Guyau's Idea of Time: A Cognitive View

John A. Michon

INTRODUCTION

There is no end to perplexity in matters of time. But with the turn of a century approaching, time's enigmatic character seems to become almost an intellectual obsession: with little more than a decade to go the usually modest trickle of books and other time-inspired products of the human mind is gradually widening into a genuine flood.

One hundred years ago, towards the end of the 19th century the situation was similar. Physicists and astronomers, historians, biologists and chemists, all showed a substantial and quite fundamental concern for the temporal structure of reality. The outcome has shaken the universe! Fundamentally new images of time emerged in the natural sciences as well as in the humanities. If the ideas of Thomas Kuhn about scientific revolutions ever had any validity, it is with respect to the changing views of time towards the end of last century.

The science of psychology – newly established in 1879 by Wilhelm Wundt – followed this general trend. The ideas of Wundt and his students in Leipzig, William James at Harvard University, Henri Bergson in Paris, and still others (see Fraisse, 1957), did much to establish a genuine psychology of time, a branch of psychology that – some 25 years later – would be characterized by Titchener (1905) as a 'microcosm perfect to the last detail.'

With so many bright stars shining on the psychological firmament at the same time, one is likely to overlook some of the more modest twinklings. However, even a faint little star may turn out to be an awesome source of illumination if we watch it through an appropriate filter. This is certainly the case with Guyau.

Jean-Marie Guyau, in spite of his short life, became and remained a considerable presence in the distant galaxy of moral philosophy. On the other hand, his only contribution to psychology, *The Origin of the Idea of Time*, was almost totally obscured by the light of such giants as Bergson, James, and Wundt. With the rise of cognitive psychology, however, Guyau's views on the human experience of time gradually appear in a new light. Only now are we able to recognize this essay for what it really is: a remarkably modern study on the acquisition and use of mental representations of time.

THE PSYCHOLOGY OF TIME

In 1957 Paul Fraisse published his classic review of time psychology (Fraisse 1957; English translation 1964). The empirical study of human time was then just about one century old. Cognitive science, on the other hand, was still in its early infancy (Gardner, 1985). But everywhere psychologists were rapidly beginning to converge on this new approach that would transform psychology once more into a *science of the mind*. In North America faith in behaviorism was badly shaken. To European psychologists who, by and large, had remained sceptical about behaviorism and, instead, had entertained a much broader range of views on psychology, the new cognitive movement brought mostly a feeling of relief together with an enhanced sense of theoretical and methodological coherence. In other words, cognitive psychology was consistent with earlier continental schools but at the same time it cleared the way for a rapid development towards an unprecedented degree of methodological and conceptual rigor.

Initially time psychology had been firmly rooted in the mentalistic tradition of the European continent. For several reasons, which have been discussed elsewhere (see Michon & Jackson, 1985a), the psychological study of time lost its prominence early in this century, except in France. In that country many prominent psychologists did take an interest in the study of time, among them Henri Bergson, Pierre Janet, Henri Piéron, the Swiss Jean Piaget, and Paul Fraisse. But despite the persistence and the formidable intellectual quality of the Gallic effort, the study of time gradually became a minor tributary to the mainstream of experimental psychology.

In the sixties, with the arrival of cognitive psychology as a prominent theoretical paradigm, more and more interest in the dynamic, chronometric aspects of human information processing – perception, cognition, action, learning and motivation – began to emerge. In their turn 'prototypical' time psychologists, that is, those investigators who are willing to treat time as an independent variable in their experiments, began to derive their inspiration from the newly established cognitive approach. It permitted them to treat time *as information* (Michon 1970/1972; 1985).

In recent years experimental research has become increasingly focused on the

problem of temporal organization of behavior and cognition. Several monographs, conference proceedings, and a considerable number of journal articles have appeared as a result of this renewed interest. Some of the more comprehensive volumes are Gorman & Wessman (1977), Friedman (1982), Gibbon & Allan (1984), Michon & Jackson (1985b), Levin & Zakay (1988), and Block (forthcoming). They constitute evidence for a considerable progress in the methodology, the theory, and the meta-theoretical foundations of the psychology of time.

Significantly they also reveal a tremendous diversification of topics.[1] The first century of time psychology had been, if anything, the age of the *psychophysics of duration*, the analysis, under an almost infinite number of experimental conditions, of that remarkably uneven subjective flow of time. Presently a much wider range of topics attracts attention: the syntactic (rhythmic) and semantic properties of time, the planning of future action, event perception, autobiographical memory, the narrative structure of event sequences, the subjective value of time, and still others have been added to the (extremely narrow) repertoire of the classical period. As a result we seem to be moving a little closer again to the microcosm Titchener had in mind, even though it does not seem at all 'perfect to the last detail.'

In retrospect the reasons for this protracted and self-imposed constraint on the scope of the research agenda of time psychology seem less than clear, but at that time narrowmindedness apparently prevailed. What transpired, for instance, into pre-modern time psychology of Guyau's rather comprehensive view on human time experience was largely confined to a simple list of factors that he had identified as the principal influences on subjective duration (*OIT* p. [85–86]; Michon, 1965, p. 409; Michon & Jackson, 1984). Presently this simple list appears to be much less simple than it did a few years ago: gradually we learn to appreciate Guyau's work for the full breadth of its contribution to the psychology of time.

GUYAU'S CONTRIBUTION

> Time is not a condition, but rather a simple product of consciousness. It is not an *a priori* form that we impose on events. Time as I see it, is nothing but a kind of systematic tendency, an organization of mental representations. And memory is nothing but the art of evoking and organizing these representations. Time, initially, is no more intrinsic to our mind than it is to an hourglass (*OIT* p. [117]).

This is the conclusion Guyau reaches towards the end of his essay. Any author who arrives at such a conclusion qualifies as a cognitive psychologist, and indeed my claim is just that: Guyau's position is consistent with the contemporary cognitive view of the mind. Such a claim, however, must be made with some *proviso*. The resuscitation of a historical text must never lead to *rampant precursoritis* (a term I borrow from Gould, 1987, p. 9). On the other hand, if a

voice is reaching us from the past, a careful rephrasing in modern terminology of what it tells us may relieve the symptoms of another, ubiquitous and perhaps more pernicious disease, *rampant auctoritis*, the widespread but misguided conviction that the present generation of cognitive scientists is constantly attaining totally unprecedented insights in the workings of the mind. Listening to the voices from the past may, nevertheless, help us to realize that tremendous progress is indeed being made with our ability to empirically decide on such insights and to quantify or formalize our theories.

Guyau's voice comes to us 'loud and clear.' This in itself is remarkable enough. Undoubtedly it is partly due to Guyau's concise and brilliant writing style, a feature of his work that has been acknowledged even by his most severe critics (cf. p. 32). But style is certainly not the first or only reason for the appeal of *The Origin of the Idea of Time*. Much more important are Guyau's metatheoretical position – essentially a functionalistic stance (Block, 1980; Dennett, 1978) – and the content of his theory. As we shall see later in this chapter, both match contemporary views of the human mind as a cognitive, computational system.

At this point I must emphasize that the perspective adopted in this chapter is psychological rather than philosophical. It is at best representative of the way cognitive psychologists presently look at the issues of time, mind, and behavior, even though there is no 'received view' on these issues. Any ontological or epistemological problem that may arise, will be dealt with in an implicit fashion that necessarily leaves many philosophical subtleties untouched. Paul Ricoeur, however, is covering a good many of these when he compares the position of Guyau with that of Kant, elsewhere in this volume (pp. 149–159).

The reality of time: A cognitive approach

Underlying every discussion about psychological time is the question whether time is ultimately real, or ideal (or as some would say an *illusion* contributed by the human mind); the question, in other words, is what 'stuff' time is made of.

Helpful for our understanding of Guyau's position in this matter, is an appreciating but critical review of *The Origin of the Idea of Time* by Henri Bergson (1891). This review is the only direct confrontation between Bergson and his one time teacher (see p. 21) and it marks the distinction between the two authors in considerable detail. In his review Bergson takes issue with what he perceives as Guyau's attempt to extract the raw materials for our notion of time from the external world. In Bergson's opinion it is impossible to derive the dynamic streaming of experienced time from the ordered but inherently static impressions – the *differences, transitions*, and *intensities* – provided by physical reality. This touches indeed upon a notorious problem that has occupied many philosophers, including Locke, Leibniz, Kant and William James: How can a succession of ideas (representations) ever give rise to the idea (representation) of

succession, to a representation of streaming time? Bergson's answer is that there is a metaphysically independent *lived duration (durée vécue)* that is synchronized with external events but not necessarily causally dependent on them. For Bergson the streaming of time is, in other words, not symbolic and not representational. It is instead the 'existential form of consciousness.'

