

7

A Brief History of Memory and Aging

AIMÉE M. SURPRENANT, TAMRA J. BIRETA,
and LISA A. FARLEY

In addition to his empirical work, Roddy Roediger has written tutorials, commentaries, encyclopedia articles, summaries of entire areas, textbooks, practical guides to research, career guides, and guides to professional development. Throughout all of his work there is a clear sensitivity to history. He has written and given talks on the works of Ebbinghaus, Bartlett, Ballard, Deese, Nipher, and others, and, through his many editorships, he has supported the efforts of others in this direction. Even though he is no longer the editor, *Psychonomic Bulletin and Review*, a journal Roddy reinvented, is known to welcome submissions exploring the history of experimental psychology. If that were not enough, in recent years Roddy's research program has added a new facet, exploring age-related differences in memory, particularly as it concerns false memory. Thus, it seemed appropriate to combine those interests and delve into the history of memory and aging at the conference in his honor.

The purpose of this chapter, therefore, is to summarize the history of beliefs and research that serves as the foundation of current work on memory and aging. Although there have been in-depth articles on the history of life-span developmental psychology (Baltes, 1983), histories and surveys of the psychology of aging (Birren, 1961a, 1961b; Birren & Schroots, 2001; Granick, 1950; Pressey, Janney, & Kuhlen, 1939), and comprehensive considerations of the history of memory (e.g., Burnham, 1888; Murray, 1976; Yates, 1966), there is no published look into the history of *aging* and *memory* specifically. Our review begins by briefly mentioning some of the ideas on aging and memory in the ancient (primarily western) world and then jumps to European philosophy/early science in the late 1700s/early 1800s. After devoting some time to the early part of the 20th century, we wind up in the post Second World War era. Along the way we will point out the similarities and differences in the questions and controversies that were important then with current conceptions of memory and aging. This account will, of necessity, be extremely selective.

THE ANCIENT WORLD

Many ancient religions acknowledged the fundamental importance of memory (and learning) by making a deity in charge of that faculty. For example, the ancient Egyptians had Thoth (*circa* 3000 BCE), the scribe, who was said to have invented the sacred writing of hieroglyphics (Bleeker, 1973). This gift of writing was not entirely appreciated as a memory aid: Socrates told a fable in which the King of Egypt spurned Thoth's gift of writing, suggesting that,

this discovery of yours will create forgetfulness in the learners' souls, because they will not use their memories; they will trust to the external written characters and not remember of themselves. And so the specific which you have discovered is an aid not to memory, but to reminiscence.

(Hermann & Chaffin, 1988, p. 38)

Living to old age in ancient Egyptian society was considered a gift from the gods, and elders were revered for their wisdom and often consulted in times of need.¹ Extant writings on tombs and other monuments make reference to the many top officials in the ancient Egyptian government who were in their 60s and 70s, demonstrating that they had retained their intellectual faculties, including memory (Janssen & Janssen, 1996). Many of the Kings and Pharaohs were said to have lived over 100 years.

Similarly, the ancient Greeks had Mnemosyne (*circa* 1000 BCE), a Titaness who was the goddess of memory and the mother of the Muses (muse means one who remembers). From her name we take the words "memory," "mnemonic," and "mnemonist" (Puhvel, 2000). Mnemosyne was considered to be one of the most powerful goddesses of her time. This is not surprising because, at least as the Greeks saw it, it is the capacity for conscious memory that distinguishes humans from all other animals. Memory is the faculty that allows us to reason, to predict, and to anticipate outcomes, and is thus the foundation upon which civilization rests. Out of Mnemosyne come the Muses, her daughters, all of whom have a science or an art to protect. Thus, metaphorically, the sciences and the arts arise from memory. Mnemosyne is also attributed with the power to call things to memory and to remembrance (*mneme*). The distinction between memory storage and recollection or reminiscence is one that has gained a lot of interest in recent times (e.g., Tulving, 1999, 2000) but it seems rather commonplace in the ancient world (see also Aristotle, below).

There is not much in the written record in this era on what happens to memory when people grow old (or what Mnemosyne does to people). However, gauging by mythological tales and Greek literature (Richardson, 1969), the ancient Greeks did not seem to hold old age in a very positive light. The gods were distinguished from humans by not "suffering" from old age. In one myth, Eos, a goddess, successfully cajoled Zeus into granting her lover Tithonus immortal life. However, she made the critical error of neglecting to ask for eternal youth. As her lover aged, he became increasingly feeble and unbalanced, eventually driving Eos to desperation with his constant babbling. As a last resort, she turned him

into a grasshopper. This myth explains why grasshoppers chirp incessantly—like demented old men.

In contrast to the pessimistic view of aging seen in Greek mythology, eastern traditions, similar to those of ancient Egypt, have endowed old age with wisdom and have respected the knowledge and memories of their elders. For example, Confucius (551–479 BCE) is almost always portrayed as an old man with a tremendous memory. In the *Analects of Confucius* he discusses memory with an acolyte:

The Master said, “Ci [Zi-gong], do you think I learned by being widely read and well retained?” Answered: “Yes. Is this not so?” [The Master] said, “No. I learned by threading everything together into a unified whole.”

(Confucius, 1999, Book 15, Part 3, p. 183)

In the above quote Confucius explains that he uses previously-existing knowledge to bind meaningful information together in order to remember it. This is perhaps the first written description of how structure and organization can aid memory. Contrary to Socrates’ dismissal of the art of writing, Confucius felt that it was a very useful memory aid: “The palest ink is better than the best memory.”

