The approach taken by the typical math textbook is to teach students a single formula or concept (e.g., Cartesian formulas), provide practice on this material, and then to move on to the next concept (e.g., the Pythagorean theorem). Such blocking of the same material can be contrasted with interleaving, whereby concepts are mixed together within a learning session. For instance, students might learn about calculating slopes and intercepts along with the Pythagorean theorem, and then practice problems focusing on a mix of these concepts. Rohrer and Taylor (2007) tested this by having participants learn to solve for the area of less- common geometric shapes, such as a wedge and spheroid. All participants learned four different formulas. Half learned a formula and then completed four practice problems, doing this for each formula in succession using blocked practice. The other half of the participants learned all four formulas at once and then did practice on all 16 problems randomly intermixed together, thus engaging in interleaved practice. Interestingly, performance on the practice problems, given just after learning, was much better for the blocked than the interleaved condition. However, on a final test given a week later, interleaving resulted in far superior performance than blocking. Although mixing problems (interleaving) led to more forgetting up front, it promoted more durable learning in the long run (see Soderstrom & Bjork, 2015, for a review). Thus, forgetting might not only reduce the clutter in our memories, but conditions that promote forgetting appear to enhance learning. However, a question lingers: how well do we understand memory and forgetting?

METAMEMORY ACCURACY AND BIASES

Metamemory refers to the ability to evaluate our own memory, and that of others. There are a variety of ways to assess metamemory (see Dunlosky & Tauber, 2016) and one common method is to simply ask people, after they have been presented with some bit of information, how well they will later recall it (see Rhodes, 2016). Often, people are fairly accurate, and this holds true for both younger college- age students and healthy older adults over 60 (Hertzog, Kidder, Powell- Moman, &



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Dunlosky, 2002). However, important biases have been identified, such that people may be overconfident (Metcalfe, 1998) or biased by certain cues that do not in fact influence memory (see Chapter 10 in this volume). Furthermore, in some cases, people will show strong false memories that are accompanied by high levels of confidence (Loftus, 1992).

People may be biased by superficial features, such that words in large font feel like they will be better remembered. We (Rhodes & Castel, 2008) have studied how font size impacts metamemory judgments and often find that people predict they will better remember words presented in larger font than words that are still easy to read but in smaller font (see Figure 9.1 for a demonstration). Actually, font size has only the smallest impact on later memory (see Luna, Martín- Luengo, & Albuquerque, 2017, for a review; but see also Undorf & Zimdahl, 2019). Thus, people report words in large font to be more memorable, but font size is not diagnostic of later memory. This memory illusion related to font size and recall occurs even when people's beliefs have been modified such that they have reason to believe that font plays little role in memory (Blake & Castel, 2018; see also Mueller, Dunlosky, Tauber, & Rhodes 2014). The font size illusion could lead people to think that they will later remember signs in large letters (such as EMERGENCY EXIT) but in a subsequent fire emergency they have little recollection of where they saw this sign. Thus, making something seem easy to learn might lead to fast forgetting, despite our intuition that things in larger font are easier and better remembered.

HABITUATION AND MEMORY BIAS

Dog – Fork or Cat – Book

Figure 9.1: What word pair do you think you will better remember? Most people think the pair in larger font size will be better remembered, either because it is easier to read (more fluent) and/ or because people have the belief that words in larger font are usually more important (Rhodes & Castel, 2008).

Repeated exposure might also engender the strong feeling that something will be remembered well and avoid being forgotten. However, while repetition can often enhance memory, it may inflate one's metamemory to the point of overconfidence. In addition, repeated exposure can lead to habituation whereby we stop noticing details of these objects or events (Mack, 2003; Simon, 2000). This has been demonstrated with common objects such as a penny (Nickerson & Adams, 1979); although pennies have been seen thousands of times, individuals often fail to accurately recall features



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such as which way does Lincoln's face point: left or right? In terms of reading and letter recognition, despite having seen the lower- case letter "g" in Times New Roman font millions of times (and many times in this chapter), people fail to notice that it is in this form with a "loop- tail" (i.e., "g") and think it is in the form of an "open- tail" g (i.e., "g") (Wong et al., 2018). People are often unaware of failing to notice these events or features, suggesting that metacognition is not tuned to our lack of awareness or what we don't notice (termed "change blindness blindness," Levin, Momen, Drivdahl, & Simons, 2000). If you are curious, Lincoln faces to the left on the penny, but all other Presidential figures are facing to the right on nickel, dime and quarter, possibly creating interference.

As an interesting example of a real- world memory quirk driven by habituation, President Donald Trump was shown with students at a school drawing the flag of the United States (a symbol he knows very well), by coloring in a blue stripe in a widely publicized media photo (Fearnow, 2018). Even if we know something well, we might not recall details precisely and perhaps especially when we are put on the spot, sometimes due to anxiety. For example, singers may forget the words to the national anthem when singing in front of a large audience, and Texas Governor Rick Perry forgot which departments he wanted to abolish during a 2011 GOP debate (he first recalled Commerce, Education, and only 15 minutes later did he recall Energy), information he knew well but temporarily forgot during this stressful moment. More recently, President Trump appeared to color in a blue stripe on the American flag, as previously mentioned. In fact, we have poor recognition memory for the details of familiar flags despite high confidence that we know the flag, and this is especially pronounced around the 4th of July holiday, when we have seen many instances of the flag (Blake & Castel, 2019). If you do not believe this memory quirk for yourself, try the demonstration with the flag of the United States of America (Figure 9.2). The Apple logo also provides a striking demonstration. Most people feel they know the Apple logo, as we have been bombarded with this iconic symbol. Repeated exposure does not always lead to good memory for details. Although seen many times, we surprisingly may not remember details (such as whether there is a stem and/ or leaf, and what side the bite is on), despite having high confidence (see Blake, Nazarian, & Castel, 2015 for more details).



