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LANGUAGE PROCESSING: A NEUROPSYCHOLOGICAL PERSPECTIVE

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SUMMARY

This article addresses a basic theoretical problem of neuropsychology: the relation between memory and language. Standard accounts stress the importance of semantic memory as a kind of passive lexicon, where words can be "looked up" as needed. While this aspect of the process is certainly important, the various memory and language systems in the brain are related to each other in far more complex ways. This becomes apparent when we realize that memory in turn is only part of an even larger problem, which is the experience of time. We do not yet really know how the brain manages time – or perhaps, as some theorists believe, creates it. The language-memory problem is an element of this problem, but it cannot be understood in isolation. In this article, the authors apply the microgenetic approach, which better frames the problems of time and consciousness, in order to create a background and foundation for further work on the brain-language problem. Only in this way can we explain how it is not only possible, but indeed necessary for us to remember the "gist" of what is said, when we can hardly remember more than a handful of the words that were actually used. Naïve accounts of language processing in the brain fail to account for the way meaning is remembered largely (but not entirely) independent of the concrete words spoken.

Key words: semantic memory, working memory, consciousness, microgenetic theory

INTRODUCTION

In order to describe a neuropsychological perspective to language processing it is necessary to provide two simple premises:

– In order to say anything at all, or to understand what has been said, it is necessary to remember the words being used, both how they sound and what they mean, as well as the syntactical rules of grammar that enable them to be put together into meaningful sentences.
– It is also necessary for the speaker to remember the purpose and substance of the intended utterance long enough to complete its vocal realization, and for the listener to remember what has already been said long enough to grasp the meaning of the sentence after it has already been pronounced.

The fact that language is largely dependent on memory seems hardly controversial, and yet the brain mechanisms involved are seldom studied together: there is a large body of neuropsychological literature on memory systems, and an equally large or even larger body of neuropsychological and neurolinguistic literature on speech and language, without much cross reference. What is more, there is no unified, generally accepted theory or paradigm of brain/mind functioning that would allow for a synthetic view of the problem. This chapter can only be an overview of the problem, surveying the grounds upon which such a theory could be erected and sketching its structure. Thus the project that begins with two all but self-evident observations about language and memory quickly evolves into a major undertaking. In order to have a theory of memory, one must also have a theory of perception, the mental state, subjective time, and language. In some sense, before there can be a theory of anything, there has to be a theory of everything (Brown 1991).

TYPOLOGIES OF MEMORY

The first problem to be confronted in attempting to sketch the relation between the brain mechanisms of memory and language is that neither of these is a closed or unified system, but rather a system of systems (Pachalska 2007).

The English word *memory* sometimes refers to a mental process, in the course of which various bits of information are recorded, stored, and recalled, and sometimes to the information itself. The distinction between memory as a process and memory as a data bank is an essential one, though often forgotten or obscured in the course of constructing theories of memory. The process of memory, understood in its broadest sense, is clearly the basis, not only for learning, but also for attention, consciousness, thinking – in a word, cognition. If the information conveyed to the brain from the sense organs disappeared as quickly as it appeared (in a fraction of a second), then the experience of life would be an incomprehensible flutter of unrelated images.

This is precisely the state of consciousness we observe clinically in many patients with brain damage.

Clinical practice with patients who have selective memory disturbances (that is, some memory functions are disturbed after brain damage, while others remain intact) also suggests that memory systems can be classified in many different ways:

– *According to time frame* (that is, how long the memory trace is retained). Here we ordinarily distinguish on the simplest level between short-term memory (from several seconds to several minutes) and long-term memory, when some fraction of the information in short-term memory is stored (remembered) for a longer period. Short-term memory, in turn, is thought by some to be a complex system called "working memory" (Baddeley 1986, 2000, 2002; Baddeley & Hitch 1974), with separate modules for processing verbal and iconic information and a "central executive" that steers the flow of information among the modules. Long-term memory, on the other hand, is often compared to a "hard disk," that is, a medium of information storage. It should be stated clearly, however, that there are serious conceptual problems with both the modular approach embodied in "working memory" theories and the "information storage" model that makes long-term memory into a data bank.
– *According to the type of information that is being processed*. The basic distinction here, institutionalized in all the standard batteries of neuropsychological tests for memory, is between verbal and non-verbal memory. There is reason to suppose that the brain remembers words and pictures in a different way.
– *According to the sensory modality*. As there are five sensory channels, so there are five memory systems to process acoustic, visual, tactile, gustatory, and olfactory information. There are differences in the way objects and events are remembered in terms of their sensory properties, though there is also a good deal of "cross-talk," as for example when a fragrance evokes the memory of a face or a conversation.
– *According to the structure of the information remembered*. It has become standard practice to distinguish between episodic memory (the recollection of events), semantic memory (the recollection of facts without reference to a temporal frame of reference), and procedural memory (the recollection of the skills and steps needed to perform a particular task). Autobiographical memory, defined as memory of one's own life, may be a separate system here, though some authors view autobiographical and episodic memory as interchangeable concepts.
– *According to the level of conscious awareness.* Some things are remembered by being brought to the foreground of consciousness (explicit memory), while other memories remain in the background

without our being aware of remembering (implicit memory). In a classic global amnesia, when the patient is unable to recall any pertinent facts from the past, language is usually preserved, which suggest that the implicit memory system is more important for speech and language than explicit memory.

– *According to time domain.* Mostly we think of memory as pertaining to the past (retrospective memory), but in daily living we very often must remember that there is a task which will need to be performed in the future (prospective memory).