Moving forward in time we come to Aristotle (384–322 BCE), who is a favorite of memory researchers because he wrote a treatise specifically on the topic, *De Memoria et Reminiscentia* (*On Memory and Reminiscence*). According to Aristotle, perception stamps an impression on memory like a seal into hot wax. Although the impression remains over time, it eventually becomes fuzzy and cracked at the edges as the wax changes with heat and cold. If the wax is young and motile or old and frayed the initial impressions are less distinct, leading to memory failures. Or, as Aristotle put it, “Hence both very young and very old persons are defective in memory; they are in a state of flux, the former because of their growth, the latter, owing to their decay” (Herrmann & Chaffin, 1988, p. 65).

Essentially, Aristotle’s view is an encoding deficit hypothesis for both very young and very old individuals: The information does not make a firm impression on their minds and thus is not well-remembered. This idea of encoding deficits accompanying aging is at least part of many modern theories of memory and aging (Simon, 1979). Aristotle’s view also might also be mapped on to some of the generalized slowing (e.g., Birren, 1956; Salthouse, 1985a) or common cause (e.g., Baltes & Lindenberger, 1997) theories of aging and cognition.

Next in our survey of the ancient world comes the Roman senator and consul (the highest Roman office) Marcus Tullius Cicero (106–143 BCE) who wrote a treatise specifically *On Old Age* (*De Senectute*). He spoke in the voice of Cato the Elder in the year 150 BCE when Cato was 84 years old. The essay consists of a series of answers by Cato to questions posed by two younger men about the nature of old age. Cato supports a fatalistic standpoint on aging, saying it is inevitable and arguing that to rebel against it is to rebel against Nature. However, he also has an optimistic view, suggesting that those reasonable men who keep themselves active and part of society actually can actually contribute more than young men: “Old

men retain their intellects well enough, if only they keep their minds active and fully employed.”

In the same essay, Cato also says:

Nor, in point of fact, have I ever heard of any old man forgetting where he had hidden his money. They remember everything that interests them: when to answer to their bail, business appointments, who owes them money, and to whom they owe it.

This, then, is a statement of a disuse theory of memory and aging—use it or lose it. Cicero, through Cato, also suggests that things that are important to older adults are remembered and they may deliberately choose to feign senility when it suits them.

From the ancient world, then, we have an encoding deficit theory, perhaps a common cause or generalized slowing theory and a disuse theory of memory and aging.

100–1700 CE

We then enter a long period of very little attention given to memory and aging. There was a lot of interest in aging, why we age and how we might avoid aging including the search for the fountain of youth as well as anti-aging elixirs. In addition, there was a lot of interest in memory, how it works, and how external mnemonics might be used to aid memory. However, there seems to have been little written on the intersection of age and memory. Even so, we can make some inferences about how some famous thinkers might describe memory and aging from their writings on other topics.

Galen (131–201 CE), a physician, believed that as we age the fuel of the body begins to dry up and the body becomes more and more cold. Thus, logically, all faculties would tend to decline. According to Galen, nature does everything for the best; old age is not contrary to nature and so old age is not a disease. Because all bodily functions, including intellectual functioning, are tied to the heat given off by the body, Galen would be likely to support a common cause view of aging and cognition.

Whereas Galen attributed aging to part of a natural process, Augustine (354–430 CE) attributed aging to original sin and felt it was god’s will and not to be tampered with. Accordingly, any decline in abilities as a function of age would be assumed to be predestined.

Roger Bacon (1214–1292) and other alchemists, on the other hand, were always searching for the medicine that would cure diseases and prolong life. “Old age,” he wrote, “is the home of forgetfulness.” In 1250 he wrote a treatise on the retardation of old age, *The Cure of Old Age and Preservation of Youth (De Retardatione Accidentum Senectutis cum Aliis Opusculus de Rebus Medicinalibus)*. As a consequence, it is easy to imagine that Bacon would suppose that mental decline as a function of age is not inevitable and that a magic pill or elixir could be found to reverse the ravages of time.

Renaissance memory theorists tended to focus on mnemonics and did not specifically worry about memory and aging (see Yates, 1966, for a review). Even towards the end of the renaissance, focus was still on memory and not on memory and aging. For example, Francis Bacon (1561–1626) is often credited with emphasizing empirical discoveries rather than metaphysical speculation. He suggested that successful memory retrieval consists of prenotation (in modern terms, narrowing the search set) and emblem (concreteness). He also articulated an early form of depth of processing (Craik & Lockhart, 1972): “things which are waited for and raise the attention dwell longer in the memory than what flies quickly by” (Herrmann & Chaffin, 1988, p. 166). Bacon did not specifically address memory and aging.

EUROPEAN PHILOSOPHY/EARLY SCIENCE

The systematic study of memory and aging, as with most of psychology, has its roots in European philosophy. However, it comes from a lifespan development, rather than associationist or empiricist, tradition.

One of the earliest developmental psychologists/philosophers was Johann Nicolas Tetens (1736–1807). Tetens was a professor of physics and metaphysics as well as philosophy and mathematics in Bitzow and Kiel in Germany. He is described as a founding father of developmental psychology and as an early empirical psychologist who had a “firm determination to rely on nothing other than immediate observation as such or evident reason confirmed by compatible observations” (Müller-Brettel & Dixon, 1990). Tetens posited three fundamental issues in aging (from Baltes, 1983):

- (1) Does the performance decrement as observed in older persons necessarily index decline or can it be seen instead as evidence for further development (change, not deficit theory)?
- (2) To what degree is the performance a function of nonuse (a disuse theory)?
- (3) Is aging due to regression or the reverse of development?

Tetens suggested that memory decrements in elderly persons could be seen as adaptive. In his view, sensations and ideas are modified by the mind and reproduced internally. This reproduced form is put inside the soul and “enveloped” with other ideas leaving a trace corresponding to it (a trace theory of memory). According to Tetens, a major problem in memory performance of older people is not one of storing the memory trace but one of retrieval, that of reaching the “enveloped” memory material or making it conscious. The ideas are not forgotten, they are just enveloped by other ideas. This seems to be one of the first mentions of a retrieval deficit hypothesis as a cause of memory deficits as a function of age.