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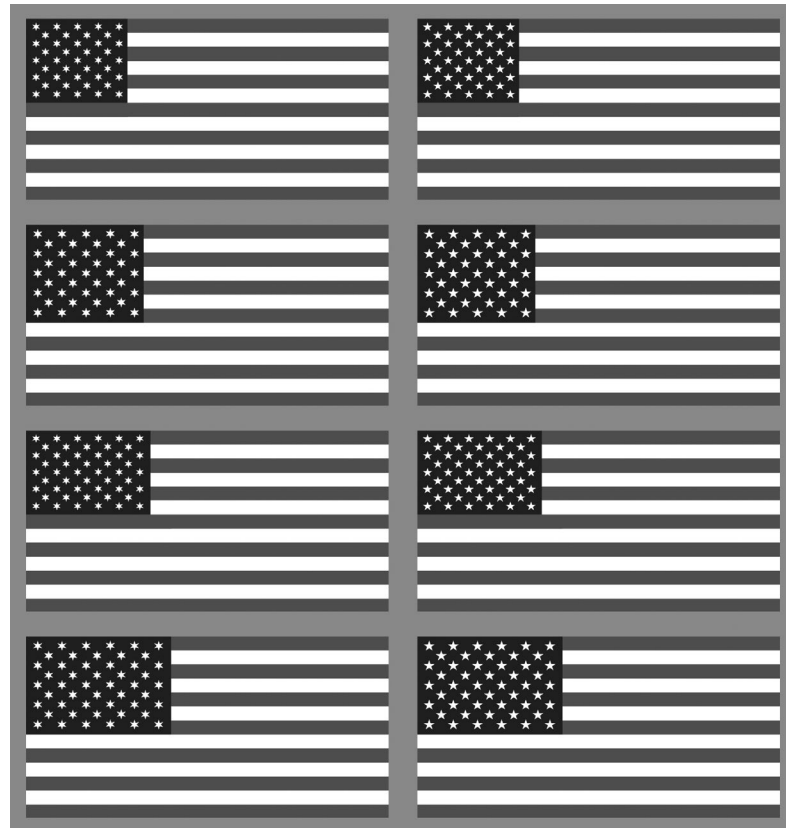


Figure 9.2: Can you find the correct US Flag? While we have partial information about the flag, have seen it many times (leading to high confidence), and know rules such as the number of stars and stripes, we may lack detailed information about other aspects. This leads to a metacognitive illusion that is especially pronounced when the flag is on display, such as before and after the 4th of July holiday (Blake & Castel, 2019). To find out the correct answer, please see the Appendix.

Misremembering features of logos and flags may be a quirk, but this habituation and lack of metamemory accuracy can have some implications in the real world. For instance, do you know where the nearest fire extinguisher is located? Most people in a workplace environment have seen them many times and know they are somewhere— but where? Can you locate yours, either at home or at the office? If you struggle, it may be explained by “inattentional amnesia”— a failure to remember something you have seen (but perhaps not noticed) many times (Wolfe, 1999). One field study conducted at UCLA asked workers (while sitting at their office desk) where the nearest fire extinguisher was located. Many of these people felt like they knew where the fire extinguisher was located but, when they were asked to find it, they failed (see Figure 9.3). This experience of failed retrieval can actually turn into a



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beneficial learning event, partly because it points to our blind spots. When queried again three months later about the fire extinguisher, most participants were now able to locate it (Castel, Vendetti, & Holyoak, 2012). It remains to be seen (pun intended) if this might generalize to situations in which vision is compromised. For instance, suppose that a chemistry lab experiment has led to a small explosion and one's vision is compromised due to chemicals in the eyes. Could one locate an emergency eye- wash station that has been in plain view the entire semester? Thus, one quirk of memory is that we might not notice our lack of awareness, as repeated exposure may create a powerful illusion of certainty.



Figure 9.3: We often stop noticing things in our environment that we see every day, referred to as "inattention blindness." Furthermore, people seem to be unaware of not noticing, making the effect even more pronounced. Castel, Vendetti, and Holyoak (2012) asked participants to recall the location of the nearest fire extinguisher while in their office. Many did not know where it was, even if they walked past it every day, illustrating inattention blindness for a conspicuously- placed object. In one especially dramatic instance (shown above), the fire extinguisher had been right next to the person's office door for more than 20 years!



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DISTRACTION AND HABITS = MEMORY BLUNDERS?

People are often distracted, when on their phones, while driving, while in conversation, and this impacts memory. Can you think of the last time you forgot something that was really important? This might include forgetting your passport for a trip or your spouse's birthday. Although people can often remember the location of important objects in lab-based tasks (e.g., Siegel & Castel, 2018), a casual inspection of lost- and- founds at airports and gyms shows that people often leave behind their car keys, wallets, cell phones, and laptops— all vital objects of everyday life. People often forget where they have hidden important objects (Winograd & Soloway, 1986), passwords they have generated, and sometimes even the location of valuables hidden away long ago. One elderly man in France once hid a large amount of gold and valuable jewelry (worth over \$200,000) in his cluttered basement, presumably to keep it safe and prevent others from finding it. The only problem was that he forgot about his treasure a few years later when he moved houses (Taylor, 2012)! Thankfully, a few months after moving from this house into a retirement home, he remembered the collection of gold bars and jewelry he had left in his basement. Squatters had since invaded the house, but they were apparently oblivious to the gold mine beneath their feet. Police were soon able to help find the gold— kept in a jar and wedged between piles of junk— and escorted the retiree to the bank.

One reason we might forget important things may be distraction. A particularly horrifying case is when parents, while driving a familiar route to work, forget they have a sleeping infant in the car— something that happens so often it has been termed “forgotten baby syndrome” (Fantz, 2015). This can lead to infant deaths and devastated parents whose memory is perfectly normal and usually high- functioning. These people have experienced a common occurrence of being distracted in a familiar routine of getting to their workplace, and forgot to drop off their child at daycare.