The confusion that often results from this mosaic of intersecting classifications, which cannot be reduced to a unified diagram or tree of derivation, makes it extremely difficult to make any general remarks about memory as such. It is hardly surprising, then, that most theorizing about memory has a mosaic character. The temptation is to make finer and finer distinctions and classifications, so that each discrete element can be identified, described, and explained (Baddeley 2002). This makes for easier scientific work, to be sure, but it prevents most working scientists from taking a larger perspective on the problem. Analysis cuts deeper and deeper, but this happens at the cost of synthesis. The brain/mind, when viewed from this cognitivist/modularist perspective, begins to look like an organic computer, a system of co-operating but discrete processors, each of which has algorithmically defined and clearly distinct input and output. This has the advantage of a certain elegance and simplicity, allowing brain functions to be diagrammed in the manner of a flow chart. Memory systems are ways of handling information, as in a computer. Language, then, becomes a coding system allowing modules to process information, so that a natural language (English, Polish, French, Chinese) serves essentially the same function as the various programming languages that allow computers to exchange information, i.e. bits of raw information are converted into conventional symbols, which can then by transformed according to known rules.

There are, however, some serious objections to this seductively coherent way of thinking about the brain. To begin with, a real brain is an organ of the body, which means that it is undergoes continuous growth and decay, changes from moment to moment. Neither to the naked eye nor under the microscope does it resemble a set of discrete processors connected to one another by wires. The boundaries between gross anatomical regions, to say nothing of neuron clusters, are indistinct and often purely conventional. Functional neuroimaging has not resolved the problem, but rather complicated it, as it proves nearly impossible experimentally to replicate exactly a given state of activation in a given brain more than once, let along between brains. Furthermore, the cognitivist model, as the name implies, is based on cognition, i.e. information processing, and not on feeling. Freud's much-derided "Id" disappears from the system, and the subconscious is reduced to "fast" processes that are highly automated and do not require conscious input.

Emotions, then, are noise in the system, mood is reduced to the working state of the system on a given day, personality is a set of predictable traits and overlearned behaviors, and consciousness (if it exists at all) consists in the processing of information. Descartes has become the favorite target (Damasio 1999), but the cognitivist model is unable to even address the problem of first-person consciousness that is implicit in "Cogito, ergo sum," let alone suggest a solution. Statistics are used to smooth out individual differences in subjective experience to create a specious uniformity of clinical phenomena. The inherent "fuzziness" of memory disturbances is thus factored out of the explanation, while the game of adding ever new processors and pathways to the flow charts of cognition continues, even though increasing numbers of neuropsychologists and neurolinguistics are no longer able to see the point of the game (Pachalska & MacQueen 2005).

Fig. 1 shows that attention, short-term memory and long-term memory are not discrete systems, but part of a larger whole. The boundaries between domains are fuzzy. Attention occupies the shortest span of time (up to several seconds), while with the passage of time the number of elements remembered and the span of time they occupy increases incrementally, through short-term memory (several different elements, from a few seconds to half an hour or so), to long-term memory. There is no single moment at which information is "saved to disk": there is, rather, a falling away of inessential information that does not have a clearly defined beginning or end. Memory traces decay at varying rates and to varying degrees, depending on the nature of the information, its emotional load, the condition of the brain as a whole etc.

One point that deserves far more attention than it usually receives in neuropsychological studies of memory is the role of time, or, to be more

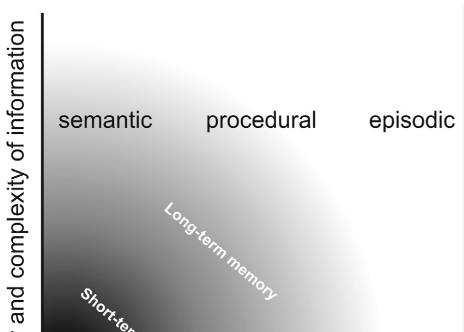

Fig. 1. An overall schema of the attention and memory systems [from: Pachalska 2007]

specific, the subjective experience of time that is mediated by the brain. Before we can really understand memory (or perception, or consciousness, for that matter), we must come to some kind of understanding of the nature of experienced time. This in turn leads directly to the development of a new paradigm in neuropsychology, based on a theory of process rather than the almost instinctive urge to map things in order to keep them from changing.

THE NOTION OF TIME

Most of us think of time as a medium for the self to travel in physical space-time. We think of time as flowing, hence the popular metaphor of time as a river. It may be more useful, however, to think of time with the use of a somewhat different metaphor: that of a fountain, which constantly replaces itself in a perceptual cycle of rising and falling, but goes nowhere, a type of recurrence that is interpreted as a linear sequence (Brown 2005). Bergson wrote that we tend to imagine ourselves standing above and looking at ourselves moving along a line in time, and that this illusion is a one-dimensional spatialization of time. He suggested that time is rather an iterated point or duration.

The idea of two different types or concepts of time is well established in philosophy. John McTaggart referred to the A and B Series (McTaggart 1934/1968), i.e. "before and after" or "earlier and later," as opposed to the familiar way of thinking about time as a space divided into the three regions of past, present and future. The "before and after" sequence does not require a perspective or a mind, since one perceives only that some events are earlier and some later, but one cannot say when they occur. In human awareness of time, everything is organized around the present. The past is realized or revived in the present. The future is the conviction in the present that this particular recurrence of the past is not going to be the last one.

