

Temporal frames of reference

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Abstract

Recent research has suggested that it is possible to model *temporal frames of reference* (t-FoRs) in terms of frames of reference (FoRs) from the domain of space (Bender et al., 2005; Kranjec 2006). There have been two recent attempts to develop theoretical models of temporal reference deploying spatial FoRs (Bender et al. 2010; Tenbrink 2011). This paper argues that temporal reference is qualitatively distinct from spatial reference. Indeed, the hallmark of temporal reference is *transience* (Galton 2011), a feature wholly absent from the domain of space. Hence, models of t-FoRs should be based on an understanding of the nature of temporal reference, rather than assuming it is parasitic on spatial experience. After analysing distinct types of phenomenologically-real transience, I develop a taxonomy of t-FoRs, providing arguments to support my claim that they have psychological reality. My arguments are based, primarily, on an original analysis of the linguistic manifestations of t-FoRs in English, supported by a brief review of findings from neuroscience and experimental psychology. I propose three kinds of t-FoRs: deictic, sequential and extrinsic.

1. Introduction

Research on temporal reference has traditionally focused on the ascription of motion to time, thereby facilitating different perspective points. Since Clark (1973), the phenomenon of *deictic reference* has been recognised with the so-called Moving Time (MT) and Moving Ego (ME) perspective points. In the examples in (1), temporal reference arises from the ascription of motion to temporal events with respect to a stationary ego—as in (1a)—or from the ascription of motion to the ego which moves towards a temporal event, conceived as a static location—as in (1b).

- (1) a. Christmas is approaching (us) [Moving Time]
 b. We are approaching Christmas [Moving Ego]

Since Moore (2000, 2006; see also Núñez and Sweetser 2006), a further distinction has been recognised, that of *sequential reference* in the domain of time. Building on insights by Traugott (1978), Moore argued that the ascription of motion to events—conceived as a sequence—provides an alternative, and complementary, means of facilitating temporal reference. Importantly, while deictic reference encodes a future/past relationship, sequential reference facilitates an earlier/later relationship (see also Evans 2004):

- (2) Christmas comes before New Year's Eve

In the example in (2), Christmas is fixed in time with respect, not to an ego, but to a later event, namely New Year's Eve.

In addition to deictic and sequential reference, Kranjec (2006) has suggested, that a third type of temporal reference may also exist. This type he dubs *extrinsic reference*, which also makes use of the ascription of motion to time. In this reference strategy, motion provides an extrinsic field which serves to fix an event, or events in time. In this, time is conceived as a matrix, or manifold (Evans 2004), which constitutes *the* event within which all other events occur. This way of conceiving of time allows the human experiencer to fix events by virtue of 'where' in time they occur, and is evidenced by motion ascriptions such as the following:

- (3) Time flows on (forever)

In addition to the linguistic evidence, there is compelling behavioural evidence which supports the view that the three temporal reference strategies have psychological reality. In a classic experiment, McGlone and Harding (1998) developed a paradigm involving an ambiguous temporal task. They demonstrated the psychological reality of the deictic temporal perspective. This finding has been since substantiated in related experimental work using spatial primes by Boroditsky (2000), and Gentner et al., (2002), amongst others. Adapting the McGlone and Harding paradigm, Núñez and colleagues (2006) provide behavioural evidence for the psychological reality of sequential reference. And Kranjec (2006) has provided behavioural evidence to suggest the psychological reality of extrinsic temporal reference. Again making use of an ambiguous temporal reasoning task, he demonstrated the following. When primed with motion ascriptions for time that adopt extrinsic reference, subjects reasoned in a prime specific way. Kranjec observed that if subjects are making use of extrinsic reference, this should provide responses which are opposite to those expected if sequential reference is being used (cf. Nunez et al. 2006). Hence, there is an empirical basis for distinguishing between these two types of temporal reference.

Given the apparent existence of three types of temporal reference strategies, the question that arises is how best to account for these. More specifically, what exactly is the nature of each type of reference strategy? How do they differ? What are their neurological and experiential antecedents if any? And do they have linguistic reflexes. These are the specific questions I address in this paper.

