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J. T. Fraser's "Levels of Temporality" as Cognitive Representations

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Summary

An interpretive proposition, made and examined in J. T. Fraser's natural philosophy of time, is called the principle of temporal levels. It maintains that each stable integrative level of the universe manifests a distinct temporality and that these temporalities coexist in a hierarchically nested, dynamic unity.

This paper argues that the hierarchy of temporalities of the principle of temporal levels may be treated as cognitive representations that derive from a fundamental set of subjective interpretations of reality, known in cognitive psychology as worldviews or basic metaphors.

After a sketch of some of the crucial features of Fraser's hierarchical theory of time, the paper discusses two major views of basic metaphors. In particular, it demonstrates that basic metaphors qualify as interpretation functions by means of which knowledge about the world is accessed and organized into cognitive representations.

Quantitative relations appropriate to each basic metaphor specify a particular type of measurement scale. If the metaphors are then taken in their temporal context, the temporal levels of Fraser's theory emerge. His five levels of temporality appear to be related to five distinct, canonical scales of measurement. The formal properties of these scales correspond closely to the properties of temporal levels specified in Fraser's natural philosophy of time.

1. Introduction

In this paper I shall discuss the metatheoretical status of J. T. Fraser's theory of time as a "hierarchy of creative conflicts" as it has been proposed in his recent work (particularly Fraser 1975, 1978, 1982). As a descriptive system Fraser's levels of temporality (hereafter referred to as FLT [singular]) has gradually matured and expanded over the past fifteen years. At the same time, Fraser's theoretical and ontological claims have become more explicit. "Time," says Fraser, "had its genesis in the early universe,

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has been evolving, and remains developmentally open-ended." And well aware of the fact that this is not an easy view to accept, he continues: "The notion of time as having a natural history is difficult to assimilate with received teachings or even to express in noncontradictory statements. Yet [a] detailed inquiry ... reveals that the evolutionary character of time is already implicit in the ways time enters physical science in particular and natural science in general" (Fraser 1982, 1).

This is no trivial matter: in fact, Fraser claims a straightforward material status for time. [**52**] But should we indeed adopt such a realist stance toward time and assume that temporality in its various manifestations derives from the intrinsically temporal properties of matter? Or should we, instead, opt for a constructivist stance by maintaining that temporality is an interpretation of observed phenomena that have no intrinsic temporal structure or perhaps only a rudimentary one (Davies 1981; Michon and Jackson 1984, 1985). Unfortunately the epistemological status Of FLT is not yet entirely clear, and consequently no unambiguous answer to this question can be derived from it immediately.

However, the least one can admit about FLT as a theoretical structure is that it constitutes a highly complex taxonomy or classification scheme, deriving from the idea that time has too many faces to fit a single descriptive mode such as the conventional time of clock and calendar. The question, then, is whether or not FLT is more than just such a taxonomy. Is it, or does it represent, a genuine theoretical structure in the sense that a mathematical group or a formal grammar or quantum mechanics is a structure? Does it, in other words, have intrinsic rules of operation that determine the explicit forms it can take? And if so, what do such descriptive terms as hierarchical, stable levels and evolutionary open-ended, imply in that context? In short, is FLT a system that can generate empirically testable hypotheses about the world, and does it therefore qualify as a scientific theory? Or, in terms of the most appropriate metaphor available in this case: What makes FLT tick? Some answers to this question may be found by considering the cognitive roots of FLT.

First, I wish to propose that there is at least one domain of discourse in which FLT specifies or instantiates aspects of an implicit but in principle testable theory about the world. This will be achieved by showing, in the first place, that FLT emerges from a more general cognitive basis. The domains of discourse associated with FLT will be seen to constitute a system of basic metaphors or 'world models'. A basic metaphor, in this context, will be understood as a generative cognitive structure or as a set of symbolic rules that can produce mental representations or concrete 'images' of the world. Metaphors in this sense are not just analogies. They behave somewhat like genuine scientific theories and models: they are generative in that they represent or mimic part of reality, the principal difference being that they do not refer literally to the objects and relations they represent.

Next it will be argued that the five levels of temporality distinguished within FLT are, in a general way, related to certain types of measurement scales derived from the (abstract) theory of measurement. These scales, moreover, represent the proper level for expressing quantitative relations between the entities within each of the metaphorical domains of discourse under concern.

2. FLT in outline

A detailed exposition Of FLT is, of course, beyond the scope of this paper. Fortunately Fraser himself has produced several clear and simple summary statements about what I perceive as the three core concepts of his system: the levels of temporality, the corresponding stable integrative levels of nature, and the extended umwelt principle connecting the other two.