In cognitivist psychology, time has largely been eliminated: flow charts give only the illusion of movement, they are in fact timeless artifacts. In the process approach, everything that is interesting in the box-and-arrow diagrams of cognitivism is in the arrow, not in the box. The box is an artifice, a break or moment of discontinuity in the process, a pause between phases. Cognitivism postulates external relations between logical solids or discrete entities with causal surfaces, while process theory deals with the internal relations within the entity itself. For cognitivism – where we deal with solid, medium-sized, substance-like entities – the problem is accounting for how things change. For process theory – where we begin with the assumption of a continuous flux – the problem is accounting for how anything becomes stable. Both theories have different kinds of problems; the present study deals with the problem of stability, which we believe can only be understood by constructing a theory of the present moment (Brown 1996).

That which stabilizes all experience within a brief span arching over the succession of physical instances was termed by William James the "specious present." In physical passage, where the past is non-existent, all one has is the instant, like the edge of a waterfall. The present hovers over that knife-edge of change, a virtual span that seems to arch over and incorporate a series of discrete instants, the causal succession of world events. But this present, as James wrote, is specious, virtual or phenomenal. We believe it arises in a core potential and distributes into, and creates, the temporal order of the world, from mind to world and not the other way around.

This is a critical problem for any mind-to-brain reduction. To say the mind and brain are identical without dealing with the problem of duration is a way of dodging the most complex problem in a materialist theory of the mind (Brown 1988). Cognitivism attempts to re-introduce time into the system in an *ad hoc,* artificial way. The concept of a binding mechanism attempts to account for the synchronicity, the spatio-temporal relations or coherence of discrete entities or modules (whether they are neural or cognitive) that were isolated by eliminating time in the first place. In other words, the cognitivists kicked time out the front door, and now are trying to bring it in through the back door, by merely postulating an extrinsic mechanism that does the work of integrating separate units.

It should be stated, at the very beginning, that we do not have a firm answer to this problem, though we will offer here some speculations, so the reader is well-advised to be cautious of any theory of time, whether a binding mechanism or the theory that will be sketched out in what follows. The most profound thinker of the past century on this topic, Alfred North Whitehead, in his essay on time in *The concept of nature* (Whitehead 1920), wrote that "It is impossible to meditate on time and the mystery of the creative passage of nature without an overwhelming emotion at the limitations of human intelligence." If a philosopher of the status of Whitehead could say such a thing, then we should all be fairly modest about what we have to offer to this difficult subject.

Most people think of time in objective terms, as an aspect of physical reality quite apart from how we experience it or what we think about it. Be that as it may (contemporary physics suggests that this may not be as simple as it seems), we are left with the problem of how time is perceived by the brain, which has proven to be far more difficult than explaining how the other three dimensions of physical objects are perceived by the brain and derive into a cognition. William James estimated the duration of the specious present as up to ten seconds, which we would now say is the duration of short-term memory. Ernst Pöppel (1988) argued that it is about two seconds in duration, an estimate based on pause analysis of speech, phrase durations in poetry, even No drama – and also the reversal time for the Necker cube and other kinds of illusions that tend to flip in the mind every two seconds or so. This objective way of thinking about time places mental time into some kind of external, objective container or clock time: that is, subjective time is held to be a more or less accurate reflection of absolute, objective time, or rather, a certain piece of it.

Pötzl described a few cases of time acceleration or deceleration, unusual cases where things seem speeded up or slowed down. Most of the work (and there is really not much of it) has been done in Korsakov or other amnesiac patients, looking at the relation between memory loss and time or duration estimate. Schilder's descriptions are classical, though somewhat anecdotal. He reported that Korsakov patients who had been in the hospital for three months would say they had only been there for a week or so. In our own clinical experience we have seen patients with right hemisphere brain damage who exhibit similar symptoms (Brown and Pachalska 2003).

One experimental study of interest was done by Richards at M.I.T. (1973), who studied H.M., the famous bi-temporal severe amnesic who had a near-total loss of memory. He still had some procedural memory, but could not consolidate new memories. Richards examined duration estimates and, by extrapolating from short durations, inferred that a year might be experienced as a month or so. This makes sense, because if we were to be asked what the last five years feel like, most of us would not have a sense of five years' duration, of what it feels like when a span of five years goes by. Rather, we would start thinking about and then remembering what we did five years ago, four years ago, three years ago, etc. This would punctuate, articulate and expand the duration, and provide some sense of its length. The amnesiac who is unable to revive memories just has an empty interval that collapses on itself.

The problem of the specious or phenomenal present and the nature of time estimation, duration judgments, and so on, are clearly related to memory, but it is not clear how. In order to get to that point we need to consider the theory of perception, and this requires turning neuropsychology upside down. It may be necessary to suspend judgment for a while to see if it all makes sense at the end. This pertains in a particular way to the way cognitivist models account for the way raw sensory information becomes a percept. The classical model is that of a construction or assembly, where sensory bits are constructed into larger bits and things are added. Microgenesis is a specification model, where sensation acts to constrain an endogenous construct so as to realize a model of the world that corresponds to what has been chipped away. The classical model can be compared to modeling with clay, as opposed to the microgenetic model, which is like sculpting out of marble. Michelangelo said he only exposed the form hidden in the block: he saw David in a defective block that had been rejected by the stonecutters, and released him with his chisel. Perception, language, memory and all domains of cognition can be understood from this point of view.

How this works can be seen in Fig. 2.