While some research shows that under certain levels of distraction we can selectively focus on remembering important information (Middlebrooks, Kerr, & Castel, 2017), one quirk of memory is that sometimes we forget the most important things because we are consumed by mind- wandering and distraction. On a more humorous note, a cartoon depicts two dinosaurs who see that they are late to the departure of Noah's Ark, having just missed their ride to avoid the flood (and eventual extinction). One remarks to the other, “Oh shoot, was that today?”



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AGING AND REMEMBERING IMPORTANT THINGS

While it is unclear whether there is an evolutionary basis to remember certain information, there are times when our memory becomes tuned to remember things that might help us survive. This could take the form of helping us to distinguish between food that we can eat safely versus food that has made us sick in the past. Although younger adults usually have better memory abilities relative to older adults, aging may bring with it an ability to selectively remember what is most important (Castel, 2008), especially when context can guide memory (Hess, 2005). Thus, despite memory challenges, older adults can remember things that matter to them, such as interesting trivia (McGillivray, Murayama, & Castel, 2015), what essential items to pack on a trip (McGillivray & Castel, 2017), grocery items and sale prices (Castel, 2008; Flores, Hargis, McGillivray, Friedman, & Castel, 2017), allergens (Middlebrooks et al., 2016), and weather forecasts (see Figure 9.4 by Gallo, Hargis, & Castel, 2019). While older adults may sometimes have difficulty remembering precise information, such as remembering “it will be 92 degrees this weekend,” they will remember the gist, such as “it will be hot this weekend” (Brainerd, Reyna, & Howe, 2009). Perhaps experiencing many past memory challenges makes older people focus on remembering what is most important and remembering the gist to offset forgetting details.

7 day forecast

MON	TUE	WED	THU	FRI	SAT	SUN
		80% 	30% 		20% 	
73°	78°	52°	82°	78°	59°	80°
46°	52°	47°	60°	59°	43°	63°

Figure 9.4: After planning a picnic, could you later remember what day you had chosen? While older adults may struggle to remember information in lab- based settings, older adults can remember the main theme or gist. For example, when presented with a weather forecast and a goal of remembering what days are sunny or rainy (i.e., the gist and not specifics such as exact temperatures), older adults remember what day would be best to plan a picnic (Gallo, Hargis, & Castel, 2019). This suggests that older adults can better remember information that is most relevant to plan and complete goals.



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Older adults often exhibit deficits in associative memory when remembering unrelated word pairs (Naveh- Benjamin, 2000), such as those shown in Figure 9.1. However, when realistic materials and frequent testing sessions are employed, older adults may be able to remember important associations (Castel, 2008). This can take the form of remembering the names and faces of people that one cares about, such as a friend or doctor that will be seen again in the future (Hargis & Castel, 2017). In addition, with repeated studying and testing, older adults can selectively remember what medications should not be taken together as this mix might lead to a dangerous medication interaction (Hargis & Castel 2018a, 2018b, see Figure 9.5).



Figure 9.5: Older adults often have trouble remembering associations, such as names and faces. However, with repeated exposure and testing, older adults are able to selectively remember important associations that are of critical importance, such as medication interactions that could cause a severe side effect (Hargis & Castel, 2018a, 2018b).

Although older adults experience challenges remembering associations, such as between names and faces, a lifetime of experiencing memory challenges may be an asset. Awareness that it is difficult to remember, coupled with frequent testing, may help older adults focus on what matters most in everyday life (which may differ from what is often tested in the lab). In order to better tune our metamemory to our actual memory function, we need memory failures. While most teachers feel that “perfect practice makes perfect,” this motto itself may be imperfect. It is important to experience failures (ideally when the costs are low), including forgetting, so that one can benefit from learning from mistakes; this form of learning can be very potent and long lasting.



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FEELINGS AND FEAR OF FORGETTING

One motivation for remembering important things may be the fear associated with forgetting. People do not want to miss their flight, forget their babies, or, as often reported as a common and reoccurring nightmare, forget to put on their pants before going to school or work. Thus, anxiety may encourage people to focus on remembering. However, sometimes this can be misguided, as people (especially healthy older adults) may experience stress about forgetting names— even if names may not be critical to remember in the grand scheme of things. Whereas failing to remember important things consistently and on a day- to- day basis (such as wearing pants) may be a sign of dementia (Castel, Balota, & McCabe, 2009), occasional absent mindedness is usually nothing to worry about as it is common at many stages in life.

Another quirk of memory is the vague worry that we might be forgetting something important. People often report dreams where they have gone to school, or work, and about halfway through the dream realize that they have forgotten to wear pants. These dreams are typically anxiety- evoking, for a number of embarrassing reasons, but for the purposes of the present chapter illustrate how important it is to remember to do certain things in the morning, before we head off for a busy and distracted day. People often experience anxiety when their memory is challenged and this anxiety could influence how we attempt to remember (Davidson, Dixon, & Hultsch, 1991).

As you are rushing to take a trip, have you ever felt that you are forgetting something? While these feelings can often mean we are indeed forgetting something(s) (Halamish, McGillivray, & Castel, 2011), they also show we have some capacity to know what we don't know, and attach some fleeting feeling to the loss of information. In addition, certain stereotypes (such as older people have worse memory) can negatively impact how older adults perform on memory test, and can be made worse by asking older adults about their age prior to the test (Hess et al., 2003). When anxiety about memory can be reduced, such as first giving older adults task success on a memory test (see Geraci & Miller, 2013), memory can be improved. Thus, our feelings and fear associated with memory tests can impact our performance but may also make us more aware of how our memory works under conditions of stress.