2.1. THE LEVELS OF TEMPORALITY

Fraser distinguishes five separate levels of temporality (e.g., Fraser 1982, pp. 29-31). The first level, atemporality, constitutes a kind of baseline: it is characterized by the absence of time as a meaningful attribute of events. It corresponds **[53]** closely to our concept of chaos, and in an atemporal world, relations between events can be qualified only in terms of coexistence, or simultaneous presence or absence. Only at the second level, prototemporality, can temporal order relations between pairs of events be specified in terms of before and after. But prototemporality is a restricted, local form of time. “Disconnected fragments of time” will prevail in a prototemporal universe and “temporal positions may only be determined probabilistically” (ibid., p. 31). Eotemporality is the next higher level in the hierarchy; it is “the time represented by the physicist’s t in equations usually described as not responding to the direction of time” (ibid., p. 30). In other words, eotemporality is essentially straightforward Newtonian time: it is metric—even isometric—and it is reversible. It is a mere fourth geometric coordinate having no other intrinsic merit than simplifying the equations of classical dynamics, the domain of discourse comprising the inorganic world of Newtonian mechanics. Although it is possible to specify a kind of zero-point (t_0) in physical time, this point is essentially arbitrary (Davies 1981) and does not have the privileged position of the now or present which emerges at the next level in FLT, biotemporality.

For a present to exist, the capacity for self-organization is a prerequisite. In biotemporality, the temporality that evolved with life, “the physiological present is the phenomenological witness to the simultaneities of need which must be maintained if the autonomy of a living organism is to be assured” (Fraser 1982, p. 30). Organisms are, somehow, capable of displaying organized behavior on the basis of reasonably accurate predictions about what is going to happen, which they derive from an internalized model of the environment. The physiological present represents the necessary ‘tuning’ interface between the sequence of outer world events and those in the simulated, inner world (Michon 1978, 1985). This ‘tuning’ is essential for survival. What chance of survival would an organism stand if it were out of tune most, or even some, of the time! Biotemporality is characteristically the time of irreversible processes: the organic world constitutes the principal battlefield against the increase of entropy. Thus biotemporality has a direction, although it has only very vague ‘beginnings’ and ‘endings.’ Nootemporality, finally, in Fraser’s conception, is the unique form of time of the human mind: it has the clear present of consciousness of self and definite beginnings and endings. Events retain their singular meaning and position in time relative to each other: someone’s identity is uniquely defined by the sequence of events called personal history.

Fraser stipulates that the five levels are structurally stable: any conceivable temporal phenomenon can, and can only, be described in terms of these temporalities.[1] They form a nested hierarchy, which means that a higher level retains all the properties of the levels below. Biotemporality and nootemporality thus offer richer descriptive frameworks than do proto- and eotemporality.

2.2. THE STABLE INTEGRATIVE LEVELS OF NATURE

A second central idea in Fraser's system is the concept of stable integrative levels of nature. The phenomenal world partitions 'naturally' into five large theoretical domains. "It is postulated that these levels of organization are distinct, stable, and bear a hierarchical, nested relation to each other" (Fraser 1982, p. 29). "They are successive forms of order that differ in their complexity, organization and relative independence" (Fraser 1978, p. 21). Physically the stable integrative levels of nature are identified as the domains of special relativity theory, quantum mechanics, general relativity theory, biology, and physiology, and the sciences of mind, knowledge, and society, respectively (Fraser 1982).

[54]

Table 1. The relations between FLT and the stable integrative levels of nature

level of temporality	temporal judgment	stable integrative level of nature (extended umwelt)
atemporality	simultaneity	particles with zero rest mass (photons)
prototemporality	order (partial/complete)	particles with nonzero rest mass
eotemporality	duration (distance)	aggregates of matter
biotemporality	now, timing	organisms
nootemporality	(personal) history (beginnings/endings)	minds

2.3. THE EXTENDED UMWELT PRINCIPLE

The third core concept invoked by Fraser is the "extended umwelt principle." This principle is derived from the concept of Umwelt as it was defined by the biologist Jakob Von Uexkuell early last century. Animals, according to Von Uexkuell, live in a world that is species-specific and optimally 'fit' to their anatomical and physiological apparatus. The umwelt concept appears also valid with respect to knowledge: "whatever is known is known according to the manner of the knower" (Thomas Aquinas; quoted in Fraser 1978, p. 21). The extended umwelt principle, as proposed by Fraser, is an extension of the umwelt concept to entities in general: not only butterflies, dolphins, and people have their own species-specific universe, but photons, galaxies, and daffodils have one too.

The relevance of the extended umwelt principle is that it expresses the intrinsic relations between the stable integrative levels of nature and the levels of temporality. Table 1 summarizes these relations. (For further details see Fraser 1978, 1982).

In its simplest, fairly trivial interpretation, the extended umwelt principle states that certain phenomena require their own domain of discourse and have no status outside that domain. There is, however, a deeper meaning to the extended umwelt principle which appears to be related to the concept of intentional system as defined by Dennett (1978). A system, according to Dennett, is intentional if we can predict its behavior by ascribing rationality, opinions, emotions, or intelligence to it. Whether the system 'really' possesses those attributes or not, is immaterial; the only point is whether the assumption that it is endowed with rationality, intelligence, and so on allows us to correctly predict its behavior to a sufficient extent (ibid., pp. 236-239). In my view the extended umwelt principle should be interpreted in this sense. Thus, photons are ascribed the potential to behave rationally in their proper umwelt, that is, in the world of special relativity. This allows physicists to make predictions about their behavior without knowing what photons 'really' are or 'really' think. If we adopt this intentional stance toward the entities within each stable integrative level of nature and thereby ascribe the appropriate temporality to them, we arrive at a position where essentially it does not matter whether or not such an entity 'really' possesses a particular 'natural' level of temporality. As long as we can validly predict its temporal behavior we do not falsify our assumptions.