The Galton Laboratory was founded at University College London (“the godless institution of Gower Street”) in 1904, as a center for research in human genetics. Its director, Sir Francis Galton (1812–1911) was one of many Victorian

natural philosopher/scientists who had wide-ranging interests including geography, meteorology, experimental psychology, eugenics, and more. He is considered to be one of the founders of differential psychology, invented fingerprint identification, and was a pioneer of statistical correlation and regression. In 1885 he created what he called an “Anthropometric Laboratory” whose purpose was “For the Measurement in Various Ways of Human Form and Faculty.” Today, visitors to the Galton Laboratory, housed at University College, London, can see photos of his laboratory, copies of the advertisement for his laboratory, subject data sheets, and the apparatuses that were used. Over the course of many years the laboratory collected observations on over 9000 individuals ranging in age from young children to the very aged. The Galton laboratory measured such things as head size, height, response time to sound and sight. Due to the massive amount of data collected, a great deal of it was not analyzed until much later (if at all).

In 1923 Koga and Morant published a new analysis of some of Galton’s data on simple response times to visual and auditory stimuli as a function of age. Figure 7.1 shows the data for response time to sound along with a cubic function that Koga and Morant fit to the data. Although we only display the auditory data here, the curves for both audition and vision were quite similar: There was a dramatic decrease in simple response times from early childhood to adulthood and a much more gentle increase from early adulthood to old age. In addition, both visual and auditory acuity declined as a function of age.

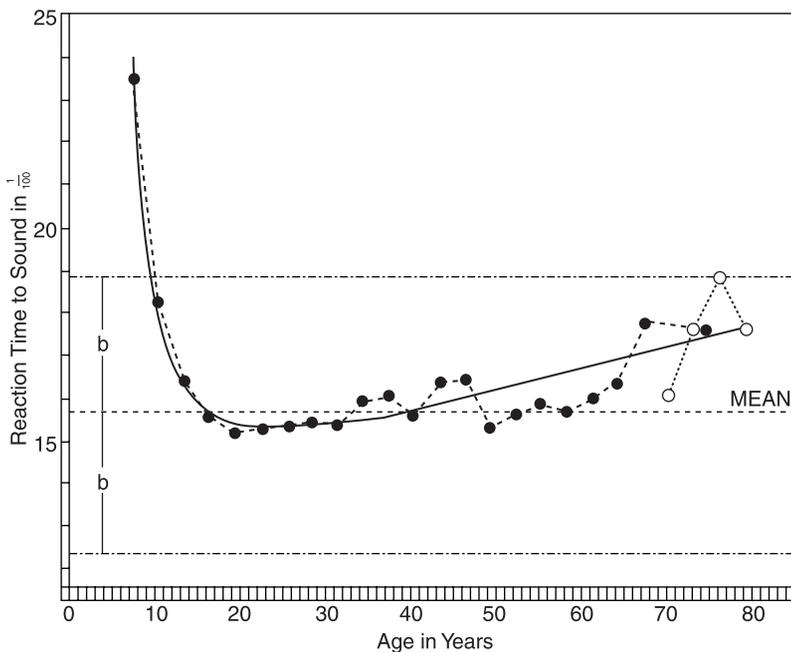


FIGURE 7.1 Response time to sound as a function of age. The points are the data and the continuous curve is a cubic function fit to the data. From Koga and Morant (1923).

However, the data show that, although sensory acuity does decline as a function of age, and response time increases as a function of age, the correlation between auditory and visual reaction times was much larger than that between auditory acuity and auditory reaction time or between visual acuity and visual reaction time. In other words, time to respond to a stimulus is mainly due to central, rather than peripheral factors. Koga and Morant suggested that, “reaction times are a function of mental rather than sensory effectiveness and must be taken as a measure rather of mental briskness than sensory fitness” (p. 372). This, then, is a generalized slowing theory of aging (Salthouse, 1985b). These observations, collected more than a century ago with what today would seem to be very crude techniques, have stood the test of time and have been replicated using multiple response and sensory modalities (Birren & Botwinick, 1955; Birren & Fisher, 1995; Johnson et al. 1985; see also Salthouse, 1985a, for a review).

At about the same time that the Galton Laboratory was being created, Alois Alzheimer (1864–1915), a German neurologist and psychiatrist, presented the first pathological findings of presenile dementia at a psychiatrist’s conference in 1906. Alzheimer published the same findings in 1907 in the article “A Characteristic Disease of the Cerebral Cortex.” The article (1907/1987) introduces Auguste D, a 51-year-old wife of an office clerk, who had become a patient of Alzheimer’s 5 years prior to exhibiting symptoms similar to senile dementia. Along with delusions and hallucinations, Auguste suffered from severe memory impairments: Although she could correctly identify many items shown to her, she could not recall the items shortly after their presentation (Maurer, Volk, & Gerbaldo, 2000).

In postmortem analyses, Alzheimer identified fibroid plaques that were typical of advanced senile dementia. In addition, Alzheimer also found evidence of dense fibroid tangles, which “indicated the site where once the neurons had been located” (1907/1987, p. 2). This led Alzheimer to believe he was encountering a “peculiar, little-known disease process” (p. 3) that was unique from senile dementia. Also, due to the relatively young age at which the disease seemed to begin, Emil Kraepelin, a colleague of Alzheimer who is credited with naming the disease “Alzheimer’s disease,” later classified the disease as “a more or less age-independent unique disease process” (1910/1987, p. 77). Thus, although most people think of Alzheimer’s disease as a disease of old age, it in fact is not necessarily related to age, as Alzheimer himself noted. However, the observation that memory capabilities were directly tied to brain functioning was an important one in the history of memory.

