Memory in Literature

From Rousseau to Neuroscience

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Contents

List of Plates viii
Acknowledgments ix
Note on the Text x

Introduction 1

1. Memory in the Era of Dynamic Psychology: Nineteenth-Century Backgrounds 6

2. Rousseau and the Romantics: Autobiographical Memory and Emotion 24

3. Baudelaire, Rimbaud and 'Le Cerveau': Sensory Pathways to Memory 43

4. Proust and the Engram: The Trigger of the Senses 60

5. Woolf, Joyce and Faulkner: Associative Memory 77

6. Apollinaire, Breton and the Surrealists: Automatism and Aleatory Memory 100

7. Nin, Borges and Paz: Labyrinthine Passageways of Mind and Language 117

8. The Almond and the Seahorse: Neuroscientific Perspectives 135

Afterword: Images of the Artists: Dalí, Dominguez and Magritte 153

Notes 159
Bibliography 174
Index 180
image into the mythic dimension. Their poetic language becomes the ultimate mediator and illuminator of a buried past recovered through the engrossing present of verbal art which approximates the memories on the written page.

8
The Almond and the Seahorse: Neuroscientific Perspectives

In the last decade of the twentieth century, designated by Scientific American as the century of the brain, special attention was paid to the role of the limbic system in the creation of long-term memory. Two particular sections of the brain were implicated: the amygdala and the hippocampus, seen by some to work hand in hand, moving from the emotional to the cognitive components of memory. Notably, the distinctions between these two structures of the brain have exciting repercussions for understanding the literary material I have already displayed. I am using their juxtaposition as a metaphor to distinguish between forms of mental processing. That is to say, on the simplest level, two sorts of memory can be detected: the sensory-emotional one on the one hand, and the factually based cognitive kind, on the other. Both structures receive and integrate inputs from specialized sites of the cerebral cortex and are therefore intermediaries in the ultimate formation of memory. They are mediators in the circuit of memory, which involves encoding, storage and retrieval – that can be detected in both science and literature.

It is my intention here to provide a panoramic overview of main developments of memory research that can help inform the interpretation of literary texts and artistic works. Specifically, the juxtaposition of different approaches in scientific memory research, as here presented, helps illuminate the classification of the diverse memory events that have been discussed in this book. In turn, such literary works may also enhance the evidentiary base for refining the theories and perspectives which have developed to date in this nascent field. It is a strange fact, for example, that the only major recourse to the literary field by the scientists is the single madeleine incident of Proust, which has provided continuous debate over the functions of the amygdala and hippocampus.
The many more untapped, wide-ranging examples of memory events that this book has uncovered can be further assessed in terms of the ongoing scientific discussion of memory scrutinized in the current chapter.

Whereas the almond-shaped amygdala is seen in the immediate reception of emotion, the seahorse-shaped hippocampus has come to be known as the processing center which strengthens connections over time between incoming perceptions into consolidations that become memory. Furthermore these two structures seem to represent demarcations between unconscious automatic memory and conscious deliberate memory. conspicuously, the evolutionarily older amygdala has been seen to store memory about emotional states, memory for motor and sensory experiences. As such it has been characterized by neuroscientists as implicit, nondeclarative memory. On the other hand, the adjacent and larger hippocampus harbors memory of facts and personal events, producing explicit, declarative memory. In fact, damage to the hippocampus has been found to cause amnesia in animals such as rats and monkeys. Such damage is known to impair explicit memory in humans; on the other hand, damage to the amygdala has no such effect. The neuroscientist Stuart Zola-Morgan, in experiments with animals, found in 1989 that lesions in the amygdala did not impair declarative memory, whereas lesions in the hippocampus did. Furthermore, it appears that for the amygdala, stimuli produce the memory, whereas for the hippocampus, it is the context itself, the place or environment, that produces the memory. Along with such distinctions, however, there are necessary connections between the amygdala and the hippocampus which continue to be explored.

Autobiographical memory, what the psychologists and neuroscientists often call ‘episodic memory’, is associated with the hippocampus and takes its place at the top of the hierarchical divisions of memory systems. It has been defined as a ‘memory of events personally lived and situated in their temporal and spatial context of acquisition’. It is a conscious awareness of past happenings, to be distinguished from dreaming, imaging and problem solving. Furthermore, in this type of recall, ‘retrieval is most effective when it occurs in the same context in which the information was acquired and in the presence of the same cues’. That is to say, there is similarity between the context of encoding and conditions of retrieval, what some might call the ‘engrapy’ and the ‘ephory’. It was originally the Canadian neuropsychologist Endel Tulving who held this view and coined the term ‘episodic memory’ in 1972 in a paper which distinguished it from semantic memory or timeless knowledge shared with others. Tulving, who went on to write an entire book on the subject, contributed largely to this encoding specificity principle and the functional properties of what he designated as ‘retrieval cues’.

This type of long-term episodic memory is characterized by a richness of phenomenological detail, a sense of reliving the experience, a sense of a travel through time, and a feeling of exact reproduction of the past. The setting or place as well as the emotional state would be included in such retrieval. In the terms of cognitive psychologists, like William F. Brewer, such ‘personal memory’ is described as a ‘recollection of a particular episode from an individual’s past’ which ‘frequently appears to be a “reliving” of the individual’s phenomenal experience during that earlier moment. The contents almost always include reports of visual memory.’ Recall of the earlier menal experience is said to be included. Accordingly, Rousseau’s and Wordsworth’s meditations about childhood would fit into this category; Wordsworth went back to the particular place to retrieve the memory; Rousseau simply evoked a past mood generated by a particular setting or place. In Rousseau’s case, it is the emotion which produces the memory in the encoding stage, and the memory which reproduces the emotion in the retrieval stage. The Romantic ethos of sincerity and authenticity attaches a belief value to those memories with the conviction that they are ‘true’ and veridical.