This position, which occupies a central position in contemporary discussions about the metatheoretical foundations of psychology (see e.g., Dennett 1978; Healy 1981; Biro and Shahan 1982; Newell 1982; Michon 1984), implies the explicit introduction of an observer **[55]** into the description of a behaving system (whether photon, galaxy, daffodil, or J. T. Fraser). It also indicates the necessity of clarifying what precisely is attributed by the observer to such behaving systems.

Perhaps the approach outlined here may answer such questions as why there are just five levels of temporality and why the properties at each level are what they are. Until now, these questions have remained unanswered. Are the levels of temporality therefore simply to be accepted as contingent matters of fact? In my opinion the answer is No, and the remainder of this paper will explain why.

3. Cognitive representations: root metaphors and world models

World model, *worldview*, *root metaphor* and *basic metaphor* are different terms for the same thing. In psychological theory they stand for so-called schemata, abstract cognitive structures that enable intelligent beings to represent and summarize their knowledge of the world in a coherent way. Schemata are rule-based, generative procedures that guide perception, thinking, and action (for an introduction, see Anderson 1980 or Johnson-Laird 1983). Such schemata are necessarily present in any system of "sufficient complexity" (Wonham 1976) and any definition of "systems of sufficient complexity" is likely to include human beings.

What role do such generative schemata play in the functioning of a complex system such as the human mind, and what epistemological status do they have? This role can be described as providing access to the unbounded field of potential, uninterpreted knowledge that constitutes the environment in which this complex cognitive system—the mind—can operate as an active agent (Newell 1982). The operations of the system can only be performed through representations, namely by generating hypotheses about the effect of certain operations, testing these hypotheses mentally, and subsequently verifying the outcome of these tests by actually executing the operations in the real world. Representations are therefore to be considered as realizations of a body of knowledge. As such they are necessarily approximative: knowledge cannot be embedded exhaustively in a representation. Such a view of knowledge and cognition has undeniably certain Kantian overtones. In particular the conception of knowledge as a cognitive environment faintly echoes Kant's world of the *Ding an sich*. The relation between knowledge as understood here and the cognitive symbolic structure that carries the representation of this knowledge has been adequately summarized by Newell (1982) in the following functional relation:

representation = knowledge + access

This equation stipulates that there may be many (approximate) symbol structures in which one and the same body of knowledge may be represented. On the other hand, the structural requirements for a representation are fulfilled only when an access or interpretation function is defined. The interpretation or access function is an ensemble of rules acting as a filter, but it is an active, self-organizing filter, since the rules adapt to the requirements of the environment and to the previous experiences (history) of the subject.

Knowledge as it is defined in this context refers not only to simple facts, but it also includes the underlying (abstract) principles or laws of nature from which these facts derive. Such principles may sometimes take the form of formal, axiomatic scientific theories. Probability theory in its axiomatic form (Kolmogorov), linguistics (Chomsky), **[56]** and geometrical optics (Luneburg) are examples of such abstract theories. They constitute what is known as *competence theories*, or prescriptive theories.

Competence theories are essentially theories without agents. Thus, probability theory is a theory about betting without bettors, linguistics is a theory about language without speakers or listeners, and geometrical optics is a theory of visual perception without perceiver. Only when given a concrete interpretation do such structures come to life: probability, for instance, may be interpreted in terms of relative frequency, as a gamble, or as a "natural cause" (Cohen 1981). Such interpretations are known as *performance* theories. With knowledge as such we appear to be in a similar position: in principle epistemology constitutes a theory about knowing independent of a knower, while metaphors are interpretations, performance theories of knowing (as, incidentally, are logics [Newell 19821). Such a view allocates a crucial role to 'metaphors' or 'world models.' It does, however, not require an unusual interpretation of the concept of metaphor. Black (1962), whose epochal *Models and Metaphors* generated most of the recent discussion about metaphorical language, pointed out that the role of metaphor is not that of an analogy, viz., substitution of terms from one domain into another domain or comparison. Metaphors of the kind that are called generative allow the use of their "associated implications" or intrinsic meaning for structuring the topic to which they are applied. As Boyd pointed out in a recent discussion of the role of metaphor in scientific theory, "the use of metaphor is one of many devices available to the scientific community to accomplish the task of accommodation of language to the causal structure of the world" (Boyd 1979, p. 358).

I wish to extend this point of view, by proposing that some metaphors are not accidental but rather derive from structural properties of the human mind. Ultimately this suggests that such basic metaphors cannot just take *any* conceivable form but, instead, constitute a finite number of what may perhaps be called "stable integrative levels of *mind*." Mental structures might, in other words, display considerable morphological stability. This position is, in one form or another, prominent in several modern theories of cognition (e.g., Chomsky 1980; Fodor 1981; Piaget 1977; see also Haroutunian 1983).