Even as late as 1906 when James Rowland Angell (1869–1949) published the third edition of his well-received textbook *Psychology: An Introductory Study of the Structure and Function of Human Consciousness*, there was little in the way of experimental data on memory and aging. However, like the ancients, these early psychologists acknowledged certain patterns of memory impairment associated with increasing age:

Memory of proper names is among the earliest of the losses and the more concrete are our ideas the earlier do we lose the memory of the words for them. It is a familiar fact too that old people are much more forgetful of recent

occurrences than of those which happened further back in the past. This is no doubt attributable to the loss of normal receptivity by the brain. It retains fairly well impressions made upon it at an earlier period, but it cannot now take on new ones.

(Angell, 1906, pp. 234–235)

Thus, Angell, like Aristotle, espoused an encoding/storage deficit of memory and aging. However he also proposed a temporal gradient with older memories being more robust than newer memories. Like others writing in this area at the time, the section of the text on aging and memory is long on supposition and extremely short on experimental data.

EXPERIMENTAL INVESTIGATIONS OF AGING AND MEMORY

Even though there had been sporadic investigations of cognitive aging up until this point, “research on the psychological aspects of aging did not begin seriously until the work of Walter Miles and associates about 1930” (Birren, 1959, p. 3). Miles directed the Stanford Later Maturity Study (Miles, 1931, 1933, 1967), which collected a variety of measurements on 863 individuals ranging in age from 6 to 95. In his 1931 paper Miles developed a unique theory of what changes as we age:

It is well known that cortical function is economical of energy and that motor function is spendthrift. A possible theory then for the slower and more difficult action in the old is that neural conservation mechanisms are built up or become more potent, with increasing lifetime. A particular decrement according to this theory would not be chiefly chargeable to a defect in the mechanism but to a positive check on it—a neural governor device protective of the mechanism. The weight of years may be in large part neural inhibition-interference to action. This is perhaps the core, or the basic behavior element, in the caution and proverbial good judgment of the old. Decrement appears more in feeling than it exists in fact.

(p. 633)

This “neural governing device” essentially prevents the brain from short-circuiting. As far as we can tell, no one has followed up on this curious theory.

Another example of early investigations of cognitive aging comes from Jones and Conrad (1933), who looked at the rate at which intelligence grows during childhood and declines during older adulthood. They used a test battery, which included memory measures such as digit-symbol substitution, that was used for assessing soldiers during “the World War.” Jones and Conrad attempted to test all the individuals in particular New England communities between the ages of 10 and 60, thus completing a true population study. Their recruitment methods were somewhat sneaky and unlikely to be approved by ethics boards today:

The procedure involved a shrewd appeal to Yankee thrift and fair play. A free moving picture show was offered in a community hall. Then, during an

intermission, the audience was asked to take the test . . . Individuals who did not attend the free movie were visited in their homes, and, if possible, were wheeled into taking the test there.

(Pressey et al., 1939, p. 164)

A total of 1191 individuals were tested. The data are reproduced in Figure 7.2. As is evident from the figure, there is a rapid increase in intelligence scores in early childhood to adulthood and then a gradual decline from a peak of about 20–30 years old. This figure looks remarkably like the inverse of the response time curves reported by Koga and Morant (1923; see Figure 7.1). Like contemporary lifespan researchers, Jones and Conrad (1933) and others studying intelligence in the field at the time (e.g., Shakow, Dolkart, & Goldman, 1938; Wechsler, 1944; Willoughby, 1929) considered issues such as cohort effects, physical health, etc. as difficulties in interpreting such cross-sectional data as a real reduction in intelligence.

Although these early psychometric investigations included memory tasks among a battery of other cognitive tasks, one of the first large-scale studies on aging and *memory* specifically was conducted by Gilbert (1941). The report was published in the *Journal of Abnormal and Social Psychology*, presumably because there was no more appropriate venue. The paper is unexpected in that it reads like a contemporary article.² The behaviorist language that characterizes much of the early verbal learning literature is absent and the methods for each test are almost all identical to ones still in use today.

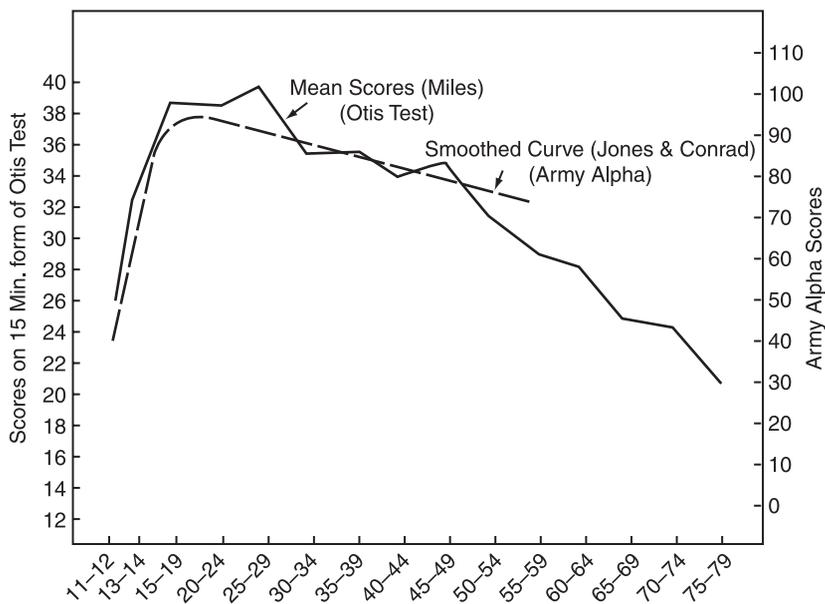


FIGURE 7.2 Growth and decline of intelligence from 10 to 80 (from Jones & Conrad, 1933; Miles, 1933). As with Galton's data, these observations are readily replicable using modern intelligence tests (see Salthouse, 1985a, for a review).