As an aside, let me point out that the issue persists. The British philosopher McTaggart (1927) made a crucial distinction which, since then, serves as a beacon for all those who sail these difficult waters. Unfortunately it is not altogether clear that the beacon can be trusted: it may in fact have caused more shipwrecks than it has prevented. McTaggart made the useful and seemingly innocuous distinction between the A-series, which orders events in time according to their pastness, presentness and futurity, and the B-series which orders events simply with respect to before and after. The A-series seems to be consistent with our personal perspective with its privileged *now*, and the B-series with a view of the universe *sub specie aeternitatis*.[2] The dynamic streaming of time derives from the A- and B-series moving relative to each other. The image of a boat floating downstream past the (fixed) objects on the river bank comes to mind.

The distinction between these two series stopped being innocuous, however, when McTaggart went on to demonstrate that attempts to combine the two into one coherent image (such as that of the boat on the river) invariably leads to a paradox: to assume that the two series are in relative temporal motion requires a third series, and this introduces an infinite regress. From this he concluded that time is unreal. Since that day philosophers have relentlessly tried to dissolve McTaggart's paradox, either by accepting McTaggart's conclusion, or by postulating the reality of time. The latter solution is usually achieved by eliminating one of the two series altogether.[3] This is not the place to discuss the issue in more detail, but so much is clear: it all hinges on the difficulty of deriving a dynamic, continuous, and integrated flow of experiences from a static series of events. This difficulty is at the heart of *The Origin of the Idea of Time*. Ricoeur (this volume, pp. 149–159) shows that it is also at the heart of Kant's *Critique of Pure Reason*. But the problem is of all times: it goes back all the way to Zeno of Elea (Grünbaum, 1968) and it is presently with us in the so-called 'frame problem' of Artificial Intelligence (McCarthy & Hayes, 1969; see also Shoham, 1987).

Guyau's approach differs considerably from that of Bergson and so do his conclusions. Perhaps we cannot really construct the stream of time from the static inputs we receive through our senses. But rather than being an existential primitive, as Bergson has it, the dynamic aspect of time is an intellectual construction.[4] The question we are facing is whether this makes the streaming of time an illusion. My construal of Guyau's answer is as follows.

In the first place our awareness of time as streaming is functionally adaptive since it allows us to cope more adequately with whatever temporal contingencies

there may be in the external world. Evolution has given us a 'tendency' to develop adaptive strategies or procedures that enable us to organize our experiences. In particular it enables us to transcend the *hic et nunc* of the world of infants and animals.

In the second place the real issue is not the derivation of the notion of the stream of time from the raw materials we obtain from the outside world. Instead our concern is the internal representation of the differences, transitions, and intensities, that we observe. We are dealing with ideas and images, and with their representational properties. The relevant question is therefore if these representations, these ideas and images, are real in the sense that they have the status of independent elements of consciousness.

Phrased in this manner we recognize the basic tenet of the psychology of consciousness as it was developed by Wundt and his school. But Guyau does not follow Wundt's lead either. Rather than explicitly assuming that ideas and images are in fact the real elements of consciousness, he claims instead that the processes, procedures, or strategies that generate our ideas and images are the ultimate basis of our experience, and of our experience of time in particular. This does not necessarily imply, however, that these processes, etc., do have a one-to-one correspondence with the elementary units of our functional architecture. Blind, indifferent evolution is sufficient for the organism to functionally adapt to the contingencies of its environment. Cognitive procedures are acquired, they remain plastic, and they have no necessary *a priori* form. In fact, a purely mechanistic or externalistic approach to the problem of making time stream is bound to fail because it cannot cope with the clearly intentional character of temporal experience.

In his review Bergson (1891) correctly points out that Guyau's position represents a radical instrumentalistic conception of cognitive adaptation. But it also represents, in my opinion, what Guyau claimed in his moral philosophy. His fundamental rule of human conduct, *You must because you can*! – literally the inverse of Kant's categorical imperative – implies that moral obligation is ultimately an arbitrary, but functionally adaptive (*i.e.* culturally acceptable) *interpretation* or '*reading*' of a dynamic internal force. Guyau's term is indeed 'blind indifference' (p. 24) But this immediately raises the question: what are the biological and psychological processes that cause the emergence of what we recognize as moral obligations? It is fascinating that this radical reversal of Kant's position, which Guyau established entirely within the framework of his moral philosophy, worked so eminently well the first (and only) time he applied it to a psychological topic.

Guyau's arguments are very similar to some current issues about the meta-theoretical foundations of cognitive psychology. However, the argument presently takes a somewhat more general form: there are non-intentional, syntactic states (states that in Thomas Nagel's (1974) phrasing 'it isn't like anything to be in')

and the question is how we can get from these states to intentional, semantic states.

One well-known version of the problem is Searle's Chinese Room metaphor (Searle, 1984, pp. 31–38). Searle argues that someone who does not know the Chinese language may still be able to produce correct Chinese messages if supplied with all the rules of Chinese syntax. Can such a person be said to 'really' understand Chinese? Searle's own answer to this question is negative: from a formal syntactic description of a language one can never infer the meaning of that language. But *this* is not the only conceivable answer, and it is certainly not favored by mainstream cognitive psychologists because it would eliminate the possibility of explaining the intentionality of behavior in terms of underlying processes and turn the cognitive program into an utterly useless exercise.

There are presently two popular inroads to the problem of intentionality. One is represented by the work of Fodor (1975, 1981, 1987), the other by Dennett (1978, 1987).

Fodor's approach is to accept the reality of intentional states, say, beliefs or propositional attitudes. They constitute the language of thought and have a neurological basis. On this view human beings are semantic engines and the intentional character of their behavior is caused by the fact that the elementary constituents, the propositional attitudes, have a real genetic and neurological basis. Dennett rejects Fodor's position outright. For him propositional attitudes are not real. Humans are only syntactic engines and the semantic units into which we decompose their behavior need not at all correspond with the syntax that constrains the processes that generate this behavior. On Dennett's view the question whether or not a cognitive system *really* understands Chinese, or *really* feels pain, etc., is meaningless, as long as the *assumption* that it really understands, feels, etc., allows us to correctly predict the system's behavior. In other words, it is enough if we know something about the system's goals and if we assume that it will behave rationally in the prevailing circumstances. This 'intentional stance' – the systematic attribution of intentionality, intelligence, or rationality to a behaving system – is purely instrumentalistic (Dennett, 1987). In practical terms, the intentional stance allows us to deal effectively with *creepy* neighbors, a *disdainful* cat, or an *aggressive* chess computer, even if we know nothing about the cognitive processes that *really* underlie the behavior of these entities.

To put Guyau against this meta-theoretical background requires, of course, considerable caution. To claim that *The Origin of the Idea of Time* was written from a thoroughly cognitive perspective is not to claim that Guyau as a philosopher would have endorsed either of the two modern positions on intentionality. But of the two perspectives, Dennett's instrumentalism appears to be much closer to the view of the author of *The Origin of the Idea of Time* than Fodor's realism that might, perhaps, have appealed to Bergson. For Guyau, after all, time is just 'the abstract formula for describing change in the universe.' (*OIT* p. [119]).

The Origin of the Idea of Time *in cognitive perspective*

In what respects is the content of *The Origin of the Idea of Time* compatible with contemporary cognitive accounts of temporal experience, and of dynamic memory as the 'orchestrator' of that experience? To answer this question I shall first summarize Guyau's arguments in terms that are consistent with such accounts.[5]

The temporal organization of experience

Why do we need a conceptual structure, an idea of time, if ultimately we experience everything as occurring *now*? And how do we attain such an idea? So much is clear from the outset: the idea of time is not present at birth. Children, like animals, live in the present and only gradually acquire cognitive strategies, procedures that allow them to represent the relations between experienced events as past, present, or future. This developmental process is greatly facilitated by what we call public time, the elaborate system of natural and artificial cues – including those provided by language – that society uses to cope with the dynamic contingencies of everyday life.

Without cognitive strategies to represent time we are unable to organize our experiences and expectations. Therefore, to acquire the notion of time is an important functional adaptation to the world in which we live, an adaptation which is the result of a long process of evolution. The fact that young children do not yet possess such temporal strategies does not imply that the world of the child is chaos. It only means that the young child can experience events as occurring right now and right here: the infant has no way of remembering and it has no way of expecting.