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GONE AND LESS IMPORTANT: A FORGETTING BIAS

Forgetting may be related to the importance of information, such that more important information is favored (and more likely to be retained) than less important information. But how does importance shape our perception of forgetting after it has occurred? For example, suppose you began your work day making a mental note to schedule an appointment. By the end of the day, you realize you forgot to make the appointment and it is too late to call. How would you evaluate this forgetting? Several sets of experiments we have reported (Castel et al., 2012; Rhodes et al., 2017; Witherby et al., 2019) suggest that people evaluate these lapses by devaluing the importance of the information. That is, we might reflect on the forgotten appointment by thinking something like, “Oh, it was probably not that important; I can do this tomorrow.”

One way to experimentally examine this issue is to have people learn items that vary in importance. In an experiment that used this value- directed format, participants learned a set of words where each was associated with a different point value indicating how important that information was to remember (e.g., apple 12, donkey 3, table 9, etc.). As shown in a host of prior experiments, participants remembered important (valuable) information better than less valuable information (Castel, 2008). Our interest, however, was in a judgment we solicited after participants had tried to recall all of the information they had studied. In particular, we showed participants each word they had studied and asked them to remember its value when first studied. A consistent pattern emerged— on the average, a forgotten word was rated as less valuable than a remembered word. Thus, if you had seen “table 9” but later forgot this pairing, you are likely to under- estimate the original value of table (e.g., think “table” was worth 7 points).

Indeed, our conclusion was that participants made this judgment via a two- step process (Rhodes et al., 2017). First, they attempted to determine whether they had remembered the item on the prior test. Next, based on that, importance was either upgraded (if it had been remembered) or downgraded (if it had been forgotten). Probably the most compelling evidence for this account came when participants mistakenly believed that they had forgotten a word. For instance, in one experiment, we first had participants tell us (“yes” or “no”) whether a word was remembered and then report how valuable it was. Based on this, we could determine whether the memory judgment was accurate (e.g., a word was recalled previously and correctly regarded as remembered) or inaccurate (e.g., a word was forgotten previously but mistakenly regarded as remembered). Interestingly, when forgotten words were



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mistakenly judged to be remembered, participants provided the same value judgments as if they remembered the information. Further work showed that these biases regarding the importance of forgotten information applied similarly with older adults (Witherby et al., 2019), belying our assumption that more experience with forgetting might temper the bias to deem forgotten information to be less valuable.

Thus, one way we move on after forgetting to make an appointment is to devalue its importance. This has some practical implications, as it may influence how we look back on our impressions of certain negative or positive events or traits of people we have met in the past (Ray et al., 2018), and that we may remember the gains and tend to devalue the losses (Castel et al., 2016; Gödker, Jiao & Smeets, 2019). In this way, a forgetting bias can make forgotten information seem less valuable, and there may (or may not) be good reasons why we need to accurately remember the value of what has been forgotten.

SUMMARY

Quirks: Why Do We Sometimes Forget Important Things and Don't Predict It?

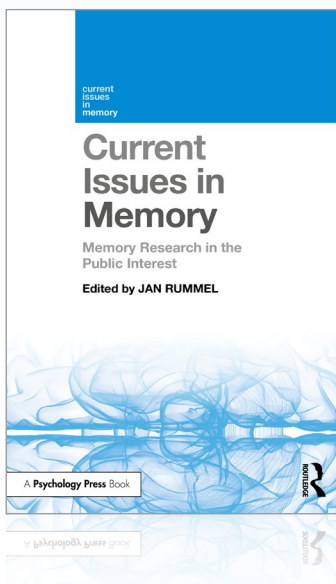
Our memory is quirky in that we may remember things we don't really care about (the jingle from a car commercial from 20 years ago) and forget things we do care about (a name of a colleague, or more consequentially, a baby we placed in the backseat of our car 20 minutes ago). While people often experience forgetting most intensely as related to proper names, people may not always be aware of the nature of forgetting in general. Unlike a computer, forgetting is a natural and sometime beneficial property of our human memory system— and thus we are often surprised when we forget something. We suggest that one reason this quirk exists is that our metamemory is often out of tune with our actual memory. People think we should remember what is important (and we often do) but when we forget something important we either dismiss it and/ or can't believe it would happen to us. No one really thinks they would forget about their baby in the car, but this too often happens to people. While some of these quirks can be described in terms of our world of distraction, there are many instances where we do not fully appreciate or understand how our own memory works until it fails us, and that is our essential memory quirk quandry.

CHAPTER

4

FALSE MEMORIES MATTER

THE REPERCUSSIONS THAT
FOLLOW THE DEVELOPMENT
OF FALSE MEMORY



The following is excerpted from

Current Issues in Memory

Edited by Jan Rummel.

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FALSE MEMORIES MATTER

Edited by Jan Rumme

Excerpted from *Current Issues in Memory*

Cara Laney and Elizabeth F. Loftus

Many of our everyday memories have repercussions. This means that they can have consequences for our later thoughts, intentions, and even behaviors. Memories of a favorite childhood pet can give people warm feelings later in life. Memories of getting horrible food poisoning after eating leftover pizza from the fridge can make people avoid pizza (or at least cold pizza) for the rest of their lives. Memories of committing a wrong against a friend can lead to lifelong feelings of guilt. But what about false memories? Can they have repercussions too? If they did not, it might lead to a way to distinguish true from false memories.