3.1. THE MORPHOLOGY OF BASIC METAPHORS

Several authors have attempted to establish a 'minimal' set of basic metaphors. Although these attempts were originally not made in the context of the search for rule-based cognitive structures, they have recently become of great importance to the field of cognitive science. The level of intelligence displayed by computers and robots is almost entirely determined by the quality of the world model they maintain, that is, in the terminology used above, by the set of rules that enables them, as agents in a knowledge environment, to organize their ‘experiences’ into coherent representations of the situations in which they operate.

The number of basic metaphors encountered in the literature turns out to be rather limited, and fairly consistent among authors. In what follows I shall restrict the discussion to two schemes. One was proposed, quite long ago, by Pepper (1942) and the other much more recently by De Mey (1982).

Pepper, in a book that has recently been gaining new prominence (see e.g., Tyler 1981), distinguished six basic or root metaphors (see table 2). First of all, according to Pepper, the world may be interpreted in terms of spiritual forces, animistically or mystically, depending on whether (many) individual, personal spirits are postulated as causal agents or one general or one absolute world spirit. Animism and mysticism as root metaphors are essentially prescientific, unlike the four that follow.

[57]

Table 2. Generative metaphors as identified by Pepper and De Mey

cognitive structure (generative metaphor)		**principal domain of discourse**	movements and topics in science (De Mey)		
Pepper (root metaphor)	De Mey (world model)		philosophy of science	psycholinguistics artificial intelligence	perception pattern recognition
animism	-	**personal spirits**	-	-	-
mysticism	-	**absolute spirit**	-	-	-
formism	monadism	**facts**	positivism	word-to-word translation	template matching
mechanism	structuralism	**relations**	logical positivism	syntactic analysis	feature analysis
contextualism	contextualism	**functions**	science of science	indexical expressions	context analysis
organicism	cognitivism	**self-organizing structures**	paradigm theory	world models	analysis-by-synthesis

Formism, Pepper’s third root metaphor is a way of interpreting the facts and relations in the world in terms of items and categories, in classificatory schemes and orderings based on rational principles (e.g., Ramon Lull), or systematic observation of natural phenomena (e.g., Tycho Brahe or Linnaeus).

Mechanism, the next root metaphor, deals with the world in terms of interrelations and interactions between elements conceived as components of a mechanical system. This was the dominant worldview of the eighteenth century, most concisely expressed by the mechanical clock.

Contextualism differs from the mechanistic view by acknowledging the dependence of a system's functioning upon the environment. The exemplary system of contextualism is the thermostat, and the exemplary science is cybernetics.

Organicism, finally, acknowledges the structural and functional interdependence of system and environment. It supposedly accounts for development and learning, recognizes the uniqueness of personal history, and centers on concepts related to self-organization.

Pepper's metaphors were originally not meant to stand in a hierarchical or sequential relation to each other. In the present context, however, I prefer to emphasize the hierarchical character they appear to have at closer inspection. Organicism, for instance, apart from dealing with the generative aspects of structure, must incorporate the feedback principle that is central to contextualism if it is to account for the interrelations among parts of a unified, organismic entity. Contextualism in turn retains the dynamic interactions among components that are central to the mechanistic metaphor, and so on.

De Mey (1982) recently proposed taxonomy for the 'natural' development of scientific theories. Although his is an independent conceptualization, placed in the context of cognitive science, there is a striking correspondence between Pepper's *root metaphors* and De Mey's *world models*. De Mey, however, only deals with structures having formal scientific importance and providing a framework for the philosophy of science and for **[58**] empirical research in cognitive science, in particular psycholinguistics (artificial intelligence) and pattern recognition (see table 2 for a summary).

Monadism, like Pepper's *formism*, deals with facts and classification. Philosophically it is disguised as positivism. It is recognizable in the word-to-word translation approach to machine language and in template matching theories of visual perception.

Structuralism, equivalent to mechanism in Pepper's taxonomy, deals with context-independent systems. In philosophy it is represented by logical positivism and in cognitive science by syntactical analysis and feature analysis.

Contextualism recognizes that science and its objects are influenced by the environment in which they operate, an insight that figures prominently in the 'sciences of science' movement, and is also central in the concepts of indexical expression in psycholinguistics and data-driven processing or context analysis of perceptual information.

Finally, *cognitivism*, the equivalent of Pepper's organicism, is found in Kuhn's paradigm approach to the philosophy of science. According to this view, science is not only influenced by external factors, but at least as much by the (self-organizing) pressures from within the scientific community. Research topics at this level are the world models or root metaphors themselves, as bases for knowledge-based data systems and automatic translation, and for analysis-by-synthesis or 'top-down' processing in perception. This point of view recognizes that subjects bring their knowledge and experience to bear upon their perceptions and actions.

As in the previous discussion it should be understood that these worldviews are considered in terms of a hierarchy. They are not necessarily exclusive but the 'higher' forms retain aspects of the 'lower' ones. Thus, for instance, perception in the cognitivist perspective entails both top-down and bottom-up elements.