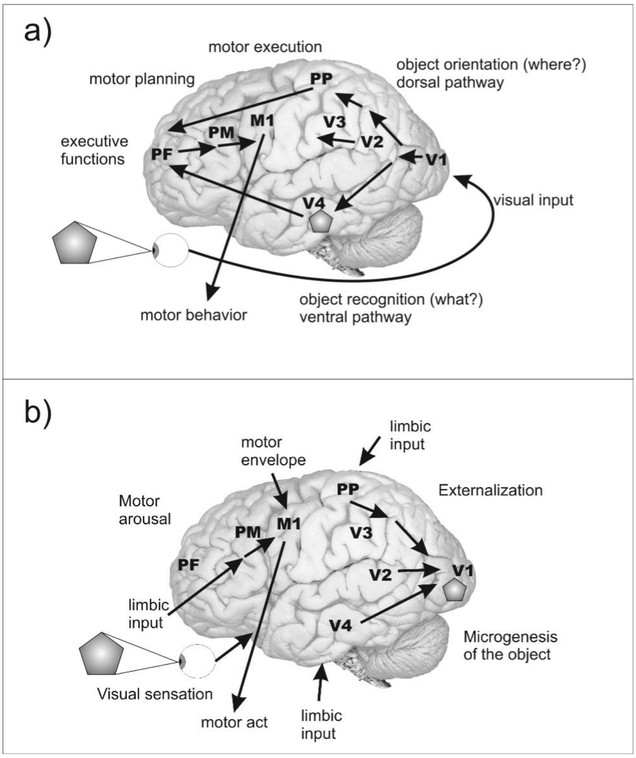

Fig. 2. Two models of how visual perception occurs in the human brain [from: Pachalska 2007]

The standard connectionist model (Fig. 2a) describes how information comes into visual cortex, marked V1 in the figure. It has been claimed that feature detectors exist for angles, which extract the angles, then pass the construct to mechanisms for simple shape construction. V2 and V3 are for complex or three-dimensional shapes, and this construct is then relayed to V4, to temporal cortex or limbic system for recognition, matching to memory, and to the parietal lobes for updating the changing spatial environment. This is standard neuropsychological theory, including the dorsal and ventral streams, often called the „where" and „what" pathways respectively. It is important to recognize, however, that there are several serious objections to this model:

– Only a fraction of the visual input passes directly from the eyes to V1, as Fig. 2a suggests; most of it goes rather to the midbrain and the thalamus. Fig 2a assumes that all primary visual processing is cortical; limbic (memory) involvement is secondary, when the "raw" image is compared to similar images stored in the memory.
– It is not at all clear how the image that is finally "perceived" at V4 becomes the object of attention in the prefrontal area (PF); there are in fact no obvious neural pathways that would explain the long arrow shown on the diagram.

– It is no easier to explain how the spatial relations of an object (at the anterior end of the "where" pathway) become part of the perception of the object once it has been recognized (at the anterior end of the "what" pathway), since the diagrams shows these pathways diverging, not converging, as the process of perception unfolds.
– The neural connections from V1 to V4 are all reciprocal. Some recent studies of cortical connectivity show, in fact, that the connectivity from V4 to V3, or from V3 to V2 is much heavier - possibly ten times as heavy – as the flow from V1 to V2, V2 to V3, or V3 to V4.

The microgenetic way of thinking about this topic (cf. Fig. 1b) reverses everything. It proposes that every perception begins in the upper brain stem pretectum with a two-dimensional spatial construct. One-third of the fibers of the optic nerve go to the upper brain stem. This seems to be far too much input just for the pupillary reflex, and these connections must be doing more than that. The initial construct is then transmitted, in an evolutionary direction, to successive planes of limbic growth, where there is a suspension of input, so that the emerging percept can pass through systems of personal and experiential memory and affect. The construct passes through an egocentric, volumetric space, which is dreamlike or hallucinatory. It then passes on to the parietal lobe to a three-dimensional, Euclidean external space of object relations (see Fig. 3). This gestalt-like object representation is still part of personal space; we typically test parietal cases by asking subjects to draw (where the relation of the arm and the object is important) a manipulo-spatial space, or, as in the congenitally blind, the space of the arms' reach (Brown 2004).

Then, finally, the pre-object receives the massive input at V1, with an analysis of emerging gestalts into their featural detail, and a full exteriorization and detachment of the world from the self. The "where" and "what"

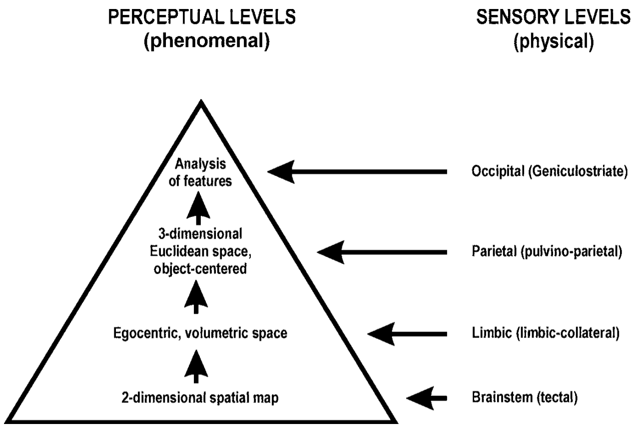

Fig. 3. The microgenesis of visual perception. Levels of object and space realization with corresponding stages of sensory constraint

pathways (i.e. dorsal and ventral respectively) converge to give a percept, whose features and context have been fully analyzed and articulated.