An important research tradition in cognitive linguistics has been to assume a close link between space and time, as perhaps best exemplified by Conceptual Metaphor Theory (Lakoff and Johnson 1980, 1999). In this approach, time arises as a cognitive artefact of experiencing and processing (motion through) space. Lakoff (1993), for instance, argues that the different perspective points associated with deictic reference in the domain of time are due to a general conceptual metaphor: TIME PASSING IS MOTION THROUGH SPACE. In other words, time may not exist as a thing unto itself, but is parasitic on first experiencing more experientially basic concrete experience types, harvested by sense-perception (Lakoff and Johnson 1999).

This way of thinking about time, in which it metaphorically recruits structure from the domain of space, implies that theoretical constructs from the domain of space can be applied, perhaps straightforwardly, to model time. Indeed, recent research has sought to adapt Levinson's (2003) seminal treatment of frames of reference (FoRs) in the domain of space—what I shall refer to as s-FoRs—and apply it to temporal reference. For instance, Tenbrink (2011) has insightfully analysed deictic and sequential reference in terms of s-FoRs. Bender et al., (2005, 2010) have also sought to apply s-FoRs to time, dealing with all with all three temporal reference types (deictic, sequential and extrinsic).

In this paper I take a somewhat different tack. While not denying that space can and indeed often does support temporal reasoning, my central thesis is that time is fundamentally different from space. Because of this, the nature of the relations involved in spatial versus temporal reference are quite different. Indeed, I argue below that they are incommensurable. While an application of spatial frames of reference (s-FoRs) to time is doubtless insightful, I argue that such an application misses the essential nature of temporal reference. Once I have made the case for the fundamentally divergent nature of spatial and temporal reference, I develop a taxonomy of deictic, sequential and extrinsic temporal frames of reference (t-FoRs). Temporal reference, I claim, is grounded in the phenomenon of *transience*, which is the hallmark of temporal reference (Galton 2011). Moreover, transience manifests itself in three distinct ways, giving rise to distinct *temporal relations*. I argue that the function of a t-

FoR is to give rise to a temporal relation, and hence is best studied not by modelling temporal reference in terms of *spatial relations*. This follows, I will argue, as transience is precisely that facet of temporal experience which is absent from spatial experience. In this paper I develop the theoretical construct of the t-FoR. This, I argue, is quite different from the s-FoR in a range of ways.

2. The nature of temporal reference

In this section I clear the path for the development, in later sections, of a detailed taxonomy of t-FoRs. I motivate the difference between temporal and spatial reference by examining the divergent nature of time and space, and the reference strategies involved.

2.1. Time versus space

Time and space can be compared and contrasted across four parameters: *magnitude*,¹ *dimensionality*,² *directedness* and *transience* (Galton 2011). I consider each of these parameters in turn. Time and space appear to exhibit the parameter of magnitude, but decrease in their level of overlap across the other parameters, such that while time exhibits transience, space does not. Hence, there is cline of decrease in overlap as we proceed along the parameters. This is captured in Figure 1.

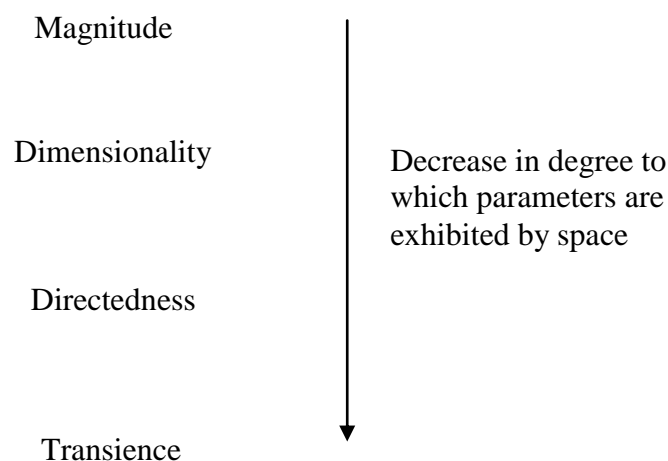


Figure 1. Degree to which parameters exhibited by time are also exhibited space

One of the most important claims to be made below is that while time is multifaceted, and involves different ways of recruiting space to support the structuring of time, temporal reference relates only to the temporal parameter of transience. That is, temporal reference involves the fixing of an event with respect to transience. As transience is a feature of time, but not space, it stands to reason that temporal reference is quite unlike spatial reference, in ways to be discussed.