The static aspect of the notion of time

The necessary conditions for the development of temporal strategies are differentiation and awareness of intentional, goal-directed effort. In the first place an organism requires sensory systems (transducers) that detect differences and produce representations of distinct events (mental symbols). In the second place an organism must be capable of perceiving its intentional effort, that is, the tension between its present state and a goal state.

An implication of these two conditions is that representations of events must take the form of spatial imagery. Hence space must precede time – logically and psychologically – as a representational medium. In addition something else is required to enable the transition from spatial to temporal representation. The extra requirement is *movement* as the application of intentional effort to bridge a spatial difference: 'No movement, no time!'

Dynamic memory

Human memory is a dynamic, temporal organization of our representations of (past) events. Presently not much is known about the functional architecture of memory. Brain research should uncover the mechanisms that encode, store, and reproduce memory traces. Fortunately, the lack of an appropriate neuro-scientific model is not terribly relevant after all, because the question is not in the first place how memory functions are implemented

in the brain, but rather what functional properties there are to create the impression that we are indeed dealing with a 'conscious phonograph.'

Schematic episodes. Since time is an acquired organization of representations that enables us to store and remember past events, the functions that realize this organization nearly always establish coherent episodes that are situated in concrete, spatially defined contexts. Most of these contexts are culturally inspired. They are passed on from generation to generation. The representations of events and episodes have a schematic or prototypical character. They possess more or less salient features that influence the ease with which they are manipulated.

Match and mismatch. The way in which these schemata are functioning depends on the principles of similarity and uniqueness. We understand something to the extent that it matches some fact we already know, but we learn and remember something to the extent that it differs from this fact.

Spatial analogy. The representation of time is mediated by our representation of space and thus by the processes that operate on spatial relations. This influence is not an arbitrary one. After all, both spatial and temporal representations derive from intentional effort, from the juxtaposition of 'what is and what is to be.' The issue is to find out how we ever get to an independent representation of time as the dimension past-present-future. There are at least two crucial features to establish a distinction between spatial and temporal representations. The first is the inherent asymmetry of temporal juxtaposition (order) as opposed to the symmetry of spatial juxtaposition (placement). The second, related feature is that while spatial representations admit travel back and forth, our traveling in mental time may well bring us back to a point in the past, but from there on our recollection of an event or episode is always asymmetrically oriented 'forward' towards the present.

'*Chunking.*' Reference points – temporal landmarks – help to simplify the organization of memory. As a rule they are salient experiences that are called to mind more frequently and easily than other events. By virtue of this increased likelihood of recall, their traces gradually become even stronger, increasing this likelihood still further. More importantly, however, they enable us to 'proceduralize' or 'compile' our search rules. Thus the frequent use of a search path creates new, more compact, temporal representations, so that ultimately only the first and last elements of a chain of retrieval operations are retained and all intermediate steps will be eliminated.

Closure. Representations of events and episodes remain plastic. Memories evolve slowly but constantly. They are embellished or deformed until they finally stabilize in ways that may bear little resemblance to their initial form. This is an esthetic process that answers the cognitive need for narrative closure. Memory must remain coherent and consistent with our present 'acting undergoing' if it is to be *someone's* memory, that is, the manifestation of a Self.

Temporal information processing

The inputs to which the cognitive procedures that shape our notion of time are responsive may vary in a number of ways. The characteristics of what we may call

temporal information influence our perception and retention of duration. We may summarize these characteristics in the following way:

(a) *metric* aspects, the number and stochastic properties of event ensembles;

(b) *syntactic* aspects, that is, the structural relations between events that specify the form or rhythm of event sequences;

(c) *semantic* and *pragmatic* aspects, specifying the cognitive, emotional, and evaluative context in which the events take place.[6]

Every one of these aspects will influence the experience of duration, our awareness of time-in-passing. In addition time estimates are based on the effort that is required to generate an adequate, episodically coherent, representation. When in early childhood or old age, or as a result of organic or mental disorders, the regular strategies for processing this temporal information are not yet or no longer available, certain characteristic distortions or illusions of time experience will occur.

THE SEVEN PILLARS OF TIME PSYCHOLOGY

Now, with this resumé of *The Origin of the Idea of Time* in hand, let us compare the position of the cognitive psychologist Guyau with some current views about what it requires to formulate a coherent theory of our notions of time. As I suggested before, there is no received view from which we can draw an undisputed set of criteria for such a comparison. There is, however, enough common territory among the prevailing views on psychological time to propose at least the following set of basic requirements.

(a) A psychological theory of time experience should specify a *functional stimulus* for our 'sense of time'. In other words, a theory should tell us what external stimuli serve as the building bricks from which the human mind builds the rich phenomenology of time experience.

(b) A second requirement is that the *levels of explanation* used in the theory be specified. Cognitive psychology apparently requires a hierarchy of explanatory levels and seems to distinguish at least three of these to deal with the system's functional architecture, its functional design, and its rational behavior and intentions, respectively.

(c) Even if we adopt the functionalistic (instrumentalistic) view that time is largely a conscious product of the computational processes by which people organize their experience, we have to admit that not all temporal relations in human behavior appear to be explicit and accessible to conscious manipulation. The distinction between *explicit and implicit temporality* of human action is a fundamental one, and it must have its place in any acceptable theory.

(d) The explicit mental representation of time can take different forms. A basic feature of a theory of psychological time is what it has to say about various *modes of representation* and about the rules of operating upon these modes.

(e) A special point is the role of space, or perhaps rather the role of the spatial

analogy or *metaphor*, for the representation of time. Not only does the ubiquity of visual imagery suggest that space constitutes an independent medium for mental representation, space is also ubiquitous in language and specifically in the semantics of time.

(f) It is evident that time as an organization of events relative to their being past, present, or future entertains a very close relation to our concept of memory. Time is intrinsically connected with *dynamic memory*, that is, with the memory for concrete episodic events, localized in space, that together constitute a meaningful narrative, including the personal history that we recognize as our Self or Ego.

(g) Last but not least a theory should specify the *ontogenesis of time*, and describe how the cognitive mechanisms that produce our experience of time develop in the course of our life.

These then are the seven pillars of wisdom that, in my view, ought to support any theory of time experience that can come forth as science. A closer examination of each of these basic criteria should bring out more clearly the qualities and contemporary significance of Guyau's theory as a *cognitive* theory of time.

Functional stimuli: the building bricks of time

Psychologists, like most other scientists, conventionally entertain the convenient working hypothesis that the world around us is real, and to a first approximation roughly resembles the way we perceive it. If reality were totally different from experience, the argument runs, the computational effort to cope with the contingencies of the environment would become infinite, and the human species would certainly not have evolved.[7] Apparently our mental models of the world work so well because they are functionally adapted to the contingencies of the real world.

Given that humans live in a world of change, the question is what processes are there to help us represent change and how from these processes a conscious experience of time may eventually proceed. We have already seen that, physically speaking, the raw materials of which our experience of time is fashioned seem to be quite impoverished: succession and order (the *arrow of time*) may be the only attributes that can be defined without reference to an observer. The streaming of time is not a property of the physical world. Not for Guyau: 'What remains is to make time flow and stream in consciousness' (*OIT* p. [26]), and not for contemporary scientists for whom the flow of time is an addition 'to the world as we perceive it in absence of specific physical stimuli that could possibly generate [this flow].' (Davies 1981, p. 63).[8]

But the psychologically inspired view that moves us here, and that is shared by Guyau, is that building bricks as such are not the only thing that should concern us. They are necessary but not sufficient conditions for our experience of time. Building bricks would have little significance if there were no means of

observing or using them. This point was emphasized by phenomenological psychologists like Brentano, Husserl, and Merleau-Ponty in particular (see Brockelman, 1985). They have pointed out that the order of events, psychologically and neuro-physiologically speaking, is represented simply because an earlier event will necessarily constitute a context for the later event.

This fact has figured implicitly in a good deal of psychophysical research, in studies on forward and backward masking in perception, as well as in studies on proactive and retroactive interference in memory (detailed up-to-date reviews of this research can be found in various chapters in Boff *et al.* 1986). This research has given us a detailed insight in the mechanisms that determine the apparent order of events. Depending on the circumstances – the differences, transitions, and intensities, of which Guyau speaks – we perceive events in their proper physical order (or not), they may appear simultaneous (when they are perhaps not), and so forth. But always the perceptual judgment about two successive events will ultimately be in terms of the presence of a later impression in a context which contains the earlier impression. Perhaps the most dramatic and incisive perceptual phenomenon studied in this context is the so-called *apparent movement*. Used as the principle of cinematography and stroboscopy, studied extensively by gestalt psychologists, and still a prominent theoretical issue (Kolers, 1972; Anstis, 1986; Hochberg 1986) it seems the perfect exemple of a sequence of static events becoming a temporal stream. Conventionally research on apparent movement puts the locus of flowing time in the functional architecture, in the structure of the nervous system.