Being able to differentiate between memories for events that truly happened and false memories would be highly beneficial, especially for the justice system. Finding a reliable distinguishing characteristic between true and false memories has been an important research goal for years (Heaps & Nash, 2001 ; Loftus & Bernstein, 2005 ; Bernstein & Loftus, 2009). Numerous potential characteristics have been tested, including confidence (Loftus & Pickrell, 1995 ; Laney & Takarangi, 2013), detail (e.g., Hyman & Pentland, 1996 ; Porter, Yuille, & Lehman, 1999), emotionality (Campbell & Porter, 2002 ; McNally, 2003 ; McNally et al., 2004 ; Laney & Loftus, 2008 ; see also Oulton & Takarangi, 2017), longevity (Geraerts et al., 2008 ; Laney, Bowman- Fowler, Nelson, Bernstein, & Loftus, 2008 ; see also later), and individual differences that might distinguish between people who are more versus less likely to form false memories (e.g., Porter, Birt, Yuille, & Lehman, 2000 ; Drivdahl & Zaragoza, 2001 ; Ost, Foster, Costall, & Bull, 2005 ; Zhu et al., 2010). Although many of these studies found some statistical differences between groups of true and false memories (or groups of people who did and did not form them in a particular case), none of these has been able to reliably determine whether a particular memory is true or false, especially to the degree of certainty necessary for the courts.

So would the presence or absence of consequences be a way to do so? If false memories are substantially less likely than true memories to have repercussions in people's lives, then measuring consequentiality could be a useful way to weed out false memories from true memories. In an important aside, it has long been known that false memories can wreak havoc in the lives of those who have them and their families, including interpersonal and legal upheavals (e.g., Gudjonsson, 1996 , 2008). The kinds of repercussions that we are talking about in this instance are both smaller and more specific.



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EARLY STUDIES: PICKLES, EGGS, STRAWBERRY ICE CREAM

In the initial published studies of false memory consequences, our research group gave subjects false memories for one of two food- related childhood events, getting sick after eating either dill pickles or hard- boiled eggs (Bernstein, Laney, Morris, & Loftus, 2005b). We chose getting sick after eating a particular food because this is a nicely concrete event that could reasonably happen at almost any time in childhood, and because there is an established literature demonstrating the psychological consequences that can occur when people genuinely get sick after eating a particular type of food (e.g., Gustavson, Garcia, Hankins, & Rusiniak, 1974 ; Broberg & Bernstein, 1987). We chose pickles and hard- boiled eggs because they were foods that we thought most kids would have had some experience with, but not everyday experience.

These initial studies, and indeed most of the studies described in this chapter, use the false feedback procedure for implanting false memories. This procedure involves three key phases, though with a host of variations (see also Laney & Loftus, 2010). In the first phase, subjects come into the lab and are given a cover story and a set of questionnaires to complete. The questionnaires all revolve around a common theme that supports the cover story but also provides key premanipulation measures for the specific study. In the second phase, which normally occurs approximately a week after the first phase (though in some studies happens as little as ten minutes later), subjects are given the false feedback manipulation. This takes the form of a supposedly computer- generated feedback profile that gives subjects information about events that happened in their childhoods. The content of this profile is determined not by subjects' answers to the phase 1 questionnaires (as they are told), but instead by random assignment. In particular, experimental (but not control) subjects are told that they had a specific experience as a child. In the studies described here, this is normally a specific experience with a particular food (e.g., you got sick eating a hard- boiled egg). Subjects are asked to read their profile and, in most studies, to answer some questions about it to ensure that they do actually read and understand it. In the third phase of the study, which normally immediately follows the second phase, subjects are given an additional set of questionnaires that assess whether the manipulation has produced changes in subjects' confidence that the suggested event occurred, as well as measuring the false memory consequences of interest in the particular study.

How do we decide that someone has developed a false belief or memory? In most false feedback, false memory studies, subjects are said to have developed false



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memories (termed “believers”) if they meet three specific criteria: (1) their premanipulation confidence that the critical event happened is low (that is, they do not have arguably “true” memories), (2) that confidence increases after the manipulation, and (3) they report a specific “memory” or a less specific “belief” for the event at the end of the study (see Morris, Laney, Bernstein, & Loftus, 2006). Often, the key comparison for determining whether false memories have repercussions is between these “believers” and control subjects. In the initial false memory consequence study (Bernstein et al., 2005b, Experiment 1), subjects first completed just one questionnaire (asking about their preferences for various foods) and then were told that their data would be analyzed by a special computer system. A few minutes later, subjects were given a feedback profile that the computer had supposedly generated. This profile contained three filler items for all subjects (that as young children they had disliked spinach and enjoyed fried foods and chocolate-covered almonds) and for experimental subjects also contained the suggestion that they had once gotten sick after eating either dill pickles or hard-boiled eggs (depending on condition). Subjects were then asked to briefly elaborate on their critical item (controls elaborated on a filler item) and then to complete a further set of questionnaires designed to assess whether their confidence that they had gotten sick on pickles or eggs had increased and whether these altered beliefs might have consequences (detailed later).

The methodology for Experiment 2 was similar, except that (a) subjects completed the confidence measure (called the Food History Inventory) and three filler questionnaires at premanipulation, (b) the delay between phase 1 and phase 2 was a week instead of a few minutes, (c) the food preferences questionnaire was used as a postmanipulation confidence measure instead, and (d) we used an additional postmanipulation questionnaire called the Memory or Belief form, on which they were instructed to judge their experiences of three different events (including their critical egg or pickle event) as specific memories, less specific beliefs that the event occurred, or neither of these. In Experiment 1, subjects given the pickle feedback were more confident than egg feedback subjects or controls that they had indeed gotten sick eating pickles, though egg feedback subjects were no more confident than pickle feedback subjects that they had gotten sick after eating hard-boiled eggs. In Experiment 2, both types of feedback produced significant increases in confidence in their respective subjects from pre- to postmanipulation. In addition, the combination of confidence change and a “memory” or “belief” response on the Memory or Belief form became the criteria for labeling subjects as having false memories (being “believers”) for their critical sickness event. Specifically, 25% of



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pickle feedback subjects and 31% of egg feedback subjects believed their feedback, reporting increased confidence that they had been sick after eating the food and reporting a specific memory or belief that they had been sick.