According to the microgenetic model, the world around us is realized through V1. It is lost when V1 is lost, as in cortical blindness. But earlier phases in the perception still occur, as is the case with blind-sight. The patient with cortical blindness who has lost V1 does have implicit perceptions. Some have claimed to have extracted semantic information from words in blind hemi-fields. Moreover, this theory is consistent with the direction of evolution in the forebrain.

The anterior, i.e. motor system develops a behavior, i.e. a motor response to the visual stimulus, not as a second pass process after perception is complete, but in a parallel process. At the lowest layers of the nervous system, perception and action constitute a virtually Newtonian action-reaction system, developing out of reflexes. The streams of perception and action then diverge as microgenesis proceeds upward and outward.

Going from limbic formations to V1, one also goes from long-term to short-term memory, from potential to actual, from past to present, from subject to object, from the mind to the world. On this view, the world we see around us is like the skin of our minds. Indeed, like multi-layered skin that sheds its surface, an act of cognition, mediated by brain tissue that is derived from primitive ectoderm, creates objects that perish for the next round of actualization. What V1 does is represent the final phase of an object, but embedded within that object is the egocentric, volumetric limbic space of dream. There is also a transition from context to item or from whole to part. That is what sculpting is. Wholes are analyzed into parts, and those parts become wholes for the next whole-part transformation. Here we do not have a percept coming from the world and constructed into an object; we have, rather, constraints intervening at successive points in this process. The final object we see is not the end of a sequence of box-cars, not the end-product in a production line. The percept is the entire sequence of phases that constitute a single mental state: in order words, it is a process and not a substance.

The mental state is a continuous, bottom-up surge in milliseconds over these evolutionary planes. We could say that an object has a certain temporal thickness. It takes a certain amount of time for the processing of this object to go from the base to the surface of this system, from the mind to the world. The self is laid down somewhere in between, but that is another story.

The movement from limbic planes toward V1 is also the transition from hallucination to illusion to perception (see Fig. 4). With pathology of the limbic phases, which exposes this process, there are hallucinatory images. Moving towards the parietal phases, one has illusory phenomena. An illusion is the distortion of an object, as opposed to a distortion imposed on an object. The image is more like a physical entity, while at the hallucinatory stage it is more endogenous, more internally represented, less constrained by the world. As one gets closer to the real physical object, one sees physical features of that object in an image that is also illusory.

Finally, at the V1 level, the pathology involves after-imagery, where one sees highly physicalized features of the object, very different from hallucinations. After-images are like a film over an object, where hallucinations replace objects. One cannot hallucinate and perceive in the same locus in space at the same time. The reason for this is that hallucinatory space is the precursor of object space. It could also be said that an object is a fully realized hallucination, or that a hallucination is a momentarily attenuated object. The other point is that if this whole sequence is one object or one perceptual moment, change occurs within the object. The object does not change; change lays down the object.

Fig. 4 is a schematic representation of the progression from dreamless sleep (upper brain stem), through limbic, to successive stages of hallucination and imagery. The normal series of images are on the left side and the pathological series are on the right side.

The perceptual model presented here emerged originally from work with aphasia patients, which again suggests that language is not as separate a system in the brain as is ordinarily assumed (Brown 1972). The theory of perception is really the same theory as that of language or action: they are all part of an underlying *Bauplan* of the way the mind/brain is organized. There is a transition from a core in an unconscious layer, to a private mental space, and then to the world. We are all living in a momentary bubble, in which successive mental states constantly replace themselves (Brown 2000). One question that arises is, what does this tell us about the nature of the present?

In his *Principles of psychology* (1890), William James was interested in the philosophical problem of identity, or of self-repeatable moments and in how

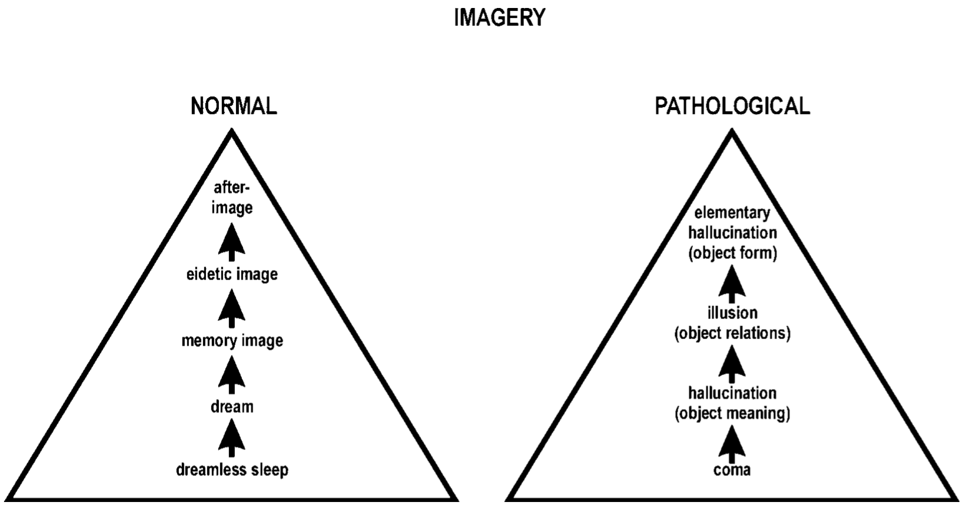

Fig. 4. Microgenetic levels in object formation with reduction of sensory constraint: normal and pathological imagery

one can account for the continuous identity of the self. Hume wrote that he did not understand why the self seems identical over time, and chose to leave this to others to solve. James focused his attention on pulses of cognitive consciousness. In Fig. 5, Point A represents a pulse of cognitive consciousness or, we might say, a mental state. State B is what happens the next moment. A is the residue over which the new state develops. State C unfolds over states A and B. James believed the overlapping, in a continual unfolding over the residual of the just-prior state, might explain the feeling of identity.