This widely accepted definition of episodic memory, however, tends to yield a rather narrow view of autobiographical memory. In fact, the scrutiny of a whole literary subgenre of fictional autobiography, referred to in some of the literary examples, suggests that this form of memory is more complex and broader than scientists might believe. It is telling, therefore, that the contemporary American psychologist Daniel Schacter calls attention to the notion of memory distortion as a natural and common vulnerability of personal memory, often observed in cases of frontal lobe damage. For example, he maintains that ‘source memory’, the ability to recall when and where an event transpired, may be easily impaired. This deficit may occur before reaching the structures of the medial temporal lobe. In Schacter’s view, failures in source memory can lead to what he calls ‘confabulation’ or false recollections of events that did not in fact take place. Moreover, since the encoding process involves the subjective element of experience and draws on degrees of preexisting knowledge, it can introduce further distortion. It’s common, after all, for two people to have entirely different experiences of the same event. Also, Schacter writes of the altering effects of present circumstances on past events: ‘New memories are inevitably influenced
by old memories, which opens the door to distortion as a relatively common occurrence. Even the way the past is probed or questioned can create distortions. Schacter thus focuses most of all on the contextual aspect of the retrieval environment as ‘the distorting effects of present circumstances on past events’ – what constitutes an important variable in the acquisition of memory and its reconstruction of the past. From this perspective, Schacter’s theories could offer a view of Rousseau and his Romantic imagination that is quite different from the idealistic premises of Rousseau’s own era which involve subjectivity as a necessary component of retrieval. The scientific notion of confabulation also jars with Salvador Dali’s playful but defined notion of ‘authentic false childhood memories’ stemming from his dream-based surrealist imagination. Dali, in remembering such memories that were construed by his childhood imagination, holds that they are real: ‘The difference between false memories and true ones is the same as for jewels: it is always the false ones that look the most real, the most brilliant.’

With a different perspective from Schacter’s and without the supportive recourse to literary texts, the British neuroscientists Tim Shallice and Paul Burgess use the term ‘confabulation’ to designate a normal element of healthy autobiographical memory. These scientists go beyond the more common consideration of it as a clinical concern arising from frontal lobe lesions or ‘source’ amnesias due to aging. In concentrating on long-term memory, Shallice envisaged ‘nested structures involving a number of processing domains’. Since such stratifications could require in turn a multilevel process of retrieval, lapses in memory could then occur in normal subjects. Such superimpositions of memory with selective lapses are apparent in, for example, Faulkner’s juxtaposition of memory sequences, Apollinaire’s displacements of memory events, and Anaïs Nin’s architectural layering of inner landscapes, as seen in the examples from literature. Moreover, it is interesting to observe that such gaps are often seized upon opportunistically by creative writers as material for artistic creation.

Also, more generally, conflations of memory have been recognized by some cognitive psychologists as giving rise to a variation of personal memory called ‘generic memory’. For example, Brewer explains: ‘Repeated exposure to a set of related experiences can give rise to a generic image of the experiences.’ Generic memory, therefore, lacks the specificity with respect to a precise time period or date in the past, and renders instead a conglomerate of repeated experiences. The best example would be repeated summer experiences resulting from a return to the same place, year after year. Virginia Woolf’s *To the Lighthouse* would certainly fall into this category, as it transforms specific recall to levels of abstraction. This type of recollection can be distinguished from ‘source memories’ which refer to specific times and places for the memory events.

Woolf admitted, however, that outside of her art, she did retain specific memories which were ‘sealed’ by way of visual ‘scene making’. This particular manner of encoding and storing visual memories could be especially pertinent to the work of the neuroscientist Alain Berthoz, who is keenly interested in the hippocampal functioning with respect to spatial memory and memory of place. In particular, he has been interested in visual memory acquired through the perception of visual objects or space in movement in cortical areas, from the frontal cortex deeper in the parietal cortex, which is a locale for what he terms ‘topokinetic memory’. His article ‘Parietal and Hippocampal Contribution to Topokinetic and Topographic Memory’ implicates the neurons of the hippocampus as serving in the storage of such memories. Berthoz contends that this dynamic process is based on multisensory cues including a sense of movement or kinesthesia (added to the traditional five senses) and involving the connection of several brain structures. He notes that the left hippocampus is especially operative in memories of the relation between whole-body movements and the environment. Elsewhere, in his book *Le Sens du mouvement* (1997) Berthoz had pointed to the intricate function of the hippocampus in processing a ‘configurational memory of events and the temporal sequence in which these events occurred’. Berthoz applauds the neuroscientist Edmund Rolls for considering this role of the hippocampus as is manifest in the reconstruction of memory from partial elements:

For me, one of the most fascinating aspects of Rolls’s theory is that he identified, in the neuronal structure of the hippocampal network, properties that enable it to recall an episode or a combination of sensations given only a portion of the information initially memorized.