To determine whether subjects' new false memories were consequential, they were given a Party Behavior Questionnaire, on which they were asked how likely they were to consume a variety of foods (including dill pickle spears and salted hard-boiled eggs, as well as related items— pickle slices and egg salad finger sandwiches) in a backyard party situation. In Experiment 2 subjects were also asked to rate their preference for a list of foods, including both critical foods and several closely related foods. Experiment 1 did not produce significant differences in expressed desire to eat pickles or hard-boiled eggs at a party between people who were or were not exposed to false feedback about getting sick, but this may be because those who actually believed the feedback were lumped in with others who did not. That is, this study was not able to distinguish between those who believed versus did not believe the false feedback. This comparison was possible in Experiment 2, and we found that those who believed their feedback were indeed less interested in eating the food that they now believed they had gotten sick after eating. And these effects even carried over to other, closely related, foods like egg salad.

That is, false memories did seem to be consequential for those who developed them, in the same way that true memories can be consequential. So looking for evidence of consequentiality appears to be another dead-end in the search for categorical differences between true and false memories. Nonetheless, there is still much more to learn about the consequences of false memories and what they can tell us about memory processes more broadly. For details regarding the food items, manipulations, proportions of "believing" subjects, and basic results regarding two key kinds of false memory repercussions (preference consequences and action consequences) for each of the studies described in this chapter, see Table 9.1.



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TABLE 9.1 Studies of false memory consequences

<i>Study</i>	<i>Item(s)</i>	<i>Manipulation</i>	<i>% “believers”</i>	<i>Preference consequences</i>	<i>Consumption consequences</i>
Bernstein et al. (2005b)	dill pickles; hard-boiled eggs	“you got sick”	n/a	n/a	none
Experiment 1					
Bernstein et al. (2005b)	dill pickles; hard-boiled eggs	“you got sick”	25% for pickles; 31% for eggs	less preference among believers	less reported willingness to eat food among believers
Experiment 2					
Laney et al. (2004)	chocolate cake; potato chips	“you got sick”	24% for cakes; 49% for chips	n/a	none
Bernstein et al. (2005a)	strawberry ice cream; chocolate chip cookies	“you got sick”	18% for ice cream; 9% for cookies	lower preference for strawberry ice cream (but not cookies) among believers	less reported willingness to eat strawberry ice cream (but not cookies) among believers
Experiment 1					
Bernstein et al. (2005a)	strawberry ice cream; chocolate chip cookies	“you got sick” plus elaboration or scenario choice	41% for ice cream; 22% for cookies	believers (combined) avoided (combination of preference and hypothetical action) more than nonbelievers and controls	
Experiment 2					
Scoboria et al. (2008)	peach yogurt	personalized “got sick” suggestion plus generic “health alert” suggestion	not measured	lower reported desirability of peach yogurt (specifically) in experimental group	lower consumption of peach yogurt and two other flavors (but not crackers) in experimental group
Laney, Morris et al. (2008)	asparagus	“you loved cooked asparagus”	48%	greater preference among believers	greater intention to eat and willingness to pay more among believers relative to controls
Experiment 1					
Laney, Morris et al. (2008)	Asparagus	“you loved asparagus the first time you ate it”	53%	greater preference among believers; more positive feelings toward picture of asparagus	n/a
Experiment 2					
<i>Study</i>	<i>Item(s)</i>	<i>Manipulation</i>	<i>% “believers”</i>	<i>Preference consequences</i>	<i>Consumption consequences</i>
Laney, Bowman-Fowler et al. (2008)	asparagus	“loved”; “hated”; also 2-week delay phase	for “loved”: 34% immediately, 26% after 2 weeks; for “hated”: 47% immediately, 40% after 2 weeks	greater preference among “love” believers and lower preference among “hate” believers immediately and after two weeks, relative to pre-manipulation levels	greater intention to eat among “love” believers immediately and after 2 weeks; greater request to eat among “love” believers after 1 week
Geraerts et al. (2008)	egg salad	“got sick”; also 4-month delay phase	39% of manipulated subjects	lower preference for egg salad among believers	believers ate fewer egg salad sandwiches than controls, immediately and 4 months later

(continued)



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Berkowitz et al. (2008)	Pluto (Disney character)	“Bad Pluto” had “inappropriately” licked kids’ ears; “Good Pluto” had licked ears to kids’ delight	30% Bad Pluto; 39% Good Pluto	none	reduced willingness to pay for Pluto souvenir among Bad Pluto believers
Scoboria et al. (2012)	peach yogurt	personalized “got sick” suggestion and/or generic “heath alert” suggestion; also 1-month delay phase	44% of personalized suggestions subjects indicated “memory” or “belief”	lower preference for peach yogurt in those given the personalized suggestion only	lower consumption of peach yogurt by those given the personalized suggestion only, at one week and one month delays
Clifasefi et al. (2013)	vodka; rum	“got sick”	20% of manipulated	lower preference for suggested alcohol type among believers	n/a
Mantonakis et al. (2013)	white wine	“loved” or “got sick”	46% of manipulated (not separated by manipulation)	n/a	greater actual consumption of wine in “loved condition” (only)

Once we had established that false memories, like true memories, could be consequential for those who possessed them, we looked at several other types of false memories and consequences. First we gave subjects false memories for getting sick on chocolate cake and potato chips, using essentially the same methodology as that of Bernstein et al. (2005b, Experiment 2) described earlier (Laney, Morris, Bernstein, & Loftus, 2004). Although we were able to plant false memories for getting sick on both of these foods, we did not see any consequences of these false memories. That is, although 24% of subjects falsely believed that they had once gotten sick after eating chocolate cake, these cake believers did not demonstrate any reduction in preference for cake or willingness to eat cake, relative to nonbelievers or nonexposed subjects. We also successfully convinced 49% of subjects they had once gotten sick after eating potato chips, but again, these believers were no less interested in eating potato chips than nonbelievers or nonexposed subjects. (Note that this doesn’t undermine the previous claim that false memories cannot be distinguished from true memories on the basis of their consequentiality— in this study, true memories were also not distinguishable from other groups on the basis of their consequentiality.)