I further argue, below, that transience is not in fact a discrete parameter. Rather, I suggest that it arises from the ways in which time manifests itself in terms of magnitude,

¹ Galton (2011) uses the term 'quantity'.

² Galton (2011) uses the term 'linearity'.

dimensionality and directedness. In other words, my second claim is that transience comes in different forms.

MAGNITUDE

The parameter of magnitude relates to the quantifiability of a given *substrate*—the stuff that makes up the domain. The substrate that makes up space is *matter*, of which two broad types can be distinguished: discrete entities (e.g., objects) and mass entities (e.g., fluids). In addition, the substrate that makes up a domain exhibits a particular property allowing the substrate to be quantified: the way in which the substrate can be ‘cut up’ into ‘amounts’. The amounts, in the domain of space, relate to the property *extension*. Extension manifests itself in three distinct types. Space’s extension involves length (one dimension), area (two dimensions), and volume (three dimensions).

The substrate that makes up time is that of *action* (Talmy 2000). As with space, action can also be broadly subdivided, as reflected in language. This relates to whether action is *bounded* versus *unbounded*, analogous to the distinction between discrete versus mass for the substrate matter.

In the domain of time, the property exhibited by action, and hence, the means of ‘cutting up’ action in amounts is *duration*, rather than extension. While duration can, self-evidently, be quantified by using *measurement systems* involving material artefacts such as clocks, duration (of relatively short periods) can be estimated without the need for measurement systems such as these. Indeed, human subjects appear to be able to reliably distinguish between periods of different temporal magnitudes. Moreover, evaluation of temporal magnitude (i.e., duration) appears to be tied to neurological function, strongly suggesting that its provenance is internal (rather than external) in nature (Fraisse 1963; Baddeley 1966; Wearden and Penton-Voak 1995). Moreover, and unlike the property of extension exhibited by spatial substrate, there is only one dimension with respect to which temporal substrate is quantified, to be discussed below. The distinctions between space and time in terms of the parameter of magnitude are summarised in Table 1.

Domain	<i>Space</i>	<i>Time</i>
Substrate	Matter	Action
Property	Extension	Duration
Distinctions	Discrete vs. mass	Bounded vs. Unbounded

Table 1. Comparing the parameter magnitude for space and time

DIMENSIONALITY

Dimensionality relates to the range of quantifiability of the substrate in a given domain. In the domain of space, the substrate is quantifiable along three dimensions. These are the lateral (left/right), sagittal (front/back) and vertical (up/down) planes. This provides a spatial environment which can be assessed in terms length, area and volume. In contrast, the quantifiability of the substrate in the domain of time relates to one dimension, namely *succession*. That is, in so far as time exhibits dimensionality, this relates to a sequential relation holding between units of action (aka *events*) whereby one event succeeds another. It is important to note here, however, that strictly speaking, thinking of time as one dimensional is in fact to apply a spatial metaphor, in order to understand the notion of succession.

DIRECTEDNESS

This relates to whether the substrate in a given domain is *symmetric* (i.e., isotropic) or *asymmetric* (i.e., anisotropic). Space is isotropic: it has no inherent asymmetry. Indeed, it is possible to proceed in any direction: forward or back, or from side to side.³ In contrast, time is anisotropic: it manifests asymmetric organisation. One of the most celebrated forms of anisotropy, in the domain of time, relates to the thermodynamic property of matter, exhibited by the dispersal of energy (entropy): all things being equal a cup of coffee cools down, and cannot subsequently and spontaneously heat up again. The anisotropic nature of time, particularly at the macroscopic level of matter led the British astrophysicist, Sir Arthur Eddington (1928), to coin the term ‘the arrow of time’ (see also Coveney and Highfield 1991). However, this is not the only form of time’s ‘arrow’. Le Poidevin (2003) has argued for three ‘arrows’ of time. The first might be termed the *thermodynamic arrow*, proceeding from lower to higher entropy. The second relates to what might be termed the *psychological arrow*, moving from the anticipation of events (future), to the perception of events (present) to the recollection of events (past). The third is a causal arrow, involving an asymmetry between causes and their effects.