The question about the nature of the building bricks of time has not been restricted to the domain of perception only. The acquisition and recall of sequences of unrelated events – say, a list of words or random digits – is very difficult; so difficult in fact, that someone who has no other cues to rely on (such as causal or logical precedence, or categorical grouping) will hardly be able to remember the order of presentation of the items, although he or she may be perfectly capable of reproducing the items in a free recall test (Crowder, 1976; Tzeng *et al.*, 1979; Michon & Jackson, 1984; Jackson, 1986). This observation underscores Guyau's claim that in the absence of strategies for the establishment of contextual associations no temporal representation is established. Memory contents would appear to move freely along the time-line, their position being determined only by the the attention being paid to them:

> The distinction of past and present is so relative that when we pay close attention to a distant image in our memory, it soon begins to move closer and to appear more recent: it takes its place in the present. (*OIT* p. [44]).

Levels of explanation

There are several levels of discourse at which psychological explanation

normally seems to proceed, but these levels are frequently confused. The consequences may be disastrous. Mixing levels is likely to introduce pernicious homunculi and vicious circles in our theories. Several authors, among them Dennett (1978, 1987), Herrmann (1981), Newell (1982), Michon (1984) have identified the various dangers that the theorist who wishes to establish a cognitive theory is facing.

In the context of time psychology I have distinguished three levels of discourse: (a) an underlying architecture of clocks and regulators (or 'switches'); (b) time as the product of temporal information processing; (c) time as the product of a dynamic (and potentially selforganizing) structure (Michon, 1985). In a sense these three levels are independent: although every temporal behavior is ultimately constrained by the available psychobiological clocks, there is no need to assume that the conceptual units in which we describe temporal behavior at the higher levels must correspond with units at the lower clock-and-regulator level. Different combinations of clock mechanisms may generate identical behavior in different individuals, or even in the same person at different times.

One should recognize that there is a resemblance between these three levels and the levels of explanation that have recently been proposed by Dennett (1978, 1987), Newell (1982), Marr (1982), and Pylyshyn (1983) in particular. The clock-and-regulator level coincides to all practical extents and purposes with physical or architectural levels identified by these authors. Considering time as information is inherently the same thing as viewing it from the point of view of design, function, or syntax. Finally the third, dynamic level of time-in-context bears all the marks of being an intentional, or semantic level of discourse.

The functional architecture of human time

Humans (and animals) have an almost unlimited number of timing mechanisms at their disposal (Moore-Ede *et al.* 1982; Richelle & Lejeune 1980). The ability to resonate or tune to exogenous regularities is one of of the fundamental characteristics of living organisms, anchored deeply in their genetic endowment. Almost any physical or mental function can be recruited to assist in this tuning. The importance of the ability to pick up order in the environment should be evident: any organism that does not possess such a disposition would be fundamentally maladaptive and consequently stand little chance of survival.

However, the tremendous flexibility of our clock architecture makes it a rather opportunistic system from the point of view of the cognitive psychologist. Richelle and Lejeune (1980, p. 165) conclude at the end of a comprehensive analysis of the available literature, that:

> Multiple time bases are continuously constructed in response to the particular requirements of each situation and replaced by others when they become useless.

Apparently then, there are no systematic rules that can unambiguously explain why one internal clock is, or should be, preferred over another. In other words, as a theory about human time experience this level of explanation does not impose enough constraints on the situation. The limitation of the clock-and-regulator level of discourse is that it underdetermines the processes that are required to account for a whole range of behaviorally and cognitively meaningful distinctions. In other words, clocks can only keep time, but psychologically there appears to be more to time than just the keeping of it.

Guyau may or may not have given some thought to this problem. He was undoubtedly interested in facts about the material brain, but in his days biological rhythms were known only in plants and lower animals. The tremendous impact that internal clocks have on human behavior was to be discovered only later. *The Origin of the Idea of Time* remains essentially silent with respect to clocks and regulators.

Guyau refers to the level of functional architecture only in a deliberately *metaphorical* sense (*OIT* p. [49]). He uses his phonograph metaphor only as a means to emphasize that the idea of time, *qua* organization of memory, must necessarily have a physical basis. But rather than concluding that Guyau really believed that the mind is in some ways like a squeaking phonograph, we should remain aware of the fact that the use of metaphors seems to be a predicament of functionalistically inclined theorists. In their desire to describe and explain the complex functional relations of the mind they have usually no other option than to describe a physical architecture, *any* physical architecture, that seems to be able to carry at least part of the weight of the functionalistic description. This implies that the theorist, in order to explain complex mental processes in *functional* terms, is likely to choose whatever is the most intricate information processing structure that happens to be available. For Guyau this was apparently the phonograph, invented in 1877, just three years prior to his article in *Revue philosophique* (Guyau, 1880).

Time as Information Processing

A different frame of reference is indeed needed if we wish to describe how different temporal contingencies (sequential patterns of events) elicit coping responses or strategies, irrespective of the way the organism can neurophysiologically encode or store these patterns. The question now becomes what functional relations about order and change in the world are encoded, stored, retained, retrieved and used. In short, the question is how the rich 'phenomenology' of our experience of time is constructed from the rather simple temporal information the world actually seems to offer us. When the information processing approach was first adopted in time psychology several attempts were made to account for the variations in subjective duration. Michon (1964), for instance, suggested that

information transmission rate (complexity per time unit) in the organism would be the functional stimulus. Ornstein (1969) proposed memory capacity required for storing the information contained in an interval. Block initially proposed as the functional stimulus the effort required in the encoding and retrieval of information (Block, 1972), but later moved to what since has been called 'contextual change' (Block & Reed, 1978). Support for each of these views has been weak to moderate, and in sum there seems to be no advantage gained over Guyau's famous list of influencing factors (*OIT* p. [85–86]) or his conclusion that

> Estimation of past duration depends on the apparent duration of the process of reconstruction itself, that is, on the effort spent in recalling various events. (*OIT* p. [91]).

Since then further serious attempts have been made to distinguish temporal information (about order, date, and duration of events) from non-temporal information (such as phonological or syntactic information in speech) and to specify the various ways in which the two interact (see several chapters in Michon & Jackson, 1985b).

Time as dynamic conceptual structure

Presently it is becoming more widely accepted that interactions between temporal and non-temporal information are in fact the body and substance of time experience. Temporal information cannot be separated in a meaningful way from the structure of events as such. Events (meaningful transitions from one definite state of the world to the next) and episodes (meaningful series of events) carry an intrinsic temporal structure. This structure imposes constraints on the possible representations of time. Meaningless sequences of stimuli – such as they regularly occur in the psychological laboratory, but hardly anywhere else in the known universe – do not qualify as events or episodes, and consequently they are unable to impose constraints on the ways people will represent time. If a series of events has no inherent structure that can be comprehended by the observer, and moreover, if the observer does not succeed in imposing some invented regularity on the input, no temporal representation of that series of events will ensue. This insight lies at the root of Guyau's discussion of the primordial confusion in the minds of animals and infants, as well as of his emphasis on the acquisition of cognitive procedures to anchor experiences with respect to their context. Guyau also emphasizes the active nature of these procedures. Indeed, to the extent that some invented, perhaps arbitrary or socially induced, regularity can be made to fit the input events, a temporal representation of sorts is established and the temporal information can accordingly be encoded and retained. Jackson (1986) has described several elementary strategies of coping with event sequences that have little or no intrinsic temporal structure (see also Michon & Jackson, 1984).

Implicit temporality vs. reflective time

Much of our behavior (and certainly most of the behavior of animals) is not based on an explicit representation of time. Phenomenological psychology in particular has emphasized the dual nature of time in human behavior, as it finds its expression in *action* and *reflection*, respectively. Recently Brockelman (1985) has given a very concise account of the phenomenological analysis of time experience which highlights this distinction.

The first temporal mode, on this view, is the direct, implicit tuning of our actions to the dynamics of the surrounding world. Concrete, adaptive, goal-directed behavior determines a so-called action field (also known as the *Now* or, with a German term, the *Präsenzfeld*). In this field retentions of earlier experiences and anticipations about the future are implied in a manner similar to the way a specific chess position may reveal much about the earlier stages of the game and its possible continuation, despite the fact that none of this is explicitly represented on the board (and even if one has not followed the game developing). The implicit temporal structure or *temporality* of behavior, that is, the dynamic tuning to the objects and events that the behavior is *about* (the so-called intentional objects), is cognitively inaccessible or impenetrable. Actions will therefore *express* temporal relations but do not explicitly represent them. Actions lack, in other words, duration, order, date, etc. Yet one should not consider this a form of 'unconscious' processing as Hasher & Zacks (1979) proposed several years ago. Jackson (1986) has definitively shown this assumption to be incorrect.