So why do false beliefs about some foods have consequences but false beliefs about other foods do not? After some thought, we hypothesized that most college students have lots of positive experiences with cake and chips. They like to eat cake and chips



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and know full well that they like to eat cake and chips. When faced with (new) knowledge that they had once become sick after eating one of these common and preferred foods, subjects in the study may have concluded that, even if they once got sick, it clearly hadn't affected their preference for these foods or willingness to eat them. After all, they had plenty of evidence from their own memories that they liked to eat these foods—much more than they likely had evidence about their feelings for rarer foods like dill pickles and hard-boiled eggs. This suggests that false memories may not be the next great diet fad (though see Bernstein, Pernat, & Loftus, 2011).

We next turned this bit of post-hoc reasoning into a hypothesis for a new study (Bernstein, Laney, Morris, & Loftus, 2005a). Specifically, we hypothesized that we would be able to give subjects false memories for getting sick after eating either a very common food, chocolate chip cookies, or a somewhat less common food, strawberry ice cream, but that we would only find false memory consequences for the less common food.

The procedures for the study were similar to those used by Bernstein et al. (2005b, Experiment 2). Subjects completed questionnaires and were told that their data would be analyzed by a special computer that would produce profiles before they returned a week later. All subjects' profiles told them that as young children they had liked bananas and hated spinach and that they had been happy when a classmate had brought sweets to school. Subjects in the experimental conditions were also told that they had once gotten sick after eating either strawberry ice cream or chocolate chip cookies. In fact we were really successful at giving people false memories only for getting sick from eating strawberry ice cream (18% of these subjects met our "believer" criteria). These people also demonstrated avoidance of strawberry ice cream, as hypothesized. No one avoided the more common food, chocolate chip cookies. Experiment 2 further demonstrated that the recency of eating the food did not, by itself, predict whether people would adopt false memories.

CAN WE MAKE PEOPLE WANT TO EAT MORE INSTEAD OF LESS?

Once researchers had clearly demonstrated that planting false memories for getting sick on a particular food, could have negative consequences for how people felt about that food, we wondered whether we might be able to do the opposite. Could we plant a positive false memory about a (healthy) food and cause people to want to eat more of it (Laney, Morris, Bernstein, Wakefield, & Loftus, 2008)? We chose asparagus as our target food because we believed that it is not typically enjoyed by young children and, although not found on every dinner table, it is approximately equally common in



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the typical diets of Asian Americans and White Americans, the two largest groups in our student population at the time.

We used the same false feedback procedure as in the prior studies, but this time the false feedback item was “You loved to eat cooked asparagus” (in Experiment 1) and confidence on the item “Loved asparagus the first time you tried it” was measured. After the manipulation, 48% of relevant subjects met the criteria to be labeled “believers”. These subjects expressed greater preference for asparagus and were more interested in eating asparagus in a hypothetical restaurant situation (similar to the early “Party Behavior” measure) than were controls. Interestingly, asparagus believers also reported willingness to pay more for asparagus in a store than did controls.

In Experiment 2 we started to look for underlying mechanisms that might explain the differences between believers and other subjects. This time, 53% of relevant subjects met the criteria to be labeled “believers”, and again these individuals displayed significantly greater preference for asparagus than controls (the restaurant measure was not significant this time). In addition believers in this study rated a photograph of asparagus as somewhat more appetizing and significantly less disgusting than controls.

In the final asparagus study (to date), Laney, Bowman- Fowler et al. (2008) used the false feedback procedure to give subjects false memories for either loving or hating asparagus the first time they tried it and again assessed whether there were consequences of these false memories. But then, instead of debriefing people in the same (second) session, we asked people to come back to the lab for a third session two weeks later. Some 34% of “loved” subjects and 47% of “hated” subjects met our believer criteria in an immediate test; these numbers dropped to 26% and 40%, respectively, by the two- week follow- up. These believers’ preferences for asparagus changed from pre- to postmanipulation in the expected directions (increasing for the “love” group and decreasing for the “hate” group) and essentially maintained these levels at the two- week follow- up. “Love” believers (but not “hate” believers) also demonstrated greater intention to eat asparagus in a hypothetical restaurant. One week after the manipulation (and one week before the last session of the study) subjects were informed (falsely) that we would be providing snacks during the final session of the study and asked to rank vegetables (including asparagus) according to how much they would like to eat them. Again, “love” believers (but not “hate” believers) were more interested in eating asparagus than were controls. Two additional studies have also looked for (and found) long- term consequences of false



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memories— see descriptions of Geraerts et al. (2008) and Scoboria, Mazzoni, Jarry, and Bernstein (2012) later.

This last asparagus study was also interesting because we explicitly compared true and false memories in terms of their consequentiality (Laney, Bowman- Fowler, et al., 2008 ; see also Laney & Loftus, 2010). True memory subjects in this study were those who started the study with and maintained high confidence that they had loved or hated asparagus the first time they had tried it. In summary, people with true memories for loving asparagus tended to behave like those with false memories for loving asparagus, but even more so (greater preference and greater willingness to eat, on average). People with true memories for hating asparagus the first time they tried it showed few consequences of this belief, just like people with false memories of hating asparagus.

DO FALSE MEMORIES AFFECT ACTUAL BEHAVIOR?