TRANSIENCE

The final parameter relates to transience. While time and space can be compared on the basis of the previous three parameters, transience is entirely lacking from the domain of space. Transience concerns the phenomenologically real experience of a ceaseless change in human experience; this amounts to the ephemeral experience of one moment being replaced by another, which in turn gives way to another, and so on. In more figurative terms, it concerns a present ceaselessly reborn, but each moment being unique, never the same as the one gone before.

In fact, I suggest that this striking feature of temporal experience is, in fact, less a discrete feature of time, but a consequence of the cumulative effect of the three parameters described above. That is, transience arises from temporal magnitude, which is to say duration, in conjunction with the sequential dimension of time, in which events form a sequence, with earlier events preceding later ones, combined with the anisotropic nature of time, particularly the psychological arrow, which relates to the distinction between future and past tied to the deictic experience of the present. This view of transience as arising from three parameters is captured in Figure 2.

³ While space has no inherent asymmetry, Galton (2011) points out that some directions in space do nevertheless exhibit asymmetry. For instance, the vertical plane is asymmetric by virtue of the gravitational pull of the Earth, which provides an asymmetry between up versus down. Analogously, there is an asymmetry between North and South, a consequence of the magnetic core of the Earth.

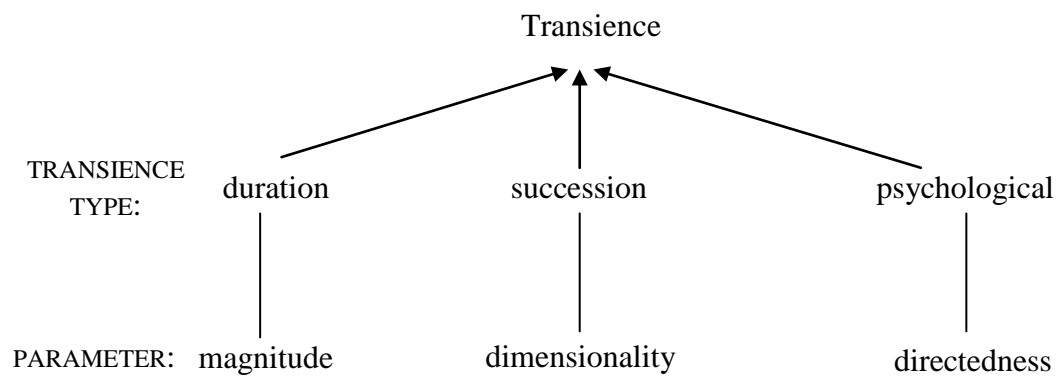


Figure 2. Types of transience and their parameters

Figure 2 captures the following. Transience is a complex phenomenological experience made up of (at least) three distinct types of transience. Duration is a type of transience that concerns the felt experience of elapse. Succession is a type of transience that relates to the felt experience of events proceeding as a sequence, a progression, with events thus exhibiting an order in the sequence. Finally, psychological transience relates to the felt distinction between the present, future and past, with the future becoming the present, before becoming the past. Together, these parameters amount to transience as we experience it, the hallmark of time.

The central claim of this paper is that temporal reference relates to transience. That is, the function of temporal reference systems is to fix an event in time, which is to say, with respect to the transient nature of time. The three t-FoRs to be described provide distinct strategies for fixing events with respect to the three distinct types of transience identified.

2.2. *Temporal reference vs. Spatial reference*

To make explicit the difference between spatial and temporal reference, I begin with a standard definition of an s-FoR:

- (4) s-FoRs are “coordinate systems used to compute and specify the location of objects with respect to other objects.” (Majid et al., 2004: 108).

As is evident from this definition, s-FoRs are concerned with spatial relations holding between objects, and specifically, locating objects with respect to other objects. The substrate involved is matter, and the domain is space. Moreover, with the notable exception of Tenbrink (2011), most theoretical work on s-FoRs has been concerned with static spatial relations on the horizontal axis (e.g., Levinson 2003; Talmy 2000).

In contrast, I propose the following definition for t-FoRs:

- (5) A t-FoR provides a coordinate system used to identify an event with respect to transience. Temporal coordinate systems are distinguished based on specific temporal relation, arising from a distinct transience type.