James did not relate his theory to the nature of the specious present. In an interesting paper in 1923, Wolfgang Köhler suggested that the duration of the present develops in the comparison of a fresh impression with the fading trace of the prior one. It may seem obvious that the duration of the present is a comparison between the immediacy of the present and some point in the immediate past, but that past point must be in the present, for as a point in the past it no longer exists. Köhler did not explain how this phenomenon might occur.

Fig. 6 shows the mind/brain at a given time point, identified as T1. Thinking of the mental state as a bottom-up process that iterates over and over, T1 represents the absolute or minimal duration of a perception or cognitive moment. In line with the illustration from James, T1 is embedded within

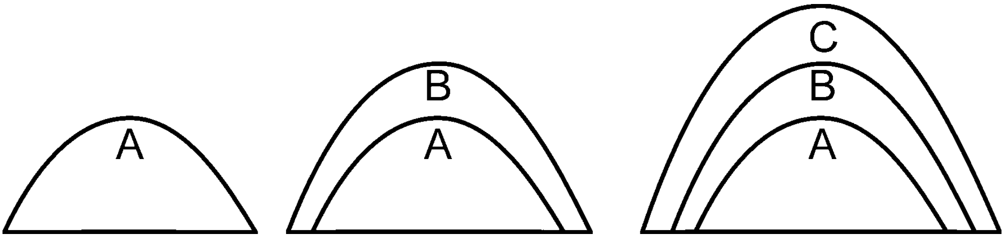

Fig. 5. The overlapping of pulses of consciousness (after James 1890). Each successive pulse develops over the preceding one. This gives the continuity and identity of the self

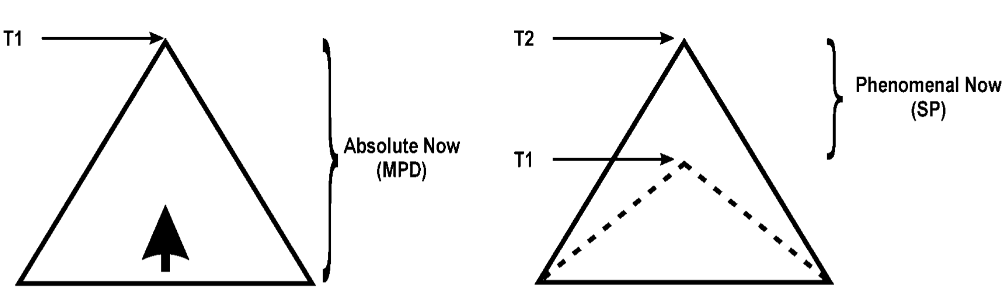

Fig. 6. The absolute Now and the phenomenal Now. T1 is the absolute minimal duration of a mental state. This T1 state decays, or is incompletely revived, in T2. The disparity between T1 and T2 is experienced as the present.

a state at T2. The term “computed” is to be avoided for various reasons, but one could say that as the trace of T1 fades into T2, the incomplete revival of T1 within T2 is extracted and felt as duration. The “vertical” disparity is felt as a linear duration of the present. This may be similar to depth perception, which occurs from binocular disparity, as a virtual three-dimensional image is computed from the disparity between the two monocular images. Thus there is a profound relation between the psychology of depth and that of duration.

Whitehead wrote that the third dimension of space is the ghost of transition. This is an interesting comment because a momentary two-dimensional slice of time has no depth. In some sense, the third dimension of an object has to have a duration or temporal extension. In binocular disparity, there is a virtual image. Depth perception is created as a kind of illusion analogous to the temporal image created by the disparity between the feeling of the present and the floor of some point in the immediate past.

How all this relates to memory is shown in Fig. 7.

We can think of each mental state as having a duration of about 50 or 100 milliseconds. At point T1, we have the state arising bottom-up, and fading over time; T1 keeps replicating itself, or is revived in the ensuing state, and has faded at T2. Then, finally, at T3 or some point in the fading of that trace or its incomplete revival within the occurrent state, the duration of the present is extracted. The present does not seem to have a fixed duration. James said it has fuzzy boundaries. In meditation it is argued that the “now” can expand. In states of confusion, the “now” may contract. This suggests that the duration of the psychological “now” is flexible.

The previous discussion needs to be borne in mind as we move to a consideration of memory. Initially, the fading of the trace is also its incomplete revival. At the point where the revival is almost complete, we can speak of iconic memory or eidetic imagery, where one has an almost physical or picturable realization of the perception. As the revival begins to fade, one can still revive and thus retain some physical features of the initial perception. This means that the revival has achieved a more physical level of realization.