Altogether the action level is difficult to grasp. There are many references to the vague awareness that seems to qualify it. Lawrence (1986) for instance spoke of 'the hum in the basement,' and Haldane (forthcoming, p. 25) in similar terms refers to it as 'a faraway, steady, mellow beat to which I am keeping time.'

However it seems that over the last few years progress has been made in the experimental analysis of what Schacter (1987) calls implicit memory. It is a form of memory which expresses itself in and through our knowledge or performance but cannot be represented in propositional (verbal) terms. That description has a considerable likeness with modern theories about associative memory and remembering. The subtleties that are involved in finding out to what extent the investigator is indeed dealing with the organization of memory and to what extent the methodology interferes, have been the subject of a very detailed analysis by Richardson-Klavehn & Bjork (1988).

In particular it is gradually being established that duration is not an explicit control parameter of behavior. This means that variations in the (required) duration of certain perceptual-motor activities play no systematic role in the quality (and the duration!) of the performance of these activities. One relevant example, for instance, is contained in the work of Thomassen and Teulings on handwriting. It is possible to influence people's handwriting by manipulating

various parameters of the finger/hand/arm system. The fine and consistent timing required for writing is 'a consequence of smooth functioning of the physiological and biomechanical systems involved in the process'. (Thomassen & Teulings, 1985; pp. 261/2; Teulings, 1988). Influencing force, mass and trajectory does indeed affect smooth writing. Directly influencing the duration of writing movements, on the other hand, has no systematic effect. The same is true of other types of skilled behavior, *e.g.* musical performance (*e.g.* Shaffer, 1985).

In contrast, time viewed as past, future, order, or duration, is the conceptual structure by means of which humans express their awareness of temporal relations between events, their reflection on their actions. Reflection entwines the action that is the object of reflection into the intentional object with the, initially implicit, Now in which that action is taking place. The action thereby becomes an explicit temporal object, an event that lasts so and so long, and that can be placed at such and such a position in an explicit temporal dimension of past-present-future. Past experiences are localized at a point in the remembered past, expectancies are projected as event that are still to happen in a future that gradually comes closer and closer. Conscious reflection being cognitively penetrable, it enables the organism to plan its actions and to adaptively tune to the prevailing circumstances in the world (Brockelman, 1985).

Representations of time

The transition from the implicit, non-reflective awareness of temporality to an explicit representation of time and of events-in-time is functionally significant. It occurs when the human organism has no appropriate *automatic* tuning procedures at its disposal to cope with the situation in which it finds itself (Michon, forthcoming b). In other words, there will be a shift from automatic information processing towards the reflective mode whenever the organism finds itself in an impasse. Of course, another good reason for the development of the reflective mode is that the intentional (goal-directed) character of the communication between humans frequently refers to events in past or future.

The encoding of temporal information may take three forms: literal or episodic, figurative or analogical and formal or abstract (Michon, forthcoming b). At the first, literal level concrete episodes (Tulving, 1983) and generalized episodes or scripts (Schank & Abelson, 1977) are used to support our awareness of the temporal organization of what is happening. Failing appropriate episodes or scripts we may turn to the figurative level at which we use strategies for finding and using analogies or metaphors (Lakoff & Johnson, 1980; Carbonell, 1982) for the same purpose. In some cases we can rely on formal representations that in an effort of decades or centuries have achieved the status of scientific theories, sometimes to such an extent that we accept them as 'true' representations of the real world. Thus, for instance, we now tend to dress the universe in spacetime

garments designed by Albert Einstein and tailored by the mathematician Herman Minkowski (*e.g.* Smart, 1964; Sklar, 1974).

Rather than being independent, structurally incompatible forms of representation, these three categories seem to be arranged along a continuum with rather smooth and indistinct transitions between the forms, especially between the figurative and formal representations. What ultimately unites the three forms of representation, however, seem to be the following important issues: (1) the structure and function of dynamic memory, including our memory for personal experiences; and (2) the conspicuous role of (visual) space as a medium or analogy for the representation of time.

Literal or episodic representations

In the course of their development humans build a repertoire of temporal standards. We attribute prototypical or 'natural' temporal relations to events. Deviations from the standard are quickly noticed and may be remembered quite explicitly and in great detail. In recent years a considerable body of empirical evidence has been obtained which confirms the idea that humans are quick in picking up a repertoire of elementary temporal structures, and equally quick in using these elements to build an explicit representation of what is going on. The evidence mostly derives from three research paradigms: scripts or scenarios (Schank & Abelson, 1977), qualitative or 'naive physics' (Hayes, 1978), and the perception of structural information in serial patterns (Jones, 1985; Jones & Boltz, forthcoming). In each case the underlying thought is that the human organism must be able to encode the tremendous mass of incoming information without running the risk of a computational explosion. It must therefore have a general disposition to distinguish in any structured domain it has to cope with, a small number of between, say, 30 and 100 elementary units that constitute the 'alphabet' on which to base its syntactic computations. Jackendoff (1987) has recently made a powerful argument for this position on the basis of recent research in such diverse areas as speech, vision, and music.

Consider, for instance a person listening to a musical composition. If there really is a tune, the listener will be able to adapt to it and to generate expectations about the way it will continue. If the melody runs off according to expectation, its time span will seem to be normal. If, on the other hand, the composer (or more likely the psychomusicologist in her laboratory) interferes with the temporal structure as expected, the melody may seem to end sooner than expected, or later than expected as the case may be. The well known experience of time passing too slowly or too quickly is on this account caused, not so much by the number and complexity of events, but by these events experienced in their proper cognitive context (Jones & Boltz, forthcoming).

Only if there is no intrinsic structure will special strategies be called in an

attempt to make sense of the situation. But if no inherent structure can be extracted from the ongoing situation at all, no time experience will follow: time may then pass unnoticed.

This view has much wider ramifications in cognitive psychology than one realizes from the point of view of the experience of duration in the limited sense of the word. Recent work, *e.g.* by DiSessa (1983), Shepard (1984), or Freyd (1987), has made a plausible case for the existence of elementary physical schemata in which generally valid facts about the physical world are represented.

Schank's work on dynamic memory (1982) and on patterns of explanation (1986) is relevant for this approach. In this framework coping with reality is seen as a matter of schema instantiation: whenever people have to understand or explain a state of affairs, they will always attempt to call to mind a concrete example of that state of affairs. People are – to use Schank's phrase – constantly reminded of something. If the situation does not quite fit, some tweaking will be necessary. Tweaking introduces a (minor) modification of the schema so as to retain its functional resemblance with the prevailing situation.

Guyau's arguments rest on this same fundamental point and he thus anticipated, in a remarkably explicit way, the dynamic view of information processing as it is now defended by the authors mentioned above.

The development of the dynamic idea of time is, according to Guyau, guided by a natural logic. Not everything is possible, and although we are capable of forming quite different and personal strategies, the results emerging from these 'natural' processing strategies must ultimately result in more or less uniform concepts:

> There is a certain logic in life and it is this logic which makes it possible for memory to exist. Wherever the illogical and the unpredictable reign supreme, memory will lose its hold. Life absolutely devoid of logic would resemble those ghastly stage *dramas* in which the various events are totally unrelated and from which one extracts only fuzzy images that blend into each other. (*OIT* p. [36–37]).

Figurative representation of time

Reasoning by analogy is ubiquitous in human thinking. It is perhaps the universal way of thinking, because one could well maintain that even the literal 'reminding and tweaking' proposed by Schank (1986) is not literally literal. At this point, however, I restrict the idea of figurative or analogical representation of time to situations where we do not have an adequate, concrete representation, a *simile*, to match the situation at hand. In such a case we are forced to widen our criteria of being reminded until we find a suitable analogy that we may then 'tweak'. The search for such an analogy (or its verbal expression, a metaphor) takes place through a gradually deepening search process (Carbonell, 1982). The difference with a literal representation is that only a few important characteristics,

such as the goal structure and the functional relations of the source domain need to be be applicable to the situation at hand, the so-called target domain. For instance, the metaphor 'time is war' requires that the goal of war – conquering territory (or defending it, as the case may be) and defeating the enemy – can be given a meaning in the context of the temporal domain. If we cannot imagine what it means, for instance, to conquer time or to gain the upper hand in our fight against the past, the analogy is useless and the metaphor will not work. But apparently we do give an interpretation to 'time is war.' That is at least what a recent book under the title *Time Wars* suggests (Rifkin 1987). At the same time it is unnecessary that all the structural features and physical properties of war do integrally apply to time. The organization of the war machine with its officers and soldiers, its guns and its hospitals and cemeteries need not have a counterpart in the domain of time. Years, months, days and seconds do not seem to be organized in quite the same way as an army. Similarly the fact that tanks are made of steel is irrelevant to whatever role it is that the functional counterpart of a tank plays in our time wars.