So we seem to arrive at a set of four stable root metaphors, whose prominent characteristic is the fact that they may serve as interpretation functions (or access functions) for a body of uninterpreted knowledge.[2] In other words, we may recognize the basic metaphors as ensembles of theory-constitutive (Boyd 1979) or generative rules that, when applied to a particular domain, will produce representations of reality in terms of certain more or less complex systems ranging, for instance, from a sophisticated, but essentially formist or monadic description of the phyla of life on earth (Margulis and Schwartz 1982) to equally sophisticated but essentially organismic or cognitivistic arguments about self-organization in systems far from thermodynamic equilibrium (Prigogine 1980, e.g., p. xvii and ch. 9). It should be emphasized, perhaps unnecessarily, that the hierarchical relation stressed in the foregoing discussion does not imply a qualification or disqualification of the scientific value of any of these metaphors: each has its proper own domain.

The choice of interpretation will sometimes be suggested by the nature of the data that are to be accommodated in a particular representation. More often than not, however, this choice will be determined by the needs of the observer, rather than by the entity under concern.

3.2.THE RELATION BETWEEN FLT AND THE BASIC METAPHORS

It is now possible to state the relation between FLT and the basic metaphors described in the previous section. The argument in what follows is that the stable integrative levels of nature as Fraser describes them should be understood as specific representations of knowledge. Each of these stable integrative levels is generated by, or derived from one of the basic metaphors **[59]** defined above. The resulting connections are summarized in the first three columns of table 3.

Table 3. The relations between Fraser's Levels of Temporality, Pepper's "root metaphors" and corresponding measurement structure

level of temporality	root metaphor	representative system	measurement structure	scale type
atemporality	animism/mysticism	magic wand	elements, wholes	nominal
prototemporality	formism	library	monotonic	ordinal
eotemporality	mechanism	clock	linear	interval
biotemporality	contextualism	thermostat	Dedekind complete	ratio
nootemporality	organicism	self-organizing system (organism)	identity	absolute

Although in some of Fraser's most recent work—particularly his study on the genesis and evolution of time (1982)—the levels of temporality are presented in a purely physical and therefore seemingly non-metaphorical context. The theory, in fact, is supposed to deal with the grand total of all phenomena, physical as well as mental. "The temporalities of nature are paradigmatic. Although they may be recognized as emerging in the history of complexifying matter, they may also be identified in the structural organization of the mind" (Fraser 1981, p. 5). The following two quotations, one dealing with the emotions of participants in the French Revolution and the other taken from a discussion about modern art, may help to illustrate the mental ramifications of FLT:

> The participant becomes an *enfant de la patrie*, a child of the almighty fatherland. His self definition lessens as he turns into an indistinguishable member of the mob whose actions may only be described statistically. Drives appropriate to the bio-, eo- and prototemporal umwelts cathect the mental representation of objects and produce the corresponding temporal feelings: that of the abiding present and/or fragmented time, the eternal jour de gi6ire. The significance of future and past lessens or vanishes. The temporal world of the child emerges into consciousness as a rediscovered reality. (Fraser 1981, p. 8)
>
> The following are representative examples from the arts which I have found as inducing, in my experience, the peculiar moods that correspond to hallmarks of temporalities. Aleatory paintings, novels whose pages may be fully exchanged, radio and television programmes put together from unrelated fragments exude the atmosphere of the atemporal and the prototemporal, depending on their degree of incoherence. (Ibid., pp. 20-21)

Analysis of such examples reveals their thoroughly metaphorical character. Following the lead of the second example, for instance, a field full of football players would exude the atmosphere of prototemporality, or perhaps eotemporality, or even show the hallmarks of one of the higher temporalities. But we should realize that the choice of temporality depends on those characteristics of the situation that strike the observer most: “chaos for the atemporal; fragmentation for the prototemporal; directionless continuity for the eotemporal; directed continuity for the biotemporal; future-past-present, self vs. other, guilt, anxiety, and human freedom for the nootemporal” (ibid., p. 20).

What *actually* does strike the observer most, depends on his or her ability or willingness to adopt a particular intentional stance toward the event, that is, to recognize a particular [**60**] extended umwelt. If I am not able to ascribe intelligence to what goes on in a football stadium (because I do not know the rules of the game), or if I am not willing (simply because I loathe football), I impose temporal chaos or prototemporal fragmentation on the situation. On the other hand, if I am enthusiastic about football I intentionally ascribe intelligence and rationality to the players and perhaps even to the team as a whole.

Whatever I ascribe, though, appears to be consistent, not only with the hallmarks of the various levels in FLT, but more generally also with the abstract generative rules of the basic metaphors. If I am ignorant of football, I can only adopt a formist, that is, counting, classifying, and fact-gathering stance toward the game, not capable of seeing the forest for the trees. As a football coach, on the other hand, my generative metaphor will more likely be of an organismic nature, although I may at any time regress to a hierarchically lower worldview.

In short, an extended umwelt, with its corresponding temporality, is to be considered as a particular case of intentionality on the part of the observer who ascribes certain (metaphorically dressed) system properties to that entity. This implies that we may conceive of Fraser’s stable integrative levels of nature specified in FLT as cognitive representation, that is, as instantiations of the basic metaphors described before. In this light we are able to understand why on occasion subsuming certain types of events under the appropriate level of temporality may be difficult.