Gilbert (1941) tested 174 individuals between the ages of 60 and 69 years old and the same number of individuals between the ages of 20 and 29 years. Each individual was exactly matched with another individual in the other age group in terms of his or her score on a vocabulary test. They were then given eleven separate memory tests ranging from digit span to retention of a paragraph of text over a delay interval. Her data are plotted in Figure 7.3.

Gilbert's (1941) tasks included three measures of span (visual, auditory, and backward presentation); immediate sentence repetition and immediate and delayed paragraph memory tasks (from the Stanford-Binet battery); and immediate, delayed paired associates, and a Turkish-English vocabulary test (from the Revised Babcock Test of Mental Efficiency). The Knox cubes test (Knox, 1914), is similar to Corsi blocks task except that there are only four cubes placed in a single row. The experimenter uses a small cube to tap on one of the four larger cubes in patterns of increasing complexity. The subject is asked to recreate each sequence. Although there were significant differences between the groups in all of the conditions, the more complex the task, the larger the difference. Gilbert then compared the "brightest older persons" in the sample to the total 20-year-old group and found that this select group was actually superior to the younger group on many of the tasks, but even so fell below the

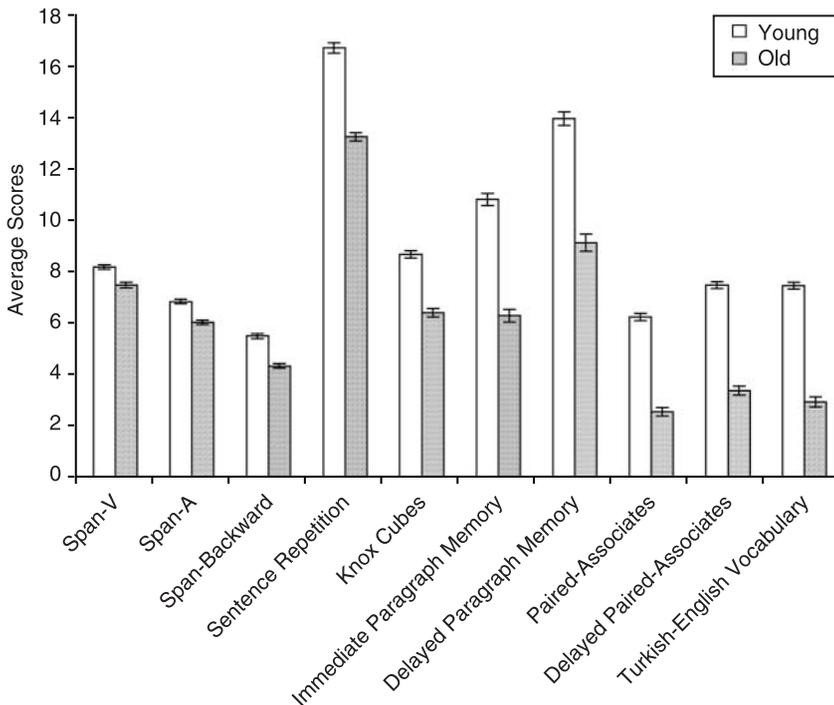


FIGURE 7.3 A comparison of older and younger adults on a variety of memory tests ($N = 348$). From Gilbert (1941).

younger group on those tasks requiring the formation and retention of new associations.

Gilbert concluded that “[t]he greatest obstacle is in the formation of entirely new associations, particularly if these may interfere in any way with previously formed associations, as in paired associates (both immediate recall and retention) and in the retention of Turkish-English vocabulary” (1941, p. 85). These data have been replicated many times and this conclusion is a direct precursor to the associative deficit hypothesis supported by Naveh-Benjamin and colleagues (e.g., Naveh-Benjamin, 2000; Naveh-Benjamin, Hussain, Guez, & Bar-On, 2003).

Along with the increase in experimental data on memory and aging came an increase in physiological investigations on the same topic. In 1942 Donald O. Hebb noticed that the tests that are not impaired by late brain injury (i.e., tests of vocabulary and information) appear to remain intact with advancing age. Hebb suggested two types of intelligence: “(A) the development of direct intellectual power, by neural maturation, and (B) the establishment of routine modes of response to common problems, or of perceptual and conceptual modifications leading to qualitative modifications of behavior” (p. 289). Intellectual power is what is often being tested in intelligence tests. This power “which is generally thought to reach its peak earliest, perhaps between the ages of 12 to 15 years, is the kind which is also apt to be sensitive to the effect of brain injury after this period, and sensitive as well to the changes of senescence” (p. 289). However, intelligence does not involve only (A), but also (B), and should thus “continue to rise to the point at which declining intellectual power offset the increase of intellectual products” (p. 290). This is clearly a distinction between crystallized and fluid intelligence from a physiological point of view.

It is sometimes instructive to look at contemporary textbooks to as an indication of the prominent theories in any time period. One of the most well-known textbooks of the time was written by McGeoch (1942) and had a chapter on learning as a function of chronological age, sex, and test intelligence. In the section on age, McGeoch says:

Age, in the sense of the length of time lived by an individual, cannot itself be a determiner of learning. Time, in and of itself, does nothing, but is scientifically important not only as an index of other variables which are correlated with it or, in more figurative terms, because it is the bearer of other conditions. When we use age as an independent experimental variable, we retard it as a useful symbol for the complex conditions which age brings with it.