In fact, the British neuroscientist Edmund Rolls presented in his paper ‘A Theory of Hippocampal Function in Memory’ (1997) the notion that a partial memory cue in the autoassociative network of the hippocampus can contribute to the formation of long-term episodic memories. Rolls posits that if such autoassociation can allow various elements of an episode, for example, its spatial context, the people present, what was seen, etc., to be stored as one memory event, then its recall from
a fragment by way of back-projections from the hippocampus to the neocortex can occur:

Later recall of that episode from the hippocampus in response to a partial cue can then lead to reinstatement of the activity in the neocortex that was originally present during the episode. The theory described here shows how the episodic memory could be stored in the hippocampus and later retrieved to the neocortex.\textsuperscript{15}

Subsequently, in his book The Brain and Emotion (1999), Rolls went on to focus on the emotional component within this contextual aspect of memory storage and retrieval. He writes: 'It is suggested that whenever memories are stored, part of the context is stored with the memory.'\textsuperscript{16} This phenomenon readily applies to Romantic memory, as has been seen. According to Rolls, another aspect of emotional processing concerns memory retrieval in that 'the recall of a memory occurs best in such networks when the input key to the memory is nearest to the input original pattern of activity which was stored. It thus follows that a memory of, for example, a happy episode is recalled best when in a happy mood state.'\textsuperscript{17} Again, the locus for such contextual processing is thought to be in the associative neuronal networks of the hippocampus. In line with the approach of William James, more recently, Tulving and Rolls consider memory to be often dependent on emotional conditions at the time of retrieval.

An acute form of emotional recall is described by the catchy term 'flashbulb memory'\textsuperscript{18} first introduced by the cognitive psychologists Roger Brown and James Kulik to designate a shocking, common external event that preserves the personal experience of it. The Kennedy assassination or, more recently, the Terrorist attack on the World Trade Center in New York City are clear examples. Discussion of such emotion-triggered memories has centered on the structure of the amygdala. In terms of literary examples, James Joyce's Christmas dinner scene serves to be a particularly poignant memory for the young artist because it relates to the death of the controversial Irish leader Charles Parnell.

The connection of emotion with memory has surfaced in another form in Joseph Ledoux's best seller The Emotional Brain (1996), which focused in particular on the amygdala as the receptor of the 'model emotion' of fear. This subject leads to studies about fear conditioning, which becomes particularly interesting to psychologists and psychoanalytical approaches to autobiographical literature, concentrating on traumas, childhood abuse, and the like. Although studies of such emotion can bring insight into the topic of the neural basis of memory, he has cautioned\textsuperscript{19} about the general unreliability of brain mapping and tracing in studies of localization since certain areas of the brain can be bypassed under certain conditions, as in the direct shortcut route from the sensory thalamus to the amygdala. As previously mentioned, both Woolf and Nin averred that memory can leave its trace by painful emotion.

Historically speaking, the phenomena of engrams have been pursued from the time of their discovery by the German biologist Richard Semon in 1904. It was he who coined the term for the cumulative encoding and storage of an enduring memory trace. Subsequently, the word was given prominence in the article 'In Search of the Engram' (1950) by the Harvard psychologist Karl Lashley. Ironically, what may not be fully acknowledged in the frequent citation of this article is that it actually provided more questions than answers in the search for the so-called engrams. As a behaviorist interested in the effects of brain damage on the ability to acquire habits, Lashley himself concentrated on the sensory areas of the cerebral cortex, refusing to delve into subcortical levels. He humbly declared that his experimentation 'has discovered nothing directly of the real nature of the engram.'\textsuperscript{20} He challenged the previous studies of nineteenth-century clinical neurology that attempted to localize specific memory traces. For he argued that pathways of specific memory traces across the cortex were not identifiable. Influenced by Gestalt psychology, Lashley was suggesting that there were other factors in the detection of memory which included 'the pattern\textsuperscript{21} of energy on the sense organ, the factors of space and time, the combinative activity of neurons as in 'reverberatory circuits'. He declared that 'there is no gree: excess of cells which can be reserved as the seat of special memories.'\textsuperscript{22} He also demonstrated that associative areas of the neocortex could not be considered to be static storehouses of memory and saw them rather as being 'concerned with modes of organization'.\textsuperscript{23} Despite Lashley's conclusion that it is 'not possible to demonstrate the isolated localization of a memory trace', he seems responsible for spurring some future scientists on in search of sites for specific memory functions in considering the engram as a physical entity.

Interestingly, the 'literary' case of Proust proves the point about the intricacies of memory tracing. The famous Proustian paradigm of memory remains all the more complex since it is both autobiographical and stimulus-produced, dependent on the contingencies of the 'present' to
evoke the past. In fact, Proust is the only writer seriously referred to by scientists in their discussions about the localization of engrams. At first, scientists envisaged engrams of the Proustian kind in the context of the amygdala for understandable reasons, given Proust’s focus on sensory stimuli of memory and its inextricable link with emotion – notably the ‘rush’ of exquisite feelings. Such a localization was based on the established connections between the amygdala and emotion. The inspiration of Proust leads a neuroanatomist like Herbert P. Killackey to marvel at the morphological complexity of the neocortex – ‘the extensive role of sensory imagery in the memory process, and, by extension the role of the neocortex toward which most sensory information is directed’. Like others, this scientist refers unilaterally to the taste and smell of Proust’s madeleine as suggestive of the fact that chemical senses play an important role in the memory process. The poet Baudelaire could also be brought into this discussion because of his keen olfactory sense which is a gateway to his memories; after all researchers have singled out the highly charged emotive aspect of the olfactory sensations due to their most direct route to the limbic system.