Thus the criterion of acceptability of an analogy or metaphor may differ from one application to the other, but when it is finally accepted, an attempt will be made at an 'extended reading' in order to find the limits of the match over the full extent of the target domain (Carbonell, 1982).

Although at first sight the number of metaphors would seem to be almost unlimited, reality has been quite constrained in this respect. Lakoff and Johnson (1980) strongly argue in favor of a limited number of core metaphors or analogies, conceptual structures that cover the majority of all metaphors. They suggest there may be only some fifty 'core metaphors' which they then condense into no more then three generic metaphors: ontological categories, which include such metaphors as 'time is money' (*i.e.* time as a valuable substance), personification (*e.g.* time as a killer, or time as the healer of all wounds). The third and most pervasive is the spatial metaphor (*e.g.* we are moving towards the future, leaving the past behind us).

The universal character of the spatial core metaphor has received considerable attention in the scientific literature. First there is the attention paid to it by linguists. Clark (1973), for instance, assumes that there is a special cognitive system for dealing with spatio-temporal relations (or rather a special spatial system on which temporal relations are parasitic). A similar, but better formalized position was adopted by Gruber, whose 'thematic relation hypothesis' holds that human language has a set of very precise substitution rules that enable us to map temporal (and some other) attributes and relations onto the spatial domain (see Jackendoff, 1983, pp. 188–193).

The strong impact of the spatial domain has also been emphasized in the study of the role of 'Anschaulichkeit', visualization or imagability in scientific discovery. It is difficult to overestimate the importance of visualization. To compare the

atom with the solar system was incorrect, and Niels Bohr knew that it was incorrect, but this 'image' has had a tremendous impact on the development of atomic physics, simply because of its visualizability. (See further, among others, Miller (1986); Holland *et al.* (1986); Langley *et al.* 1986).

Formal theories

I will deal only very briefly with the third class of conceptual structures that people can use to deal with time: the formal theories. Some analogies (or metaphors) are so successful that they become the vehicles for scientific thought. In the case of time it is not different. The first such analogy to be elevated to the status of scientific formalism was the mechanical clock, born from ancient attempts to represent or simulate the heavens. When Newton formulated his mechanics the clockwork universe became a fact, and in that universe absolute time, which 'flowed equably in and of itself', was the first formal framework for the description of temporal relations. Around the turn of the last century the revolution that would lead to the dethronement of classical mechanics, to be replaced by the theory of relativity, was already in full swing. Einstein, Minkowski and Weyl, in particular, transformed the old idea of time as a totally independent, but not terribly interesting, attribute of reality, to the modern concept of integrated spacetime: time as a somewhat peculiar fourth dimension of space, actually connected to space by the invariance of the speed of light (Sklar, 1974; Park, 1980).

The formalization of time does not stop with physics, however. Logicians and linguists have successfully tackled the problem of time and as a result temporal logic and a semantics of time have emerged, so that a number of very difficult problems of dynamic systems theory have come within reach. (Van Benthem, 1982; Rosen, 1985; Georgeff & Lansky, 1987).

The formalization of our ordinary representations of time has progressed to the extent that we use geometry and measurement theory to express temporal relations in terms of abstract scales. Guyau was aware of this when he wrote 'time will only emerge when events can be positioned in linear fashion along a single dimension, length' (*OIT* p. [8]), but he could, of course, not anticipate later developments in measurement theory and psychophysics, which would eventually lead to the distinction of various types of one-dimensional scales, the nominal, ordinal, interval, ration and absolute scales (Narens, 1981). The role of these scale types as 'formal mental theories' of time has been outlined by Michon (1985, 1986) in an attempt to account for the hierarchy of levels of temporality proposed by Fraser (1982).

The role of space

What modes of representation do we have for the encoding, storage and recall of information? Most contemporary authors (but not all, see *e.g.* Pylyshyn, 1984) will agree that there is at least an abstract, propositional medium for the representation of knowledge and, very likely, also a concrete spatial one (Shepard & Cooper (1982), Kosslyn (1983), Johnson-Laird (1983). A few authors, moreover, claim that there is some evidence for a special independent conceptual structure for temporal information. Thus Anderson (1983) postulated a special mode for temporal strings, in addition to the conventional propositional and spatial modes. A temporal string representation would be especially useful for representing information that is crucially dependent on order.

To appreciate the merit of a string representation consider repairing a vacuum cleaner. Instead of remembering how to dismantle it by propositionally representing the functional relations between various parts, or the spatial relations between them, one will do better by representing the order in which each part is removed. But such an example casts immediate doubt on Anderson's proposal: doesn't one after all represent this temporal order in a spatial medium? Wouldn't one, for instance, put the loose parts on the work bench in the order one took them from the vacuum cleaner?[9] How could we possibly remember the order if not by using a spatial, or a functional analogy of that order? This and other, similar examples from the literature on the art of memory (Yates, 1966; Luria, 1968) should warn us that the temporal mode may not be nearly as independent as Anderson claimed.[10]

Though there are numerous arguments against a visual correlate of spatial representations (Pylyshyn, 1984), the privileged character of spatial relations – even if they would be encoded propositionally rather than quasi-visually – seems beyond doubt. One picture is worth more than ten thousand words, and we even know why (see Larkin & Simon, 1987).

Even a full century after Guyau made his claims about the precedence of space as the medium in which the idea of time evolves, it is still less than transparent whether the prominence of space as a medium for representing temporal relations should indeed imply priority for spatial extension – by means of effort and movement – in the development of temporal representations. There is no clear empirical evidence (as is pointed out by Friedman on p. 207 of this volume, for instance), and it could therefore well be that the two, the idea of space and the idea of time, develop more or less simultaneously. Logical precedence would, in fact, work just as well as ontogenetic precedence to explain the dominance of space over other representational media.[11] Although he is not particularly clear on this issue, Guyau may have been leaning towards this position; this is at least what he suggests when he argues that by 'desiring, and acting toward our desires we simultaneously create space and time' (*OIT* p. [46]). *Simultaneously*!

Dynamic memory

Perhaps Guyau's idea of memory is the most advanced of the several aspects of his theory of mental time. In his eyes memory is simply a way of effectively and efficiently using the strategies by which we organize our knowledge representations: 'memory is nothing but the art of evoking and organizing these representations.' (*OIT* p. [117]). That is as dynamic a conception of memory as one can possibly conceive. The significance of this conception is underscored by the fact that Guyau's ideas about memory center around two important concepts: schematic representations, and autobiographical or personal memory. Both topics are currently the focus of considerable attention in memory research.

To underscore the timeliness of Guyau's views on these matters, let me first point out that our outlook on human memory has changed fundamentally in the short period that has elapsed since the inception of cognitive psychology and the introduction of the computer metaphor in the late fifties. Especially in the past twenty years a dramatic shift has occurred. At first the standard view of memory was based on the Von Neumann computer architecture with its rigid, spatially distinct memory units: short-term storage, long-term storage, and various kinds of external memories. The model proposed by Atkinson & Shiffrin (1968) is characteristic for this perspective. Ten years later an entirely different view became popular. A functional view emerged in which one single memory system, rather than a series of spatially distinct components, served various short-term and long-term functions, depending on the way this system was addressed or activated. Characteristic models of these days were Shiffrin and Schneider (1977) who integrated long- and short-term memory, Baddeley and Hitch (1975) who redesigned short-term memory and by adding a couple of functions turned it into a genuine working memory, and Tulving (1972) who introduced the distinction between semantic memory on the one hand and episodic memory on the other. Semantic memory contains generalized factual and in principle timeless knowledge; episodic memory, in contrast, serves our personal history by storing and retaining real life experiences.[12]

The structure and function of episodic memory have become a most active and attractive area in memory research in recent years. Two aspects appear to be of special interest for our discussion. One of these, dynamic memory, has been developed by Schank and his colleagues (Schank & Abelson, 1977; Schank, 1982; 1986), the other did derive from the pioneering work of Linton (1975, 1986) on autobiographical memory. I shall briefly outline the main issues of each, in relation to Guyau's ideas with respect to these two lines of thought.