(p. 207)

This lesson is one that has been well-taken by future researchers in the area and is why most of the results are couched in terms of “age-related” differences between older and younger adults. (As an aside it is interesting to note that in the 1952 revision of the textbook, published after McGeoch’s death, the chapter is retitled “Individual differences and learning,” placed at the end of the book, and says little about age-related differences.)

In the chapter McGeoch (1942) discusses methodological issues such as advantages and disadvantages of cross sectional and longitudinal designs and

cohort effects. From the theoretical side, he mainly focuses on a maturation–degeneration hypothesis (aging is the un-doing of development) and a hypothesis of changing conditions of learning (transfer, motivation, and personality traits). McGeoch suggests that older adults will show decreased learning rates in conditions that require a reorganization of older learned behaviors. Thus, the bulk of the difference between older and younger adults has to do with increasing negative transfer as a function of more and more experience. Again, chronological age or time, *per se*, is not the causal factor in age-related differences in memory; it is what occurs during that time.

In 1946 Alan Welford, along with Frederick Bartlett, founded the Nuffield Unit for Research into Problems of Ageing at Cambridge and became one of the founding fathers of aging research in Great Britain. Alan Welford is best known for his book *Ageing and Human Skill* (1958) in which he challenged the use of reductionist methods in studying aging and, instead, suggested that a better strategy would involve “taking complex, continuous performances and making analyses to reveal their essential ‘key’ features” (p. 2). Fittingly, this suggestion foreshadows the “components of processing” approach described by Roediger, Buckner, and McDermott (1999). Welford also emphasized the whole organism and the need to take genetics, environment, and accumulated skills into account when developing theories of aging and cognition. In addition, Welford stressed the idea that not only do older adults perform more slowly on many complex tasks, they also can and will carry them out in qualitatively different ways. Thus, we should look at the pattern of data as well as overall level of performance in making inferences about differences between older and younger adults.

In addition to the impact Welford had on the field of human factors, he also discussed the importance of the limited capacity short-term store and noted that individual differences in problem solving are mainly caused by short-term or working memory limitations. He realized that older individuals tend to exhibit a greater deficit the more complex a task becomes. In today’s parlance, we would say that performance of older adults is more affected by working memory tasks that require active reorganization of materials than short-term memory tasks that merely require a passive retention of information. This was a prescient idea and, indeed, as Rabbitt (1997) put it, “In all but the coinage of their indispensable phrase ‘working memory’, Alan [Welford] seems to have anticipated Baddeley and Hitch (1974) by nearly 30 years” (p. 977).

The Nuffield Institute and others of its kind spurred a great deal of research in aging and in 1959 James E. Birren edited one of the first compendia of the literature on the psychology of aging in his edited volume, *Handbook of Aging and the Individual*. The volume covers the entire field from the biological bases of aging to social and personality theories of aging and includes chapters on age and learning, experimental studies; theories of learning and aging; intelligence and problem solving.

In one of the chapters in the *Handbook*, entitled “Theories of Learning and Aging”, Harry Kay provides a comprehensive review of the literature up until that point. He breaks down the stages that make up learning into “its traditional three R’s—registration, retention, and recall” (p. 615). The theories he reviews mainly

spring from a behaviorist tradition, although Kay is careful to give credit to the influences of the biological and physical sciences as well as mathematics on the field. He delves deeply into Hullian theory as it pertains to aging and touches briefly on plasticity and Hebbian learning. The relatively new “cybernetics and communication theory” and “information theory” are also given a brief consideration.

Kay identifies five theoretical constructs employed in studies on aging: maturation degeneration, transfer, retroactive and proactive inhibition, and the influences of early experiences, all of which are, to one extent or another, constructs that are still used today. Finally he considers some of the difficulties in conducting studies on aging and learning including inter- and intraindividual variability; task complexity, motivation; and the difficulties in comparing different types of tasks. In conclusion Kay notes: “This chapter has been concerned with the interaction between learning theory and aging phenomena. Such interaction is more a pious hope for the future than a matter of recordable history” (1959, p. 649). In the years that followed, there has been an explosion of research on memory and aging, more than fulfilling Kay’s wishes.

SUMMARY AND CONCLUSIONS

From the ancients we have theories of disuse, encoding deficit, and generalized slowing as explanations of age-related decline. Tetens added a change in processing idea as well as aging being the reverse of development. The psychometricians generally seemed to prefer a generalized intellectual decline, with Hebb adding physiological basis for the difference between crystallized and fluid intelligence. Gilbert suggested an associative deficit, while learning theorists discussed interference (or inhibition) as possible causes of age-related differences in memory functioning.

Current theories of differences in memory as a function of age include disuse, episodic decay (Tulving, 1983), slowed speed of processing/generalized decline (Baltes & Lindenberger, 1997; Salthouse, 1985b; 1996; Verhaegen & Salthouse, 1997), inhibition deficit (Hasher & Zacks, 1988; Hasher, Zacks & May, 1999), encoding/storage deficit (Craik & Byrd, 1982; Rabinowitz, Craik, & Ackerman, 1982), binding/associative deficit hypothesis (Naveh-Benjamin, 2000; Naveh-Benjamin et al., 2003), and reduced resources and/or lack of environmental support (Craik, 1983, 1986; Craik, Anderson, Kerr, & Li, 1995). All of these views have clear historical precedents.

Theories that did not stand the test of time include Miles’ “neural governor” and Cicero’s idea that older adults feign senility when it serves their purposes. In addition, the disuse theory is not terribly popular for very good reasons (Salthouse, 1991). However, one could say that the majority of modern theories are represented, in one form or another, in the early writings and theorizing about memory and aging.