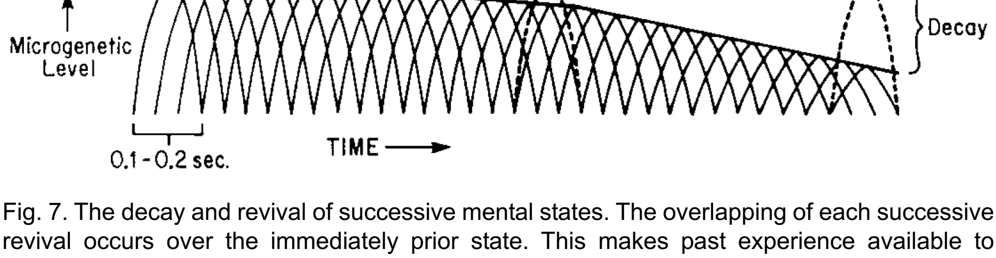

Fig. 7. The decay and revival of successive mental states. The overlapping of each successive revival occurs over the immediately prior state. This makes past experience available to present cognition. Perception develops out of phases in memory

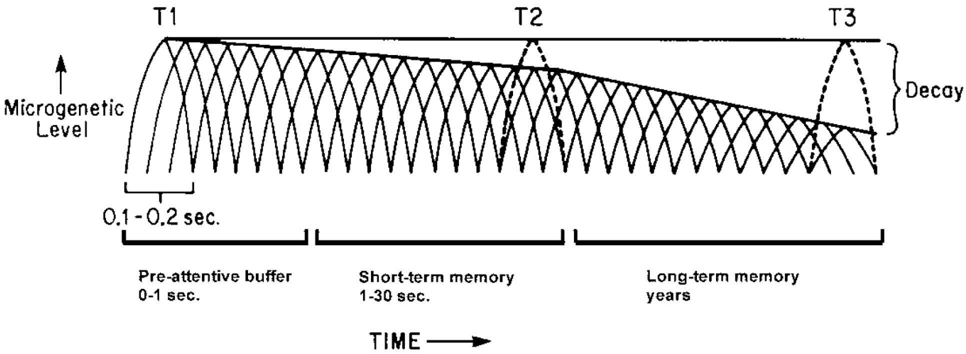

Fig. 8. Components of memory reflect decay levels in the occurrent state. At T2, the T1 state has decayed to short-term memory, preserving some physical features of the original perception. At T3, T1 has faded even more, perhaps beneath the floor of the conscious present, to long-term memory, which shows relations of affect and meaning. The central point to be emphasized in this figure is that the present, T1, is derived out of long-term through short-term to iconic memory, and then into perception, so that in the subsequent decay, or incomplete revival, of T1, these previously buried phases are exposed. Specifically, the original “input” is not, as required in the traditional model, secondarily conveyed to short-term, then long-term memory. Rather, features of short-term and long-term memory recur in the course of the perceptual decay.

This is referred to as short-term memory, when what is recalled has a more physical character. At a subsequent stage, the trace recedes to, or cannot be revived beyond a floor, where it then has conceptual or semantic relations to the original perception. This phase is referred to as long-term memory (see Fig. 8).

Since everything is occurring within a single mental state, one does not go from iconic to short-term to long-term memory. What is happening is that as the trace fades it recaptures phases in its original transit when the perception originally unfolded. All one does is uncover phases that were embedded in the original perception. This was depicted in the initial diagram of a perception (Fig. 3). According to this model, one recognizes an object before it is consciously perceived. Even very primitive organisms manage to recognize an object in the immediate environment (as being food or not food, dangerous or not dangerous, friend or foe) without any consciousness at all.

We think of change as going from one object to another object in the world, but that is apparent or illusory change. The real change is in the laying down of a state, which then perishes. The Buddhists say that there is an arising and a perishing of each flashing moment of life or nature. Whitehead proposed an actualization, a perishing and a re-actualization.

LANGUAGE

The "building block" model of perception (Fig. 2a) has an obvious analogue in the traditional model of how meaning is derived from the way an utterance is presumed to be built; indeed, the origin of microgenetic theory can be found (as for most neuropsychological theory since the 19th century) in work on aphasia (Brown 1972, 1988). Neuropsychologists tend to make of language, however, a separate issue, as though the laws and principles of brain work that apply to other cognitive functions and processes do not apply, or apply differently, to speech and language. Yet there is no reason to assume *a priori* that this should be so. Speaking and listening, writing and reading, are processes of action and perception in a rather obvious way, though the objects have a very complex nature. The point of departure in the 1972 study was precisely the observation that the fundamental mechanisms of disturbances of speech (aphasia), purposeful movement (apraxia) and sense perception (agnosia) consequent upon brain damage reveal fundamental analogies, suggesting that at some level these are the same basic process. In all of these processes, memory enters at the limbic phase, when the utterance (like the perceptual object) is *felt* before it is articulated, both in the active processes (speaking and writing) and the passive (listening and reading). The utterance is not created by assembling the "raw" sensory perceptions of the phonemes and graphemes that compose its linear structure, and then comparing what has been built to what is already stored in memory, but rather the reverse: the utterance, like the perceptual object, is "remembered" into existence.

In the connectionist model of speech, which has taken on the character of a litany recited from textbooks by generations of students learning the basics of linguistics, phonemes combine to make morphemes, morphemes combine to make words, words combine to make sentences, and so on (Pachalska 2007). The length of time it takes to pronounce a phoneme would thus seem to be the atomic unit of speech time, its temporal thickness, and the accumulation of such temporal atoms into strings is the duration of the utterance – again, assuming a clock model of objective time. This makes sense in a computer system, assuming that the binary bits (1 and 0) are combined into strings of a fixed size (bytes), which in turn become the characters of a language that can be used to write and execute programs, and to process input and output. The logic seems impeccable – until we consider what actually happens when someone is speaking and someone else is listening. When an utterance is a speech act, that is, a concrete behavior that occurs here and now for a particular purpose, then much of what occurs is dependent upon how the parties involved feel about the situation in which the verbal exchange is taking place, and about each other. Without the context, in other words, the text seldom makes much sense – a fact that scarcely needs to be rehearsed in a book on applied linguistics, though traditional neuropsychological models of the language system cannot really explain why this is.