Subsequently, scientists like Larry Squire and Stuart Zola-Morgan laid the groundwork for placing the madeleine episode in the autoassociative network of the neurons of the hippocampus because of the role of this organ in the integration of the various perceptions once the initial trigger is called up. Their landmark paper ‘The Medial Temporal Lobe Memory System’ (1991) in the journal Science featured the hippocampus as the principal storage site relied upon and called upon by the neocortex in the evocation of long-term declarative memory. Models of human and animal amnesia were used to detect the anatomical components of such coordinated memory function. In a later article ‘Memory, Hippocampus and Brain Systems’ (1995) Squire went on to develop his view of the hippocampus as part of the larger structure of the medial temporal lobe, which includes the entorhinal cortex, the parahippocampal cortex, and the perirhinal cortex. Specifically for declarative memory, he has concluded that the amygdala is excluded from this system. Squire’s main goals have been to ’link particular brain regions and systems to various kinds of memory’ and to locate ’where the synaptic changes occur that support different kinds of memory’. Generations after Lashley, Squire considers this search for exact localization of memory sites as the challenge for neuroscience in the future. So, too, the jury is still out on the madeleine episode.

Whereas Proust has been connected to the study of engrams, poets like Baudelaire and Paz fall within the context of biochemical approaches to the study of memory. Their evocation of certain memories is conveyed as a chemical process, actually compared metaphorically to drug-induced states by Baudelaire and expressed by the catalytic power of poetic language by Octavio Paz. In neuroscience, the subject of tracing on the synaptic level has offered significant results for neuropharmacologists, who come to be known by the chemical enzyme they identify in the creation and the strengthening of neuronal circuits. The creation of synapses in any of the structures involves a chain reaction which connects signals through a junction from one neuron to another. The biochemical side of such transmissions has become spectacular with the focus on neurotransmitters which ultimately account for the synaptic transmissions by way of certain enzymes that are activated. Eric Kandel, who early on examined the activity of nerve cells in the hippocampus, has studied protein synthesis (that activates adenylyl cyclase) and gene expression required for changes in synaptic connectivity for the creation of long-term memory. The molecular biologist Tim Tully, in a manner similar to the genetic etiology of memory, has most vividly referred to the protein CREB as a ‘master switch’ that, when turned on as a result of recurrent events, induces long-term memory. Of course, in current and past studies, various neurotransmitters have been identified as memory enhancers. For example, acetylcholine for Jean-Pierre Changeux (subsequently interesting for those who study Alzheimer’s Disease), serotonin for J.T. Goldberg and Antonio Damasio, dopamine for Arvid Carlsson and Jacques Glowinski, protein kinase A for Aryeh Routtenberg, captain for Gary Lynch, syntaixin for Serge Laroche, glutamate for T.H. Brown and Joseph Leduc. Moreover, it has been shown that varying doses can have positive or negative effects.

In neurotransmitter systems, hormonal influences have been studied in terms of modulations of memory: ‘memory storage may normally be regulated by stress-related hormones that are released by emotionally arousing experiences’. For example, James McGaugh, among others, has singled out norepinephrine to be a memory enhancer when injected into the amygdala. It is also commonplace to cite the age-old adrenaline as a memory enhancer. Moreover, in this chemical context of memory, standard Freudian notions of repression of traumatic memories can be explained in terms of certain opiates such as enkephalins. As the neurobiologist Ted Abel and his colleagues have noted: ‘A painful incident may lead to repression because endogenous opiates are released in response to the experience, and these in turn can interfere with the memory storing process’. Anaïs Nin, with her metaphor of chemical compounds forming unconscious memories, comes to mind here.
The structural aspects of brain circuitry have also been studied in the hippocampus, where the strengthening of synapses can be detected. The fascinating process of the catalytic neurotransmitters is said to lead to the modification of the neurons' dendrites, making the neurons more susceptible to incoming information. The neurobiologist Gary Lynch has explored the structural changes in the hippocampal neurons. Throughout his research, he has continuously presented a neuroanatomical model of the combination networks of sensory inputs. His early, pathbreaking studies in the 1980s focused on a schema which pointed to the changes of the dendritic spines that are prompted by electrical signals and enzyme activity as the increased receptivity by neurotransmitters created new synapses for the rapid formation of memories. His 1986 book Synapses, Circuits and the Beginnings of Memory probed the olfactory-hippocampal circuit in this respect. In his focus on the hippocampal region as a model for the study of the brain as a whole, he selected olfaction 'as a model for cortical combinatorial systems', because the sense of smell is directly interconnected with various parts of the limbic system. As discussed, Baudelaire's poetry, marked by intense olfactory memories, gives further evidence for such directed synaptic formations.

Clearly, the field of brain research has become highly specialized and segmented. This is particularly true in the United States, where three major approaches can be discerned: the biochemical, the structural and the electrophysiological. Nevertheless, a few scientists have accompanied such physiological discussions with reflections about larger philosophical issues. A leading exemplar is Antonio Damasio, the biologist who has spoken about 'Descartes error', what he defines as the French philosopher's dualist notion postulating for Western thought 'the abyssal separation between body and mind'. Damasio has even contested his colleagues, the neuroscientists who go the other way and view the mind exclusively in terms of brain events without regard for its customary interaction with the coexisting social and physical environments. In his 1994 book Damasio objected to the notion of an intellect independent of emotion, and he attacked the Cartesian concept of a 'disembodied mind', the fallacious view that 'the suffering that comes from physical pain or emotional upheaval might exist separately from the body'. With his study of what he calls the 'neurobiology of rationality', Damasio was at the vanguard of theorizing the biological link between memory and emotion.