Of course, Fraser is quite aware that the stable integrative levels of nature and the corresponding levels of temporality are necessarily fuzzy at the edges. For instance, when he writes: “The theory of time as conflict assumes that the human mind, beyond displaying its peculiar nootemporal features, also subsumes functions that are appropriate to the lower temporal umwelts” (Fraser 1978, p. 25). But some problems appear to have deeper roots. I mention two of them. The first is that many social or psychological attributes or events can only be subsumed under discrete, classificatory schemes: motherhood, for instance, or academic degree obtained, or membership in the International Society for the Study of Time. Although there can be no doubt that these characteristics refer to the biosphere or noosphere, they can of course only be discussed at the formistic, that is, at the prototemporal level. (Actually, the difficulty lies at the core of the relative impenetrability of sociological phenomena for scientific analysis.) With respect to FLT this means that “functions that are appropriate to the lower temporal umwelts” are not necessarily relics of the objects and events that constitute the natural kinds of these lower temporal umwelts, but mental or biological properties that have no prototemporal or eotemporal ancestors at all. In other words, the fact that I happen to be a member of said Society is not in the least a consequence of the prototemporal properties of the elementary particles that I consist of, and yet requires a prototemporal description.

The second and more problematic difficulty is that the fuzziness of the various levels of temporality actually works in both directions: not only do lower temporalities appear in higher level phenomena, but the reverse appears to occur as well. This, in my opinion may create serious problems for an interpretation of FLT as a physical theory. At the prototemporal level, for instance, according to Fraser (1982, p. 29), “temporal positions may only be specified probabilistically.” However, if probability density functions are locally defined on the order of (pairs of) events, then the prototemporal character would seem to be lost automatically, simply because these probability functions impose a metric over the whole range of observation points (Thurstone 1927; see also Torgerson 1958). Consequently, genuine **[61]** prototemporal phenomena may indeed display eotemporal properties, depending on the chosen interpretation.

In this interpretation then, FLT can be considered as a particular—namely, time-oriented—set of cognitive representations derived from, or generated by a well-established, perhaps fundamental set of basic metaphors, and a systematic and consistent test of the “associated implications” (Boyd 1979, p. 364) of these metaphors in the chosen universe of discourse.

The implications that concern us most in the present discussion pertain to the levels of temporality. We may conceive of a level of temporality as the representation of the proper temporality associated with, and generated by one of the basic metaphors. This implies that part of each basic metaphor is a measurement structure, a necessary or at least preferred way of quantifying relations within the context of that metaphor and of the representations derived from it.

The reason is simply that if metaphors are to qualify as theory-constitutive in a quantitative sense, they must have an internal structure that provides consistency, completeness, intransitivity, internal validity, and so on. The question is, therefore, whether the various temporalities as defined in FLT can be derived from the internal structure of the basic metaphors and, more specifically, from the characteristic measurement structures associated with these metaphors. And, in the second place, we should find out whether these measurement structures do indeed produce a stable and exhaustive set of temporalities. The latter requirement is to be met, if we accept Fraser’s claims that the five levels of temporality are exhaustive and that mesoforms do not appear often and are unstable if they do.

4. FLT and measurement theory

4.1. MEASUREMENT AND FORMAL SPACE

The proper frame of reference for answering these questions is suggested by Fraser (1982) in a chapter that focuses on the measurement of time. Time measurement, according to Fraser, is an experiment, a controlled observation. It requires two clocks or repetitive processes, one of which is assigned the status of master clock. It also requires two pairs of events—one pair in each process domain, as well as a rule of correspondence.

Within this framework we can conceive of each temporality as a particular type of measurement, each one obeying the generic rules set by a formal theory of measurement, but each providing a different interpretation of these rules. Measurement theory, in the terminology of my earlier discussion, is a theory of surveying without a surveyor, and metaphor-specific measurement structures are interpretations of that abstract theory which generate the properties of the various levels of temporality. Measurement is usually defined as the “consistent assignment of numbers to states of an empirical variable” (Torgerson 1958), and we may observe that the more regular of the two processes required by Fraser’s definition of time measurement serves essentially the purpose of the required number scale. That process is conceptually treated as true Newtonian time for lack of an absolute reference, and as such it formally has exactly the properties that the number system has in formal measurement.

The systematic assignment of numbers to observed states of the world produces a particular type of representation called a measurement scale. Because measurement theory is **[62]** a formal theory, measurement scales are void of empirical content and can, therefore, handle any kind of information including time.

This, incidentally, refers to one basic tenet of the psychophysics of time, which took form as the “equivalence postulate” in my contribution to the first conference of this Society in 1969 (Michon 1972). That is, if time behaves like any other psychophysical dimension such as brightness, loudness, itch, or sweetness, then the levels of temporality are correctly looked at as representations generated by particular measurement structures.

Measurement can be considered as the formal specification of relations between objects and events within any given domain of discourse. But when it comes to the actual interpretation of these formal relations it seems hard to avoid spatial terms. In experimental psychology perceived relations between, for instance, colors, speech sounds, emotions, or facial expressions are frequently expressed in terms of vectors (directions and distances) in formal, multidimensional space. The spatial metaphor is apparently a very powerful means of expressing quantifiable relations.