The studies described so far use as a dependent measure intention to eat, reported by subjects via paper and pencil tasks, rather than actual eating behavior. Other researchers took the next step of actually putting food down in front of subjects and measuring how much they ate. Geraerts et al. (2008) tested whether false memories of getting sick after eating egg salad would affect subjects' subsequent consumption of egg salad sandwiches. They used the false feedback procedure and succeeded in giving 41% of experimental subjects false memories for getting sick on egg salad. In an immediate test after a bogus debriefing, manipulated subjects ate fewer egg sandwiches than did nonmanipulated subjects. Four months later, subjects were recontacted under the guise of a separate study and again offered egg salad and other sandwiches. This time believers ate fewer egg salad sandwiches than controls. Scoboria, Mazzoni, and Jarry (2008) used a suggestion similar to those used in previous studies plus a "health alert" suggestion to convince subjects that they had once been exposed to and sickened by contaminated peach yogurt. A week later, in what subjects were led to believe was a separate study, subjects tasted actual peach yogurt, as well as strawberry yogurt, cherry yogurt, and three flavors of crackers. Although Scoboria et al. did not separate out their "believer" subjects, they found that manipulated subjects as a group liked peach yogurt less and ate less of all three types of yogurt (but not fewer crackers) than control subjects. Two critics (Pezdek & Freyd, 2009) argue that these results don't matter because yogurt "is not commonly consumed" (p. 179; we suggest that the shareholders of Yoplait, Danon, Chobani, and Oikos, among others, would disagree).



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Scoboria et al. (2012) extended the findings of Scoboria et al. (2008) by separating out the two distinct manipulations (personal suggestion and generalized “health alert” suggestion). Different subjects received each of these manipulations individually, or both, or neither. These authors found that the personalized suggestion worked best and that the generalized suggestion actually reduced the likelihood of forming false memories. This time Scoboria et al. also reported that 44% of their personalized suggestions subjects reported a “memory” or “belief ” after the manipulation. Subjects given the personalized suggestion also reported lower preference for peach yogurt and consumed less peach yogurt (but not less strawberry yogurt, cherry yogurt, or crackers) when given the opportunity after one week or one month.

Bernstein, Scoboria, and Arnold (2015) conducted a mega- analysis (a type of meta- analysis where raw data from several studies are combined into a single data set) of eight food studies and found that the false suggestion directly affected some consequences (food preferences) but not others (intention to eat), that belief in the false suggestion predicted intention to eat, and that positive suggestions (loving on first consumption) were more powerful than negative suggestions (getting sick).

DOES IT ONLY WORK ON FOOD?

Although our lab was never very successful at reducing hypothetical consumption of unhealthy foods (Bernstein et al., 2005a ; Laney et al., 2004), other researchers have also attempted to alter negative consumption habits with false memories. Clifasefi, Bernstein, Mantonakis, and Loftus (2013) used the false feedback procedure to convince subjects that they had once been sick after drinking either vodka or rum (depending on condition) before the age of 16. Some 20% of subjects formed false memories, and subjects whose first drinking experience had occurred at a younger age were more likely to be believers. These believers’ preference for the manipulated alcohol type (and indeed that of all those who were exposed to the “got sick” manipulation) decreased from pre- to postmanipulation. This suggests, but does not directly demonstrate, that alcohol consumption, like food consumption, may be affected by false memories.

Mantonakis, Wudarzewski, Bernstein, Clifasefi, and Loftus (2013) took things one step further by actually giving subjects alcohol to drink. These authors used a version of the false feedback procedure to convince some subjects that they had become sick after drinking (or had loved) white wine before the age of 20 (a more recent event than those used in prior studies). These researchers were able to convince 46% of subjects that they had had a specific experience with white wine (these authors did not say



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what proportion of these believers were in each of the two conditions). They also found that, when given the opportunity, “love” believers drank more wine than controls. Sick believers did not, however, drink less than controls.

Mantonakis et al. (2013) discuss the implications of their research for the field of advertising, suggesting that policy makers might want to attend to the research demonstrating that false beliefs can alter behavior. Rajagopal and Montgomery (2011) tested the relationship between advertising and false beliefs even more directly. These authors had subjects listen to radio advertisements that varied in their imagery. Subjects exposed to high imagery ads often believed that they had actually experienced a product that they had not. The researchers found that false beliefs (that subjects had actually tried the advertised product) led to similar outcomes (including favorable attitudes toward the product) to those produced by true beliefs.

In a rather different kind of false memory repercussion study, Berkowitz, Laney, Morris, Garry, and Loftus (2008) used the false feedback procedure to give subjects false memories for one of two experiences with the character Pluto at Disneyland (close to the UC Irvine campus where this research was conducted). Some subjects were told that, based on the outcome of their fear profile (similar to the foodrelated false feedback profiles described earlier), a news story might be relevant to them. The news story described an unpleasant and drug- fueled Pluto character who had inappropriately licked the ears of children who visited Disneyland during the childhoods of the subjects. Other subjects were given a happier profile and a story of a happy- go- lucky Pluto character who had licked the ears of children in a delightful way. Thirty percent of the “Bad Pluto” subjects and 39% of the “Good Pluto” subjects formed false memories of being licked by Pluto. Although these manipulations did not affect subjects’ feelings about the character of Pluto, the “Bad Pluto” subjects reported being less willing to pay for Pluto souvenirs at Disneyland.

CONCLUDING REMARKS

Why does it matter whether false memories have repercussions? For starters, it means that this is yet another way (besides confidence, detail, emotionality, etc.) that false memories can be indistinguishable from true memories. In one sense, this is unsurprising. Because memory is reconstructive, even memories that are largely accurate may contain bits of fiction.

Smeets, Merckelbach, Horselenberg, and Jelicic (2005) argue that too many researchers who claim to be studying false memory are in fact studying something



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less concrete, like false beliefs, and suggest that in order to speak meaningfully about false memories we should only ever consider false memories that have real behavioral consequences. At the time these researchers made this argument, there were few studies of behaviorally consequential false memories available. More than ten years later, there is now a sizable body of work that supports the conclusion that false memories really do matter.

NOTE

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