The metaphysical issues raised by Damasio have been confronted more broadly by leading scientists in France where the Cartesian tradition is ingrained in the collective consciousness. Two prominent conferences took place in the 1990s focusing on Bergsonian legacy for neuroscience - which naturally brings larger issues into light. I have witnessed first hand that a particularly intense, ongoing discussion has emerged among leading scientists at the prestigious Collège de France, the old forum for experimental psychology at the beginning of the last century. It is as if we have come full circle a century later. The implications of such debates for the study of memory are especially stimulating in view of the pragmatic studies which are overwhelming the field. The neuroscientist Alain Berthoz has become a mediating figure in such debates, having assembled a book Leçons sur le corps, le cerveau et l'esprit featuring some of the initiators of the cognitive sciences at the Collège de France who were concerned as well with the broader perspectives. Despite his own specializations, Berthoz has urged a synthetic approach which would take into consideration necessary interactions between the network of psychologies and the various physiological approaches to the nervous system. Berthoz's own statement 'il faut passer du cerveau à la pensée' ['we must pass from the brain to thought'] highlights the challenge for a larger understanding of mental processes.

It is an interesting, basic fact that problematics surround the use and translation of the French word 'esprit', which in turn shapes the way the study of memory is discussed. I have called attention to the point that, despite the ambiguous meaning of the word, the poet Baudelaire had begun to connect 'l'esprit' to a physical brain or 'le cerveau' as concerns the stimulation of the senses, a very avant-garde notion for a writer of his time. Still, I find it very illuminating that some current-day scientists have become cautious about giving equivalents for the word 'esprit'. A striking instance is found in a parenthesis in the original French version of Changeux's L'Homme neuronal, which is deleted in the official English language translation of the book, Neuronal Man:

Le débat sur le 'mind-body problem' (que les auteurs français hésitent à traduire: problème des relations de l'âme et du corps?) n'existe que dans la mesure où l'on affirme que l'organisation fonctionnelle du système nerveux ne correspond pas à son organisation neurale.

[The debate on the 'mind-body problem' (an expression that the French authors hesitate to translate: for them, it is the problem of the connections between the 'soul' and the body!) only exists when one affirms that the functional organization of the nervous system does not correspond to its neural organization.]
Changeux admits that he is reluctant to translate the word ‘mind’ into French, because the French word ‘esprit’ produces a confusion of meaning that it carries along with it the repercussions of the notion of ‘spirit’ and thereby conjures up the old Bergsonian dualism of the body and the soul. So, Changeux goes so far as to even question the use of the word ‘esprit’: ‘À quoi bon parler d’‘Esprit’?;’[^40] [‘What’s the use of speaking of the mind?’].[^41] In his view, as long as the so-called ‘spiritual’ is eradicated, reductive as it might appear, he posits that correlations can be made between mental and neuronal activity. Ultimately, Changeux vividly constructs a ‘footbridge’ or ‘passerelle’ between the two:

... to destroy the barriers that separate the neural from the mental and construct a bridge, however fragile, allowing us to cross from one to the other....[^42]

And with panache, he proclaims: ‘L’homme n’a dès lors plus rien à faire de l’“Esprit”, il lui suffit d’être un Homme Neuronal’;[^43] [‘Man no longer has any need of the “Esprit”; it is enough for him to be Neuronal Man’].

Changeux weaves his discussion of memory within his continued treatment of the mind/brain debate. He treats the subject within an extended interdisciplinary dialogue with the French philosopher Paul Ricoeur in their book *Ce qui nous fait penser: la nature et la règle* (1998). Changeux remains uncomfortable with Ricoeur’s formulation of the physical brain as the ‘substrate’ of thought, or mental experience. In response, Changeux rather humbly presents his own neurobiological approach as admittedly reductive and inadequate for explaining fully the phenomenological mental experience that he describes as ‘internal reflective processes’.[^44] But in also challenging the metaphysical legacy of Bergson, which treated thought (‘pensée’) as independent of the brain (‘cerveau’), Changeux refutes Bergson’s notion of memory:

Bergson, in *Memory and Matter* (1896), had concluded that ‘memory must be, in principle, a power absolutely independent of matter’. ... On this point, however, the great philosopher’s intuition proved to be mistaken.^[45]

In contrast, Changeux speaks of the scientifically established notion of the ‘materialization’ of memory traces. However, he has also pointed to the interconnections between different kinds of memory traces in the brain. For instance, he, like others, connects the emotional component of memory to the amygdala:

The neurosciences provide a definite basis for asserting a connection between the memorized cognitive representation, the knowledge trace, and the emotional trace associated with this knowledge, which appears to be located at the level of the various pathways that unite the frontal cortex with the limbic system, and most especially with a specialized nucleus, the amygdala.^[46]

Previously, dismissing the idea of a unilateral localization of traces in either the hippocampus or the temporal lobe, he had envisaged ‘the memory trace as spread throughout the cortex and maybe even through a large part of the rest of the brain’.[^47]

Like Changeux, another outspoken French neuroscientist, Jean Delacour, has presented a model of the memory system which ‘does not have a single anatomical location’.[^48] In his view, the memory system involves the whole brain and consists of the interaction of three interacting structures: the association cortex (for motor and sensory activity), the limbic system (for arousal and excitability) and the prefrontal cortex (for deliberate behavior). Delacour takes a tempered approach to the subject of traces, viewing memory as being affected by the short life of individual neurons and their enzymes. He also emphasizes the variation in the accessibility of traces, based on conditions present at the moment of retrieval. For example, in differentiating the brain from a computer, he notes the possibility in human memory for interference by adjacent, competing memories. ‘De façon générale, la mémoire vivante est beaucoup moins localisée que celle d’un ordinateur’;[^49] [‘Generally, living memory is much less localized than that of a computer’]. Eventually, however, he arrives at the conclusion that long-term memory in the adult depends on the plasticity of the nervous system, the capacity of the nerve tissues to form new connections, an ‘exuberance’ which naturally declines with age. Other scientists, however, are currently envisaging neuron renewal. Survival factors often known as trophic interactions are being explored in connection with synaptic pathway formation in the hippocampus during maturity. Ira B. Black speculates that trophic factors are affected by excitatory or inhibitory transmitters.[^50] And Changeux has already argued that memory in later age is compensated for by a replacement of chemistry by geometry in the sedimentation and stratification of the synapses.