Even the most cursory reading *The Origin of Time* will reveal a very close resemblance between the views of Guyau and Schank on the structure and function of dynamic memory. Their common point of view can perhaps be

summarized as follows: we understand to the extent that things are identical and we learn something new to the extent they are different. Guyau tells us that

> Resemblance activates the recall of differences. The present image, in as far as it is identical with the past image, regenerates the old context in as far as that context differs from the present one (*OIT* p. [63]).

Schank's paradigm can be expressed in an equally simple and very similar way: understanding is a matter of reminding and tweaking.

> In order to to find an explanation, what is required is to find an applicable old pattern, determine to what extent it differs from the current situation and to begin to adapt it to fit that situation. (Schank, 1986, p. 24).

Schank's theory of dynamic memory rests on the concept of schema instantiation. If we are facing a new situation of a kind with which we are already familiar, then understanding that situation involves the instantiation of a schematic structure with details specific to that particular input. In other words 'people do not feel they understand a description unless they can imagine a concrete example of what is being described.' (Glass & Holyoak, 1985, p. 267).

It is impossible to read *The Origin of the Idea of Time*, and especially the second part of Chapter Four (*OIT* pp. [59–84]), and not be struck by the resemblance between these two theories, developed a century apart. It is almost as if they were meant to be an illustration of the very ideas they are dealing with: Schank's theory reminds us of Guyau's theory with just the barest minimum of tweaking. Thus Guyau:

> What in a portrait reminds us of the original are not the features that evoke the reminiscence, but precisely those that play no role in it. In fact, the true object of memory is the context in which you have met originally, in as far as this context differs from the circumstances under which you meet this time. (*OIT* [62–63]).

And Schank:

> The issue in understanding is indexing. We must be able to abstract the cues from the situation that we are processing and use those cues to access a knowledge structure that we have previously stored away using those cues (Schank, 1986, p. 228)

These are very general views of dynamic memory, but they fit even in great detail. As a matter of fact they fit in more respects than I am able to pursue here.

Two important principles of temporal organization raised by Guyau in Chapter Four are the notion of temporal landmarks and the notion of chunking. Both are processes that help us to simplify memory search.

A temporal landmark is a particularly familiar or vivid experience that helps to quickly access the content of memory. Empirical studies have established the nature and extent of temporal reference systems, but they have hardly contributed

any theoretical insight that is not already contained in the paragraphs Guyau has written on this topic (Underwood, 1977; Brown & Kulik, 1977; Brown *et al.*, 1985; Robinson, 1986). The major findings from this research confirm that the organization of memory is heavily dependent on socially induced reference systems, such as clock, calendars and public events. As a rule there is a considerable interfacing between the public and the personal domain:

> The knowledge one stores concerning a current event may include facts about the event itself (participants, locations, types of actions), facts relating the event to other events (actions that caused the event, actions resulting from the event), and facts about the event's personal context (how and where the event was learned, with whom the event has been discussed). (Brown *et al.*, 1986, p. 156).

The second principle raised by Guyau in this context is that of 'chunking' (Miller, 1956; Laird *et al.*, 1985), the process by which complex search rules are simplified by integrating a fixed sequence of steps in the search process into a single step.

> This process is analogous to habit formation. Intermediate states vanish because they are no longer useful. The series is reduced to two terms, which suffice because their temporal separation is sufficiently established. Without this *abridgment procedure*, without the disappearance of an enormous number of elements, localization in time would be very time consuming, clumsy, and confined to narrow bounds. (*OIT* p. [69]).

Autobiographical memory is for Guyau the effort to make one's personal history into a coherent, well-organized account, a 'narrative' of one's past from the perspective of one's present views and priorities.

> Time, in and of itself, is an an artist idealizing the world. In fact, we remember only the prominent and characteristic aspects of past events... We tend to embellish what has been pleasing to us and to deform what has displeased us, and this tendency, incessantly adding effect upon effect, finally reaches a point of maximum beauty or ugliness that constitutes the [ultimate] adaptation of a recollection to our personal inclinations... This is necessarily an esthetic classification. Time is therefore a judgment based on the strength and the esthetic value of objects and events. (*OIT* p. [107–108]).

Temporal order relies on the ability to file our memories coherently. Thus we create time awareness alongside a coherent personal history, and it is this private narrative which, according to Guyau, lies at the root of what we commonly call our Self. This statement reflects the cognitive stance Guyau takes toward personality. The remarkable thing is that the Self in this specific narrative sense appears to be a rather straightforward consequence of the cognitive view. The Self had all but disappeared from scientific psychology, and not just because behaviorism wanted it that way. Even existential psychologists worked towards its demise. They liked to compare the Self with an onion: you may peel off one layer after the other, until nothing remains (Kouwer 1957, paraphrasing Ibsen's *Peer Gynt*). Only recently the Self has made its – not yet quite triumphant –

re-entrance on the stage of experimental psychology. Borrowing from phenomenological psychology (see Brockelman 1985) it is now gradually accepted that our reflective awareness – in Guyau's terms our idea – of time, allows us to recall and expect events as occurring at their proper point on the time scale. On this view our Self is the mental representation of our personal history, a *narrative* made coherent by plausible interpolation, and continuously updated so as to make it comprehensible from the person's present outlook. The recent avalanche of experimental and clinical research into the domain of autobiographical memory supports such a constructive view of Self or personal identity.

Autobiographical memory has come under close scrutiny in recent years. First of all historically, philosophically and, not least in literary criticism (*e.g.* Ricoeur, 1984/86; Brockelman, 1985; Casey, 1987).

The experimental study of autobiographical memory by psychologists is seriously lagging behind; researchers are only just beginning to scratch the surface of this extremely rich domain of creative cognition. It was made into a researchable topic by Linton (1975, 1986), who found an extremely clever way to circumvent the extremely unreliable nature of autobiographical memory. Over a period of many years she systematically collected autobiographical facts and then subjected herself to a strict regimen of systematically recalling these events at various later times. The purpose of these studies was not the actual content of these recollections as such, but the procedures and strategies that she used in organizing and retrieving these recollections. Later Wagenaar (1985) has also reported on a very similar study, which differs from Linton's heroic attempt mostly with respect to the precision of the recording and retrieval procedures.

The ontogenesis of time

Half a century before Piaget (Krafft & Piaget 1925; Piaget, 1946) Guyau already gave a detailed description of the ontogenesis of our notion of time. Unlike Piaget, but consistent with our present inclinations, he did so in terms of cognitive processes rather than in terms of a series of structural age-related stages. In essence Guyau traced the genesis and development of our idea of time from its initial state, confused because of a lack of organizing strategies, to an adult dynamic memory that is capable of creating and maintaining an adequate temporal organization of experiences. Elsewhere in this book Friedman takes a close look at the developmental implications of Guyau's view (pp. 199–211). Here I wish only to highlight one or two issues that appear to be of particular relevance for cognitive development in general.

Acquiring cognitive procedures and strategies means acquiring ways of interpreting and representing the facts about the world. Acquiring a repertoire such procedures brings with it the possibility of representing the same facts in a number of different ways. One of the most remarkable features of the human

mind is the exceptional ease with which it can switch from one context to another, a pervasive cognitive relativism that enables us to sidestep a great many practical problems. The human mind may have various weaknesses, but single-mindedness is not one of them. Flexibility is the propensity that distinguishes us most from the computer as we know it today (Dennett, 1978, pp. 256–266; Goodman, 1984; Bruner, 1986).

We may watch this conceptual relativism at work in the way people deal with metaphors. In order to deal with certain primitive concepts – love, causality, and indeed *time* among them – we need to have access to an ensemble of partially overlapping metaphors; by 'judicious vacillation' between these metaphors we may succeed in thinking coherently about such complex concepts (Goodman, 1984, p. 32). In their delightful analysis of the metaphors we live by, Lakoff & Johnson (1980) have listed a considerable number of metaphors that can be used to express temporal relations, but what their analysis fails to reveal is how we vacillate between these metaphors, or indeed how integration is achieved.

The most systematic effort to study the developmental dynamics of representing our time experience appears to be the work of Montangero (1977, 1985). Montangero, working in the tradition of Piaget, has outlined the gradual development of an integrated structure consisting of three separate subsystems (or metaphors). We may label these *movement, change,* and *repetition.*[13] In this overall structure time *qua* duration is the connecting concept, the glue that holds this intricate mental representation together. Montangero seems entirely in agreement with Guyau's views when he claims that children first acquire the separate concepts within each of the subsystems – *e.g.* number and frequency in the case of *repetition*. Later they will gradually be able to combine these concepts into dyadic and eventually complete triadic relations, but only when they ultimately attain the insight that *duration* in all three subsystems is to be treated as one and the same concept can we say that their notion of time is complete.