Although the bulk of the research on memory and aging is primarily found after 1960, its beginnings can be found in early philosophy and science. Many elements of contemporary ideas about aging and memory have similarity with

ancient beliefs. In the early history of scientific psychology emphasis was placed on either experimental methods involving nonhuman animals, young adults, or children. Histories of cognitive psychology and developmental psychology generally do not include much consideration of age or adult development past late adolescence. However, in the past decades there has been a strong resurgence in interest in memory, and the literature is increasing exponentially. A knowledge of and appreciation for the early literature will surely be of use to any investigator hoping to make useful contributions.

ACKNOWLEDGMENT

Preparation of this chapter was sponsored by National Institute on Aging Grant AG021071 awarded to Aimée M. Surprenant.

NOTES

1. Much like many people consult Roddy.
2. At least up until the last paragraph in which Gilbert suggests that it is important to keep mentally active and cautions those older adults “who in later years tend either to cease reading entirely or to read trashy literature they would have scorned in their younger days” (1941, p. 86).

REFERENCES

- Alzheimer, A. (1987). A characteristic disease of the cerebral cortex. In K. Bick, L. Amaducci, & G. Pepeu (Eds.), *The early story of Alzheimer's disease: Translation of the historical papers by Alois Alzheimer, Oskar Fischer, Francesco Bonfiglio, Emil Kraepelin, and Gaetano Perusini* (pp. 1–3). New York: Raven Press. (Original work published 1907)
- Angell, J. R. (1906). *Psychology: An introductory study of the structure and function of human conscious* (3rd Ed.). New York: Henry Holt & Company.
- Baltes, P. B. (1983). Life-span developmental psychology: Observations on history and theory revisited. In R. M. Lerner (Ed.), *Developmental psychology: Historical and philosophical perspectives* (pp. 79–111). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Baltes, P. B., & Lindenberger, U. (1997). Emergence of a powerful connection between sensory and cognitive functions across the adult life span: A new window to the study of cognitive aging? *Psychology and Aging, 12*, 12–21.
- Birren, J. E. (1956). The significance of age changes in speed of perception and psychomotor response. In J. E. Anderson (Ed.), *Psychological aspects of aging* (pp. 97–104). Washington, DC: American Psychological Association.
- Birren, J. E. (1959). *Handbook of aging and the individual*. Oxford, UK: Oxford University Press.
- Birren, J. E. (1961a). A brief history of the psychology of aging, Part I. *The Gerontologist, 1*, 69–77.
- Birren, J. E. (1961b). A brief history of the psychology of aging, Part II. *The Gerontologist, 1*, 127–134.

- Birren, J. E., & Botwinick, J. (1955). Age differences in finger, jaw, and foot reaction time in auditory stimuli. *Journal of Gerontology*, *10*, 429–432.
- Birren, J. E., & Fisher, L. M. (1995). Aging and speed of behavior—possible consequences for psychological functioning. *Annual Review of Psychology*, *46*, 329–353.
- Birren, J. E., & Schroots, J. J. F. (2001). The history of geropsychology. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 3–28). San Diego, CA: Academic Press.
- Bleecker, C. J. (1973). *Hathor and Thoth: Two key figures from the ancient Egyptian religion*. Leiden, The Netherlands: E. J. Brill.
- Confucius. (1999). *The analects of Confucius. A new-millennium translation* (D. H. Li, Trans.). Bethesda, MD: Premier.
- Craik, F. I. M. (1983). On the transfer of information from temporary to permanent memory. *Philosophical Transactions of the Royal Society of London*, *B302*, 341–359.
- Craik, F. I. M. (1986). A functional account of age differences in memory. In F. Klix & H. Hagendorf (Eds.), *Human memory and cognitive capabilities, mechanisms and performances* (pp. 409–422). Amsterdam: North-Holland/Elsevier.
- Craik, F. I. M., Anderson, N. D., Kerr, S. A., & Li, K. Z. (1995). Memory changes in normal aging. In A. D. Baddeley, B. A. Wilson, & F. N. Watts (Eds.), *Handbook of memory disorders* (pp. 221–241). New York: Wiley.
- Craik, F. I. M., & Byrd, M. (1982). Aging and cognitive deficits: The role of attentional resources. In F. I. M. Craik & S. E. Trehub (Eds.), *Aging and cognitive processes* (pp. 191–211). New York: Plenum Press.
- Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, *11*, 671–684.
- Gilbert, J. C. (1941). Memory loss in senescence. *Journal of Abnormal and Social Psychology*, *36*, 73–86.
- Granick, S. (1950). Studies in the psychology of senility—a survey. *Journal of Gerontology*, *5*, 44–58.
- Hasher, L., & Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. In G. H. Bower (Ed.), *Advances in research and theory: Vol. 22. The psychology of learning and motivation* (pp. 193–225). San Diego, CA: Academic Press.
- Hasher, L., Zacks, R. T., & May, C. P. (1999). Inhibitory control, circadian arousal, and age. In D. Gopher & A. Koriat (Eds.), *Attention and performance XVII: Cognitive regulation of performance: Interaction of theory and application* (pp. 653–675). Cambridge, MA: MIT Press.
- Hebb, D. O. (1942). The effect of early and late brain injury upon test scores, and the nature of normal adult intelligence. *Proceedings of the American Philosophic Society*, *85*, 275–292.
- Herrmann, D. J., & Chaffin, R. (Eds.). (1988). *Memory in historical perspective: The literature before Ebbinghaus*. New York: Springer-Verlag.
- Janssen, R. M., & Janssen, J. J. (1996). *Getting old in ancient Egypt*. London: Rubicon Press.
- Johnson, R. C., McClearn, G. E., Yuen, S., Nagoshi, C. T., Ahern, F. M., & Cole, R. E. (1985). Galton's data a century later. *The American Psychologist*, *8*, 875–892.
- Jones, H. E., & Conrad, H. S. (1933). The growth and decline of intelligence: A study of a homogeneous group between ages of 10 and 60. *Genetic Psychology Monographs*, *13*, 223–298.
- Kay, H. (1959). Theories of learning and aging. In J. E. Birren (Ed.), *Handbook of aging and the individual* (pp. 614–654). Oxford, UK: University of Chicago Press.