The topic of memory attrition brings attention to the phenomenon of ‘oubli’, or biological forgetting. Some recent researchers have studied the consolidation of memory in sleep, performed by the hippocampus.[^51] Others have observed that the elimination of certain ordinary
trivia can provide for acquisition of long-term memory. On the other hand, the redundancy resulting from the coexistence of several memory systems can account for the reversibility of forgetting. It is also true that forgetting can provide a compensation for surcharge which can arise from an overload of short-term memory. Early on, the studies of amnesia by Ribot had demonstrated this notion. Over time, long blocks of forgetting can safeguard the original imprint intact rather than jeopardize it with interference. This returns us to Changeux’s point that ‘To learn is to stabilize preestablished synaptic combinations, and to eliminate the surplus’. Without connecting his data to current scientific findings, the literary critic Harald Weinrich in his book Lethe does confront Bergson by interpreting Proust’s involuntary memory as being indirectly connected to forgetting rather than to ‘durée’: ‘das unwillkürliche Gedächtnis unternimmt ein langes und tiefes Vergessen’; ‘Unconscious memory progresses in subterranean fashion through a long and deep oblivion’. Weinrich’s conclusion through the literary experience is that contrary to Freud, such forgetting is purgative and beneficial in its human and poetic form. In a strictly literary context, Weinrich is sensing the strengthening of memory through selectivity. The poets Mallarmé and Borges, as has been seen, have both provided additional data for the interaction between remembering and forgetting.

Just as forgetting can contribute to remembering, so, too, may the study of short-term memory shed light on long-term memory and layering of memories. Striking elucidations of these aspects of memory study can be drawn from the literary texts of Faulkner and Nin, and even from comments by Salvador Dalí, as shall be seen. Nin, in particular, demonstrates interactions between short-term and long-term memory. Initially, scientific researchers classified short-term and long-term as separate storage systems. Derived in part from William James’s category of primary memory, Alan Baddeley first offered the model of working memory in 1974 to designate the temporary storage of information necessary for the performance, in the prefrontal cortex, of cognitive skills, including learning and reasoning. More recent research has been concerned with the interaction between different types of memory. Eric Kandel has compared synaptic plasticity in long-term and short-term memory and has discussed the process of consolidation which converts short-term into long-term memory. Also, Antonio Damasio has pointed out regions where emotion and working memory actually interact. Changeux has averred that in actual practice, working memory solicits varieties of long-term memory but which are

‘differentially activated when... called back up to the working compartment’. It was Tulving who in 1995 proposed a formal model of organization of memory in five systems: procedural, perceptual priming or cue based, semantic or factual memory not tied to language, primary or working memory, and episodic. Yet even with these categories, Tulving asserted that ‘classification requires a multilevel approach’. He went on to stress that such taxonomy should not be limited to neuro-anatomical analyses which seemed to stress cortical geography instead of functioning.

Such classification considers procedural memory and perceptual memory to be forms of unconscious memory, which has received insufficient scientific exploration. Since, for example, procedural memory has always been involved with habit, this automatism has demeaned the study of unconscious memory. Furthermore, the Freudian notion of repressed, traumatic memories remains predominant over other forms of unconscious memories. Nonetheless, those cognitive neuroscientists who have pursued the subject have realized the subtleties of unconscious memory beyond the well-known Freudian interpretation.

For example, some researchers who have been engaged in sleep research focusing on dream memory, have unwittingly called to mind the Surrealists with their interest in the peculiarities of dream states. The neuroscientist Jonathan Winson has hypothesized that the brain mechanism that underlies the unconscious is a normal associative process, however distorted it might appear; it is not a defense mechanism as Freud viewed it. In fact, in terms of evolution, it was the complete neural system prior to the advent of consciousness. Winson states:

I find the unconscious a cohesive, continually active mental structure which takes note of life’s experiences and reacts according to its own scheme of interpretation and responses. This reaction is reflected nightly in our dreams.

Similarly, J. Allan Hobson and Robert Stickgold have pointed to physiological reasons for the chaotic imagery and bizarre discontinuity that is manifest in the intense dream phase known as Rapid Eye Movement (REM) sleep. They state:

From our perspective, the presence in sleep of thoughts, images, and emotions is sufficient to characterize this sleep as altered consciousness rather than unconsciousness.
Only in 1987 did the psychologist Daniel Schacter give a definition to the currently used term ‘implicit memory’, stating ‘when previous experiences facilitate performance on a task that does not require conscious or intentional recollection of those experiences’. More recently, his book Searching for Memory, has gone on to elaborate on distinctions between implicit and explicit memory that he had originally made; he states: ‘while our sense of self and identity is highly dependent on explicit memory for past episodes and autobiographical facts, our personalities may be more closely tied to implicit memory processes’. But he is left with an unresolved issue: ‘We don’t yet know whether differences between the hippocampus and the amygdala are implicated in the peculiar kinds of implicit emotional memory that has been observed in some psychogenic amnesia patients.’ Although Schacter finds the amygdala to be fully involved in mediating persisting emotional after-effects of unconscious memory, he also recognizes the role of the hippocampus in consolidating memories during sleep. By even mentioning Pierre Janet and his notion of dissociated memories of the unconscious mind and by reconsidering the inhibitory processes suggested by Freud as actually playing a significant role in memory (rather than in forgetting), Schacter seems to be reevaluating certain memory debates of the 1880s. It also appears as though Schacter were continuing the discussion of the collaboration between unconscious and conscious memory initiated by Hermann Ebbinghaus in that era.