Temporal relations are no exception to this rule. Clark (1973), Miller and Johnson-Laird (1976), and others have pointed out that expressions for temporal relations are indeed also based largely on spatial terminology. Clark in particular has argued that this is not a coincidence but, on the contrary, refers to the existence of “a thoroughly spatial metaphor, a complex cognitive system that space and time expressions have in common” (Clark 1973, p. 62). Thus it is not surprising that temporal relations should fit the requirements of the formal space of measurement theory.

4.2. MEASUREMENT SCALES AND FLT

We must now show that each of the five temporalities does indeed correspond to an appropriate measurement scale type with its underlying measurement structure. This amounts to imposing a formal structure on FLT from which it must then be shown that (a) five levels of temporality do indeed exhaust the possible forms of time, or nearly so, and that (b) the mutual (hierarchical) relations that characterize FLT do indeed follow from the properties of this structure. Empirically this seems fairly straightforward and in figure 1 a suitable, widely accepted typology of measurement scales is given.

Scales may be classified hierarchically according to whether they are ordered or not, whether distance is defined or not, and whether a zero-point and/or a unit are defined or **[63]** not.[3] These distinctions produce a set of five scale types, exactly the number we would need for showing that they do indeed meet the requirements of FLT.

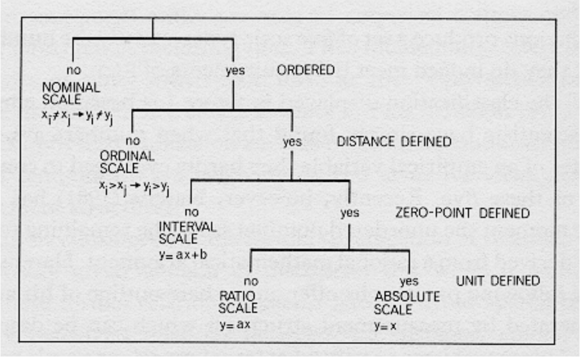

Figure 1. Hierarchy of measurement scale types

Unfortunately, the classification displayed in figure 1 is based on empirical and *ad hoc* considerations; scientists have simply found that when numbers are systematically assigned to the states of an empirical variable, they hardly ever need to construct a scale type that is not one of these five. Recently, however, Narens (1981) has shown that if we disregard for the moment the unordered nominal scale, the remaining four canonical scale types can also be derived from a rational mathematical argument. Narens' analysis is quite involved and the following paragraphs offer only a bare outline of his arguments.

Scales are generated by measurement structures which can be described in terms of automorphisms. Automorphisms specify what transformations a scale may undergo before it will lose its type-identity and become something different. Thus a nominal, unordered scale may be subjected to any transformation that will leave the identity of the 'measured' objects or events unchanged. Postal account numbers, for instance, may be altered without changing the properties of the system. They serve only for individual identification and it suffices that no two distinct accounts have the same number. Ordinal scales, at least the completely ordered ones, will accept any monotonic transformation, including sign reversal. Interval scales preserve relative distance; they are essentially linear metric scales of the type $y = ax + b$ in which both a and b are free parameters. Ratio scales of type $y = ax$ remain invariant only under transformation of the unit parameter a, while their origin is fixed. The absolute scale, $y = \iota x$ finally, accepts only the identity transformation *iota* (ι): every point on an absolute scale is fixed.

Narens (1981) was able to show that the automorphisms that characterize the ordered scale types are exhaustively described by two fundamental properties of the underlying measurement structures: uniqueness and homogeneity. The degree of uniqueness of a scale type specifies the number of points that must minimally be determined to see whether two scales are automorphically identical. The degree of homogeneity can loosely be described as specifying the number of points that may be varied together in one scale, without destroying the properties of that scale. Uniqueness and homogeneity may both in principle vary between zero and infinity. It can be shown, however, that the degree of homogeneity can be at most equal to the degree of uniqueness and that, moreover, the degrees of uniqueness and homogeneity must be smaller than 3, except when certain requirements are relaxed. This reduces the number of possible scale types considerably, as is shown in figure 2.

The most important, that is canonical, measurement structures are those that have equal degrees of uniqueness and homogeneity. If both have zero degree, we have an identity structure for which the absolute scale is the proper scale type. Uniqueness and homogeneity both of degree 1 define the so-called Dedekind Complete Structure, which generates ratio scales.[4] Uniqueness and homogeneity both of degree 2 specify the linear structure and the corresponding interval scale. For the monotonic measurement structure which determines ordinal scales, certain requirements need to be relaxed. In the resulting so-called η-uniqueness and η-homogeneity, η stands for the number of distinctly ordered points on the scale and consequently may vary between 2 and infinity. Among the non-canonical scales that can be found below the main diagonal of the diagram in figure 2 are, for instance, scales with an invariant constant. These scales, marked by the asterisk (*) in figure 2, all have zero degree of homogeneity. The best-known species of these 'funny' scales is found in this category, namely the relativistic addition theorem, $x \oplus y = \left(x + y\right) / \left(1 + xy / c^2\right)$.