Guyau did not quite envisage anything as detailed as this complex developmental model, although he came close indeed. He did stipulate the importance of movement, change, and number in the development of the idea of time (*OIT* pp. [19–24]), but all the same he remained more preoccupied with the fundamental role of effort in space as the antecedent of the notion of time (*OIT* p. [47]). This, unlike Montangero's approach, is actually more representative of the line authors coming after Guyau would take with respect to the development of temporal representation. I have already considered the role of measurement scales as a medium for formally representing temporal relations (p. 181). The relation of these time scales to the properties of space is, of course, evident. But the increasing complexity of these scales from nominal – primordial chaos again![14] – via ordinal and interval scales to ratio and absolute scales is not just a theoretical matter. That there is also a developmental progress from simple to complex was argued only quite recently by Riegel (1977). In Riegel's view the immediate ontogenetic

connection between time and the spatial metaphor is maintained. In Montangero's triadic system this connection remains much more implicit, although it seems natural to assume that in this case too, the various representations of time will, at least initially, take the form of spatial schemata or episodes. It should be added in passing that ultimately these spatial analogies are quite remote from real space. That Guyau was very much aware of the indirect path from space to time to a spatial representation of time is evidenced by his warning that

> such an idealized space is quite unlike real space and it allows us to conceive of an [abstract] setting in which things occur in succession instead of co-existing like objects in space (*OIT* p. [75]).

The development of these more abstract forms of temporal representation does not generally lead to a permanent state of reflective temporal thought in the adult mind. This is evident for Guyau, who clearly indicates that even for the adult mind the more primitive mode of 'acting and undergoing' remains available (*OIT* p. [30]). This is particularly evident in dreams and that is presumably what led Guyau to this statement. In his recent study on dreaming Foulkes (1985) attributes the primordial confusion of the dream to the failure to apply syntactic rules (or cognitive strategies) in the dream state, although isolated elements of the dream can indeed be meaningful. A primitive, unorganized state of mind may, however, also prevail in in other circumstances. Smedslund (1978) suggested in particular that simpler types of representation will as a rule be adopted by adults whenever the situation does not require a more complicated representation. This argument rests on a variation of the principle of least effort.

EPILOGUE

The literary embodiment of Guyau's primordial confusion – not, as I argued earlier, a mental chaos but a 'stream of consciousness' – may have reached its zenith in the work of James Joyce. Surprisingly enough, *Finnegan's Wake* has recently become a metaphor for common thinking, and research has begun to find out exactly what the processing differences are between conscious, reflective thinking and the associative stream of thought that seems to be the undercurrent of organized mental activity (*e.g.* Koriat & Melkman, 1987). Associative thinking, rather than being an exception, should perhaps be considered the rule in everyday adult thinking. On this view the human being would seem to constitute a kind of 'Joycean engine,' a generator of a semi-incoherent stream of thought, occasionally interrupted by a fit of lucidity.[15]

It seems not unlikely that Guyau might, in time, have reached the sort of conclusion that is implied by these last few paragraphs. The notion of a stream of consciousness from which we collect fragments and then proceed to (re)construct a coherent story is certainly present in *The Origin of the Idea of Time*.

Our present life covers, without erasing it entirely, our past life which serves as support and hidden foundation. If we descend into our inner depths, we are lost among the debris. To restore and reconstruct them, to bring them into full daylight again, the most important and almost unique means available is spatial organization. (*OIT* p. [79]).

The metaphor of an archaeologist is evoked, an image that was also chosen by another master of the stream of consciousness, Marcel Proust, in his search for his past. Like Proust, Guyau was concerned about the restoration and reconstruction of the 'remembrance of things past.' Although it is probably more plausible to assume that Proust was influenced by the then very conspicuous Bergson, rather than by Guyau, he did stress the strategic aspects of the remembering so repeatedly that to infer a more direct connection with Guyau's thought would not seem totally extravagant.[16] Actually Proust intended to disagree with Bergson to a considerable extent (*e.g.* Kern, 1983).

The archaeology of the mind is an enterprise for every individual, but it is also a collective enterprise. For Guyau the continuity of life depends, after all, on society rather than the other way around (p. 24). He testified to this beyond the grave. On his tomb we read his own words:

Our highest aspirations, namely the ones that seem most unlikely, are like waves that, once they have reached us, move on beyond us and perhaps, by converging again and amplifying each other, will shake the world... Not one of my dreams will likely be lost; others will take them up again and dream them once more until, one day, they will come true.'[17]

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NOTES

[1] More general, interdisciplinary, treatments can be found in the proceedings of the conferences of the International Society for the Study of Time, published in 1972, 1975, 1978, and 1981 by Springer Verlag (Berlin and New York), and by the University of Massachusetts Press (Amherst, MA) in 1986. The principal editor of all volumes is J.T. Fraser.

[2] Elsewhere in this volume Ricoeur (p. 154) makes the same distinction to emphasize the difference between the psychological position of Guyau and Kant's transcendental position.

[3] One may gain access to this domain of philosophical activity through Gale (1968) or Mellor (1981). Recent examples are the studies by Loizou (1986) and Seddon (1987), who represent diametrically opposing views on the matter.

[4] Ricoeur (p. 156) elaborates this point when he argues that 'if one limits oneself to saying that psychology gives an account of the awareness of the idea of time, Guyau is invulnerable.' In my opinion, this straightforward cognitive approach is exactly what makes *The Origin of the Idea of Time* so impressive to the modern reader.

[5] I have, of course, tried to be faithful to Guyau's ideas. By comparing the following resumé with the original text or the translation the reader may judge if this attempt has been successful.

[6] This is my own preferred way of partitioning the characteristic features of psychological time, but I find it easy to recognize this division in Guyau's factors (*OIT* p. [85–86]).

[7] Versions of this argument are currently popular in cosmology, where it is known as the anthropic principle (Barrow & Tipler, 1986): Had the universe evolved differently, we wouldn't be here to observe it.

[8] Actually Davies treats the present (now) in the same way. For him the present is such an addition too. Physically speaking there is no privileged now in nature. At this point Guyau is of a different opinion. For him the present is real. The issue is still a very central one in the philosophy of time. It hinges on the distinction between the A-series (past-now-present) and the B-series (before-after) drawn by McTaggart. Psychologists and biologists tend to consider the A-series real, physicists prefer the B-series approach. The battle rages on.

[9] One should mark the ambiguity of this question. On first reading it suggests what it is supposed to suggest: one puts the parts in a spatial row that represents the temporal order of extraction. But that is not what the sentence 'really' says!

[10] Recent discussions with John R. Anderson have given me the impression that he does not any longer pursue the idea of temporal strings as an independent mode of representation.

[11] I owe this point to John J. Haldane, St. Andrews, Scotland.

[12] Beginning in the early eighties a fundamental discussion has surfaced about the the distinction between sequential and parallel, or between rule-based and distributed information processing. Interesting as this discussion may be for our future views of mental representation, it is largely taking place at the level of functional architecture. Guyau had, however, little to say on this issue and I shall therefore leave it without further mention.

[13] The three subsystems can ultimately be represented at the formal level bij the relations [distance = velocity × duration], [$dX/dt = f(t)$] and [number = frequency × duration], respectively.

[14] This scale level is representative of J.T. Fraser's concept of *atemporality*, the bottom level in his hierarchy of temporal levels (see Fraser, 1982; Michon, 1986).

[15] Proposition made by D.C. Dennett at a conference held at the University of Pittsburgh, 4–5 May, 1987, under the title Brain: Philosophy, Neurology, and Artificial Science.

[16] One should, however, be aware of the fact that Guyau's thoughts on the notion of time kept playing an important role in psychology in those days. In a famous series of lectures for the *Collège de France*, for instance, Pierre Janet (1928) discussed Guyau's work at considerable length. See also Kern (1983).

[17] 'Nos plus hautes aspirations, qui semblent précisément les plus vaines, sont comme des ondes qui, ayant pu venir jusqu'à nous, iront plus loin que nous, et peut-être, en se réunissant, en s'amplifiant, ébranleront le monde... Non pas un de mes rêves peut-être ne sera perdu; d'autres les reprenderont, les rêveront après moi, jusqu'à ce qu'ils s'achèvent un jour.' (quoted in Fouillée, 1889, p. 196).