Aside from speculations with respect to localization, implicit memory has perhaps been most discussed within the context of language. There is the widely disseminated work of Steven Pinker, who takes the study of memory in the direction of psycholinguistics. Notably, his book The Language Instinct, which considers the neural organization of language, has popularized the notion of the computational brain with the connectivity of neural microcircuitry. Despite what he calls the ‘near consensus’ that the left perisylvian area of the cerebral cortex is the locale for language, he admits that language functions are actually ‘hard to pin down in the brain’.

More specifically, the psychologist Douglas L. Nelson has discussed experiments on what he calls ‘target study words’ and their ‘set size effects’, which implicitly draw in past associates in long-term memory. He writes:

First, the presence of such effects indicates that previously acquired connections to related words in long-term memory can influence recall...Second, such effects indicate that unconsciously activated information can affect memory for consciously experienced events.

He goes on to say that such information previously acquired may never have even surfaced to the level of conscious awareness. In this manner, Nelson draws on automatic and implicit aspects of memory which can suddenly emerge. This implicit component in turn suggests a connectionist formulation. It also can be related to the linguistic approach to memory unwittingly used by such poets as André Breton and Octavio Paz who in their articulation of individual word images transpose clusters of connections provided by past associations into new contexts. Nelson’s own PIER model of 1992 ‘assumes that cued recall is determined by Processing Implicit and Explicit Representations’. He proceeded to consider ways of integrating the two kinds of memory. All along, he also offers a means of incorporating the processes of encoding and retrieval in the studies. But for him it is not a question of circumstances surrounding the encoding, as it is for Tulving. It is rather the closest associates of a word: words with a smaller set of associates have a recall advantage. Such associates can be activated automatically. Given such findings, Nelson suggests that the contributions of the unconscious memories are a resource to be probed by future scientists.

The study of memory thus figures in debates between what is called the symbolist and the connectionist approach. The symbolist models offer the traditional notion of memory permanently stored intact as representational, classified according to the category of memory, and retrieved in standard sequence. The connectionist models do not accept this fixed notion of memory storage, of a single memory trace. Instead, they suggest a more transitory evocation of memory, dependent upon a network of connections, involved in a patterned activity of the brain. The contingencies of the moment play a role in the interaction between a system and the environment, so that the actual functioning of the memory system produces the results. Implicit memory, with its wealth of hidden connections, seems to be better explained within this model. The psychologist James L. McClelland is known for having come up with a memory trace synthesis model to describe the reconstructive memory retrieval process which activates the connections among units:

It also involves contributions from background knowledge based on information acquired very gradually over the course of a lifetime of experience directly within the neocortical system. If these ideas have
any validity, we cannot see remembering as recall, but as a synthesis of contributions from many different sources of information.68

Ultimately, this approach supports the notion of language as another trigger mechanism for memory – that words themselves can be stimuli that can prompt the assembling of memory traces distributed throughout the brain. It has been seen that poets and writers, especially of more modern times, have exploited the use of stimulus words in their art.

Despite the specificity attributed to certain regions of the brain for purposes of encoding and recuperating memory, therefore, most scientists would agree that a holistic approach to memory remains necessary. In light of advances in the study of the memory process made by the diverse factions of pharmacological studies, computer modeling, and neuroimaging approaches, scientists are admitting that increasing collaborative efforts are on the venue for the future. For one, the neurologist Marek-Marsel Mesulam has acknowledged ‘the growing belief that explorations in the general areas of mind/brain/behavior are ripe for meaningful multidisciplinary approaches’.69 As this book has demonstrated, the marking of the literary pathways can lead toward new frontiers of such consilience, with the recognition that literary writers provide beacons particularly into the dark corridors of unconscious memory yet to be explored.

Three paintings of the twentieth century feature memory in an unforgettably striking way: Dalí’s The Persistence of Memory (1931), Oscar Domínguez’s Memory of the Future (1938) and Magritte’s La Mémoire (1948). All three paintings are surrealist, containing visual presentations of memory and time through the intermediary of concrete objects and the art of juxtaposition which are germane to surrealist artistic technique. Moreover, with their visionary but concrete optic on the future, it is all the more intriguing, if not paradoxical, to extract from the artwork some final hypotheses regarding the memory process.

It is a known fact that modern art became closely involved in the early twentieth century with the formal depiction of concepts. Art critics from Roger Fry to Guillaume Apollinaire and Kazimir Malevich attested to this fact in terms of Post-Impressionism, Cubism and Futurism. In fact, in the years 1923–25, Malevich coined the apt term ‘painterly science’.1 But it was André Breton who, most specifically, demonstrated first in 1928 in Le Surréalisme et la peinture and later in his 1939 essay ‘Des Tendances les plus récentes de la peinture surréaliste’, that surrealist poetry and painting shared the same tenets and techniques. Following the first wave of Cubism, which probed the third dimension suggested by cubes, cones and pyramids, the so-called fourth dimension became the fashionable subject to be explored. However, as the art critic Linda Henderson has pointed out, few artists fully understood the true scientific non-Euclidean meaning of the term, which was actually first introduced by Herman Minkowski as the notion of ‘space-time’ in his 1908 paper.4 Henderson makes the following distinction:
32. Breton, *ibid.*, vol. 1, p. 64.
33. The original French of this little known text reads: "Une mémoire la première sans doute et celle qui fuit les astres, ouvrit les mains. Ceux qui la sollicitent sont grands. Mais le jardin des persécutions ferme ses portes sur eux et ils demeurent traqués par les tisons de la mer, par les forts de la Halle, par les hosties à pattes d'araignée. Cette mémoire flotte ses servantes comme un grand seigneur pervers. La chambre à coucher est divisée par les parfums, parfum du Sud, Étoile de Nubie, colerettes d'enfant disparus... Cette mémoire apaisée, meurtre, ouvrage comme une grille de fer, cède quelquefois la place à une boulette de poison. Le trolley qui avance dans les bois." *Poisson soluble II* (2), in *Oeuvres complètes*, vol. 1, p. 515.
34. Breton, *Oeuvres complètes*, vol. 1, p. 516.
35. *ibid*.