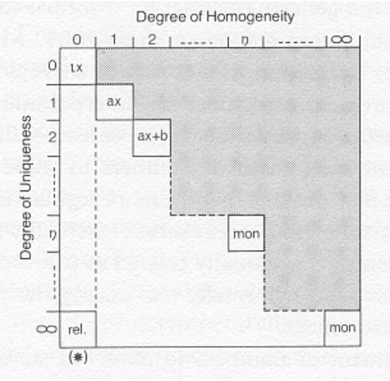

Figure 2. Classification of ordered scale types according to Narens (1981). The canonical or natural scale types appear on the main diagonal of the diagram, their degrees of homogeneity and uniqueness being equal. Increasing degrees of homogeneity and uniqueness determine the absolute scale ($y = \iota x$), the ratio scale ($y = ax$) and the interval scale ($y = ax + b$), plus any number of ordinal scales (*mon*). The position of the latter on the diagonal depends on the number of elements being scaled. Since the degree of homogeneity is at most equal to the degree of uniqueness, the upper-right half of the matrix is void. In the lower-left half below the main diagonal one will find miscellaneous, spurious, but sometimes important scale types. An example is the addition theorem of relativity theory $x \oplus y = (x + y)/(1 + xy/c^2)$, which is characterized by an invariant constant c (the velocity of light).

It is an example of a scale that **[64]** has an important and highly sophisticated meaning, but is not canonical in the sense of this paper; in particular, the relativistic sum $x \oplus y$ will be different for values of x and y for which the ordinary sum $x + y = constant$. So much, then, for Narens' arguments.

It seems appropriate to argue that the scale types which derive from measurement theory show the desired properties that make it possible to relate them to FLT. First, if one includes the nominal scale, the number of canonical scale types is precisely the required number, five—no more, no less. These scale types comprise the vast majority of all empirical measurement relations and as such may certainly be called stable. The five scale types, moreover, are related hierarchically in the sense that the more highly structured, transformation-resistant types preserve the properties of all lower types. Thus points on an absolute scale are well ordered, while their relative distances as well as their distance to the scale's non-arbitrary zero-point are both meaningful.

It appears that these measurement structures and their associated measurement scales can be mapped in a one-to-one fashion with the levels of temporality distinguished in FLT (see table 3, columns 1, 4, and 5). At the temporal level the possibility of identifying events or classifying them in a categorical fashion is restricted to essentially unordered elements or ensembles. No metric can be imposed at that level. At the prototemporal level the 'formism' of time is established, implying that order relations can be established between events, though not necessarily a total ordering. Thus fragmentation, the hallmark of prototemporality, may reign supreme, total ordering being only a limiting case. Eotemporality, the time of classical mechanics, is adequately described by the interval scale of linear measurement structures: both the unit of measurement of such a scale and its zero-point—the physicist's t_0—are arbitrarily chosen (Davies 1981). At the biotemporal level the restrictions imposed by ratio scaling acquire an intrinsic meaning: a true zero-point is a necessary prerequisite in the biotemporal umwelt. Finally nootemporality, with its "beginnings and endings" and its recognition of personal history, implies that the course of events in human **[65]** existence is unique: if events would take a different course we would become a different person altogether. Such a temporality requires the particular unique absolute scale derived from the identity structure. Consequently, the measurement structures as defined above, do indeed qualify as structures that display the required formal properties of the levels of temporality in Fraser's system.

5. Conclusions

Although the preceding discussion does in no way claim that it has covered more than a small part of the implications of FLT, it has shown that Fraser's system can be given at least one consistent interpretation. FLT may be treated as a set of representations generated by a small, and indeed perhaps minimal, set of root metaphors. More specifically the five levels of temporality derive from the measurement structures that seem to be the appropriate relational structures attached to each of these basic metaphors (see table 3).

Metaphors are not just comparative or substitutive images. As many authors have argued (see Ortony 1979) they can also be theory-constitutive, representing "one strategy for the accommodation of language to as yet undiscovered causal features of the world" (Boyd 1979, p. 364). In this sense FLT appears to describe the many features of the strategies people adopt to cope with a complex temporal reality. One crucial strategy is that of intentionally ascribing certain properties to entities in (part of) that reality and then assuming that these entities will behave rationally in their umwelt, i.e., in accordance with their given rules (natural laws) and their initial conditions.

Metaphors have particular significance in such a context, because they constitute—once more in Boyd's words—a "nondefinitional mode of reference-fixing which is especially well suited to the introduction of terms referring to kinds whose real essences consist of complex relational properties, rather than features of internal constitution." (ibid., p. 358).

Notes

1. Fraser sometimes introduces yet another level of temporality: sociotemporality or the time of human society and culture. The properties of this level are not very well defined, however, and do not differ very clearly from nootemporality.

2. To this quartet we may add one or perhaps two additional root metaphors which accommodate the absence of formal systemic characteristics.

3. The interesting case of partial versus complete ordering will not be discussed here. It would, however, not change the general line of my argument.

4. Narens (1981) deals with the point that strictly speaking the scales deriving from a Dedekind Complete Structure are defined over the positive real number domain ($\mathbb{R}$).

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