Feeling, on the other hand, is an integral part of the memory system, which explains why the easy analogies between computer memory and human memory as so very misleading. The hippocampus, one of the most crucial brain structures for remembering and recalling information (i.e. shuttling activations between short-term and long-term memory) is anatomically and functionally part of the limbic system, the group of subcortical structures that is primarily responsible for affect and mood. What we remember and forget is dependent upon what we feel, and what we feel is often dependent on what we remember and forget. This applies to language fully as much as it applies to the memories of childhoods joys and tragedies, or mathematical formulae, or the PIN number for our bank cards. To say that an utterance begins with a feeling, then, is also to say that it begins with a memory.

As Luria (1972) pointed out, the language system can be said to exist for the purpose of converting a synchronic percept or mental state into a diachronic stream. Thus the string of phonemes does not create the percept that it expresses, but rather embodies it (in a rather literal sense of the word) as a string of phonemes that can be conveyed by physical means to another mind. This suggests, again, that the traditional arrangement of the domains of linguistics (phonology, semantics, syntax, pragmatics) is in reverse order. The utterance begins with a meaning that is then sculpted into sentences, words, and phonemes, just as a percept is a midbrain construct that evolves upward through the limbic system into the cortex. It is the same whole-to-part movement. The pragmatics of an utterance is not a third- or fourth-pass polish given to a well-formed utterance created by the application of semantic and syntactic rules, but rather the point of departure and the sine-qua-non. Everything that happens in the course of realizing an utterance is actually based on the assumption (deceptively simple on its face but revolutionary in its implications when taken seriously) that there must be a reason for the speaker to say something, and a reason for the listener to pay attention, or all the linguistic competence in the world will not give any meaning to what is being done.

What is even more startling is the realization that the same movement from meaning to linguistic structure holds true for the listener. An utterance that appears suddenly, devoid of all context, can only be understood when there is a conscious effort to supply the missing context, and in many case it is simply incomprehensible, even when all the words and the syntactical structures used are well formed. We often do not hear trivial phonological errors when we know what the person meant to say (this can be confirmed experimentally without much difficulty), just as even the keen-sighted editor may miss a typographical error if the sentence makes sense. Indeed, such errors are more often noticed by non-native speakers of a given language, who lack the native speaker's ability to immediately (and often unconsciously) compensate for a mispronunciation, or a regional accent. If short-term memory were simply a buffer in which the raw sensory data are temporarily stored until they have been interpreted, this would not occur. As the sentence unfolds (MacQueen 2004), the listener acquires increasing certainty as to how it will proceed to its conclusion, while the speaker's range of possible choices diminishes with each word actually uttered.

The role of short-term memory in this process is of course crucial. As the sentence proceeds, what has already been said in a physical sense no longer exists (the problem is more complicated with reading, but this is a separate problem that would require a chapter in itself), but its trace in short-term memory must remain active for at least as long as it takes to complete the sentence. This "remaining active" can hardly be anything other than the repeated re-actualization described above in the theory of sensory perception. No meaning would be possible if this string of re-actualizations is interrupted, in which case the content of the utterance to this point vanishes into nothingness and thus cannot convey any meaning. The meaning of the utterance, the sentence, the word, is an excellent example of how the bridge between successive instants creates the specious or phenomenological present. As sentences combine to form more complex units, the memory traces of the previous sentences are still reactualized, but with increasing decay. Thus we may remember the exact words used in an utterance consisting of a few words or a single sentence, but it takes increasing effort to do so when the utterance is prolonged over several sentences. The loss of the immediate sensory experience of the individual phonemes, words, even sentences already uttered does not mean, however, that meaning is lost. Rather, it is the meaning that persists through the process of decay, which causes the individual moments of the utterance to be forgotten. Verbatim recitation of longer utterances heard only once is a phenomenon often seen in persons with profound mental limitations, whose memory feat is rendered easier by the fact that they are unencumbered in their task by any desire or ability to comprehend the meaning (Pachalska & MacQueen 2007).

There is much more that could be said about these problems, especially at the phoneme-morpheme transition, where meaning appears suddenly, as the result of a kind of quantum leap. It may be that this crucial moment is at the same time the interface between short-term and long-term memory, where the proportional importance of each varies from phonology to semantics to syntax to pragmatics. "Semantic memory" is that aspect of long-term memory that remembers the significance of particular objects, while "episodic memory" remembers the relations between the objects participating in the same event, based on the rules of "story grammar." Short-term memory seems to be more "physical," or closer to externalization, precisely because it is immediate, and this could also be said of phonology. Perhaps semantics (word meaning and experiential memory) is the long-term phase of language production and perception, and phonology is the short-term phase, with morphology and syntax mediating between them. For the present purposes, however, further development of these issues would be unduly digressive, and the problem remains to be addressed in further work on the microgenesis of the verbal utterance.

The traditional view of the relationship between language and perception gives language the leading role. Some data, however, point to the opposite direction, as a number of linguistic structures reflects the way we perceive the world that surrounds us. It is particularly true of the visuo-spatial relations which are based on the body image. At the same time, we describe our emotional states in reference to haptic, taste and olfactory senses. Moreover, the Gestalt principles distinguished to characterize visual perception are valid also for auditory perception, hence they play a significant role in understanding verbal utterances. From the above it follows that the linguistic description of the surrounding world is closely related with our perceptual abilities (Kaczmarek, 2005). At the same time, the way in which the utterance unfolds proves to be the same basic process by which the percept emerges in consciousness, through the mediation of memory and feeling.

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