7 Nin, Borges and Paz: Labyrinthine Passageways of Mind and Language

1. The *Seminar of Jacques Lacan*, Book III, trans. Russell Grigg (New York: W.W. Norton, 1993), p. 152. The full citation of Lacan's metaphor for memory is the following: 'However, it's made up of messages; it's a succession of little signs of plus or minus, which file in one after the other and go round and round like the little electric lights on the Place de l'Opéra that go on and off.'
9. *ibid*.
23. Borges, *Selected Non-Fictions*, p. 4. The article with its Spanish title 'La Naderia de la Personalidad' was published only once in the original in *Inquisiciones* (Buenos Aires: Editorial Proa, 1923). The citation of the Spanish words from this article are from that original edition.
36. *ibid.*, p. 11.
41. Paz, *Configurations*, p. 89.
43. Paz, "The Bow and the Lyre", p. 24. The next quote is on p. 27.

8 The Almond and the Seahorse: Neuroscientific Perspectives

1. In the early 1990s, these structures were highlighted by the appellation of a journal, *The Hippocampus*, first published in 1991, and a volume
31. Ted Abel et al., ‘Steps toward a Molecular Definition of Memory Consolidation’ in Schacter, Memory Distortion, p. 318.
32. This approach was given popular recognition by George Johnson’s article ‘Memory: Learning How It Works’ in The New York Times Magazine (9 August 1987), featuring Lynch and his calpain hypothesis.
35. Ibid., p. 230.
36. A conference ‘Bergson et les mémoires’ took place at the Department of Cognitive Sciences at the Université Victor Ségalen in Bordeaux, France on 1 October 1997. An earlier colloquium on ‘Bergson et les neurosciences’ was also held in France in 1995, under the direction of Philippe Gallois and Gérard Forzy.
38. The French word ‘esprit’ has often been mishandled in translation of literary texts as well. For example, in the case of Baudelaire’s famous poem ‘Correspondances’: ‘Qui chantent les transports de l’esprit et des sens’, there was the notion of the fusion of mind and body. Several translators, such as Joanna Richardson, have mistranslated ‘esprit’ as soul (Penguin edition). My own early book The Symbol of the Soul from Hölderlin to Yeats made it very clear that the concept of ‘soul’ was dying out in the mid-nineteenth century, being gradually replaced by the material self.
39. Jean-Pierre Changeux, L’Homme neuronal (Paris: Librairie Athéme Fayard, 1983), p. 364. The translation from the French is my own, in order to give the important parenthesis that was deleted in the English language translation.
40. Ibid.
41. Nonetheless, more recently in the 1990s certain scientists have revived this debate at conferences in France regarding Bergson’s legacy for science.
45. Ibid., p. 141. As Changeux indicates, the citation from Bergson is from Matière et mémoire (Paris: PUF, 1991). Changeux’s criticism of Bergson is

47. Changeux, Neuronal Man, p. 167. In light of his Darwinian notion of epigenesis, in more recent times Changeux has provocatively provided a hypothesis regarding the mental mechanism of the child, which suggests his ultimate view of the variability and development of memory across an individual’s lifetime. Curiously, Changeux’s description of the possibility of aleatory mental combinations in the early encoding of memory seems attuned to aspects of the surrealists’ view of memory in their intentional mimicking of the childhood state of mind.
52. See Ribot, Les Maladies de la mémoire.
56. See Damasio, Descartes’ Error, p. 71. Damasio considers this region of interaction to be the anterior cingulate cortex in the limbic system. Through the study of the neurotransmitter serotonin, he has also pointed out ‘the system connection between ventromedial prefrontal cortices and amygdala’, pp. 77, 184. Although Damasio does not specifically deal with the subject of memory in this book, he does suggest connections between the decision-making capacity of the prefrontal cortex and somatic states which constitute a kind of memory which can influence the reasoning mechanism of the brain.
57. Changeux and Ricoeur, What Makes Us Think, p. 139. Changeux elaborates: ‘Objects of knowledge called up to the working compartment are also recruited from the regions of the cortex where long-term memories are stored: visual areas for concrete images; motor areas for actions on the world; specialized parts of the temporal areas for the recognition of faces, animals, and artifacts, including tools and instruments; a group of areas distributed over the cortex and converging in the frontal cortex for “abstract” concepts.’

63. Ibid., p. 232.
65. Steven Pinker, The Language Instinct, p. 323.
68. James L. McClelland ‘Constructive Memory and Memory Distortions: A Parallel-Distributed Processing Approach’, in Daniel L. Schacter (ed.), Memory Distortion, p. 88. Although the memory trace synthesis model was introduced in 1981, it bears sustained validity.

Afterword. Images of the Artists: Dali, Dominguez and Magritte

7. Ibid., p. 304.
8. Ibid., p. 304. The next quotation is on the same page.
9. Ibid., p. 219. The next quotation is on the same page.
12. See my discussion of this article in Chapter 6.