- Knox, H. A. (1914). A scale, based on the work at Ellis Island, for estimating mental defect. *Journal of the American Medical Association*, *10*, 741–747.
- Koga, Y., & Morant, G. M. (1923). On the degree of association between reaction times in the case of different senses. *Biometrika*, *15*, 346–372.
- Kraepelin, E. (1987). Senile and pre-senile dementias. In K. Bick, L. Amaducci, & G. Pepeu (Eds.), *The early story of Alzheimer's disease: Translation of the historical papers by Alois Alzheimer, Oskar Fischer, Francesco Bonfiglio, Emil Kraepelin, and Gaetano Perusini* (pp. 32–81). New York: Raven Press. (Original work published 1910)
- Maurer, K., Volk, S., & Gerbaldo, H. (2000). The history of Alois Alzheimer's first case. In P. J. Whitehouse, K. Maurer, & J. F. Ballenger (Eds.), *Concepts of Alzheimer disease: Biological, clinical, and cultural perspectives* (pp. 5–29). Baltimore: Johns Hopkins University Press.
- McGeoch, J. A. (1942). *The psychology of human learning*. New York: Longmans, Green.
- McGeoch, J. A., & Irion, A. L. (1952). *The psychology of human learning*. New York: Longmans, Green.
- Miles, W. R. (1931). Measures of certain human abilities throughout the lifespan. *Proceedings of the National Academy of Sciences of the United States of America*, *17*, 627–633.
- Miles, W. R. (1933). Age and human ability. *Psychological Review*, *44*, 99–123.
- Miles, W. R. (1967). Walter R. Miles. In E. G. Boring & G. Lindzey (Eds.), *A history of psychology in autobiography* (Vol. V, pp. 221–252). New York: Appleton Century Crofts.
- Müller-Brettel, M., & Dixon, R. A. (1990). Johann Nicolas Tetens: A forgotten father of developmental psychology? *International Journal of Behavioral Development*, *13*, 215–230.
- Murray, D. J. (1976). Research on memory in the nineteenth century. *Canadian Journal of Psychology*, *30*, 201–220.
- Naveh-Benjamin, M. (2000). Adult age differences in memory performance: Tests of an associative deficit hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*, 1170–1187.
- Naveh-Benjamin, M., Hussain, Z., Guez, J., & Bar-On, M. (2003). Adult age differences in episodic memory: Further support for an associative-deficit hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *29*, 826–837.
- Pressey, S. L., Janney, J. E., & Kuhlen, R. G. (1939). *Life: A psychological survey*. New York: Harper & Brothers Publishers.
- Puhvel, J. (2000). Memory, shmemory, lest we forget Mnemosyne: The vocabulary of memory and mindfulness in antiquity. In E. Tulving (Ed.), *Memory, consciousness, and the brain: The Tallinn conference* (pp. 3–6). Philadelphia: Psychology Press.
- Rabbitt, P. (1997). Ageing and human skill: A 40th anniversary. *Ergonomics*, *40*, 962–981.
- Rabinowitz, J. C., Craik, F. I. M., & Ackerman, B. P. (1982). A processing resource account of age differences in recall. *Canadian Journal of Psychology*, *36*, 325–344.
- Richardson, B. E. (1969). *Old age among the ancient Greeks: The Greek portrayal of old age in literature, art, and inscriptions*. New York: Greenwood Press.
- Roediger, H. L., Buckner, R. L., & McDermott, K. B. (1999). Components of processing. In J. K. Foster & M. Jelicic (Eds.), *Memory: Systems, process, or function?* (pp. 31–65). Oxford, UK: Oxford University Press.
- Salthouse, T. A. (1985a). *A theory of cognitive aging*. Amsterdam: North-Holland.
- Salthouse, T. A. (1985b). Speed of behavior and its implications for cognition. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (2nd ed., pp. 400–426). New York: Van Nostrand Reinhold.

- Salthouse, T. A. (1991). *Theoretical perspectives on cognitive aging*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Salthouse, T. A. (1996). The processing speed theory of adult age differences in cognition. *Psychological Review*, 103, 403–428.
- Shakow, D., Dolkart, M. B., & Goldman, R. (1938). The effect of age on the Stanford Binet vocabulary score of adults. *Journal of Educational Psychology*, 29, 241–256.
- Simon, E. (1979). Depth and elaboration of processing in relation to age. *Journal of Experimental Psychology: Human Learning and Memory*, 5, 115–124.
- Tulving, E. (1983). *Elements of episodic memory*. New York: Oxford University Press.
- Tulving, E. (1999). On the uniqueness of episodic memory. In L.-G. Nilsson & H. J. Markowitsch (Eds.), *Cognitive neuroscience of memory* (pp. 11–42). Ashland, OH: Hogrefe & Huber Publishers.
- Tulving, E. (Ed.). (2000). *Memory, consciousness, and the brain: The Tallinn conference*. Philadelphia: Psychology Press.
- Verhaeghen, P., & Salthouse, T. A. (1997). Meta-analyses of age-cognition relations in adulthood: Estimates of linear and nonlinear age effects and structural models. *Psychological Bulletin*, 122, 231–249.
- Wechsler, D. (1944). *The measurement of adult intelligence*. Baltimore: Williams & Wilkins.
- Welford, A. T. (1958). *Ageing and human skill*. Oxford, UK: Oxford University Press.
- Willoughby, R. R. (1929). Incidental learning. *Journal of Educational Psychology*, 20, 671–682.
- Yates, F. A. (1966). *The art of memory*. London: Routledge & Kegan Paul.