In terms of these definitions, while an s-FoR locates one object with respect to another, a t-FoR, has a somewhat different function. First of all, the notion of ‘location’ is

completely absent: an event is being identified. Moreover, the event is identified not in terms of its relative location to another. Rather, it's being identified with respect to transience. Yet, transience is an experience type that is completely absent from the domain of space. Finally, s-FoRs involve coordinates mediated by vectors. In contrast, the “coordinates” involved in temporal relations are not mediated by vectors, as they do not relate to one (or more) dimensions, in the same way that space does. Strictly speaking, the notion of a ‘dimension’ is a fundamentally spatial notion. Hence, I conclude, temporal reference is wholly different from spatial reference.

While there are commonalities between space and time, for instance, in terms of a shared ability to evaluate magnitude—although the properties involved are of qualitatively distinct types, extension versus duration—it doesn't follow that temporal reference is analogous to spatial reference. For that to be the case, temporal reference would have to involve similar experience types, and have a similar purpose to spatial reference. But my claim is that the functions performed by spatial reference, on the one hand, and temporal reference on the other are incommensurable. A t-FoR is something fundamentally different from an s-FoR: the property that is central for t-FoRs is transience, the very property that is not apparent in the domain of space.

A researcher interested in applying findings on s-FoRs to t-FoRs might counter that the linguistic (and indeed behavioural) evidence appears to show that temporal reference invokes language relating to motion to achieve temporal reference. And in so doing, substrate from the domain of space is being imported in order to support temporal reference. However, as pointed out by Galton (2011), motion involves a correlation between space and time. It concerns, after all, a change in location of an entity over time. In other words, motion involves transience, which is provided by virtue of motion being structured *in terms of* time. Hence, the reason why ascriptions of motion provide, presumably, a ready means of (linguistically) supporting temporal reference is precisely because they provides a concrete, and highly salient, reflex of transience, the very quality that is the hallmark of temporal reference. Moreover, the lexicalisation of motion in t-FoR constructions does not relate to veridical motion—see for example Moore (2011), who observes that metaphorical motion is distinct from veridical motion. That said, there is nevertheless compelling linguistic and behavioural evidence for thinking that space has a role in, at the very least, supporting temporal cognition. I provide a possible reason for this later in the paper, once I have adduced a taxonomy for t-FoRs (see §7).

2.3. Temporal relations

While transience concerns that aspect of time which is the hallmark of temporal reference, I argue below that each transience type relates to a distinct t-FoR. The hallmark of each is a specific temporal relation. In this section I make the case for the construct of temporal relations.

It has long been noted by philosophers that time is conceptualised and lexicalised in terms of motion in space. Smart (1949), for instance, described two metaphorical conceptions for time, in which time is conceived in terms of motion towards an observer, or an observer's motion towards the future. In relatively recent times this observation has been taken up by psychologists and linguists. In characteristically insightful work, Clark (1973) modelled this distinction in terms of a divergence in *perspectives*, paving the way for the contemporary study of temporal reference. As noted earlier, Clark distinguished between the Moving Ego (ME) and Moving Time (MT) perspectives of temporal conceptualisation. The distinction between ME and MT space-to-time motion models was formalised by Lakoff and Johnson (1980) in their highly influential Conceptual Metaphor Theory (CMT), as figure-ground reversals of the more general TIME PASSING IS MOTION conceptual metaphor (Lakoff

1993). On this view, inferential structure from the domain of (motion through) space is recruited by the domain of time in order to structure our conceptualisation of time (see Lakoff and Johnson 1999).

In more recent work, Moore (2000, 2006) has convincingly argued that, in addition to the ME and MT perspectives, there is a conceptualisation of time which is sequential in nature. Building on insights by Traugott (1978), Moore points out that in an example such as (6), time is conceptualised not in terms of an egocentric perspective-point, but rather, as being sequential in nature:

(6) Christmas comes before New Year's Eve

Moore's work is important in at least two ways. Previous research, both within and outside the CMT tradition, while acknowledging the importance of perspective in conceptualisations of time, hadn't stressed it to the degree found in Moore's work. Moore, arguably for the first time in contemporary research, refers to 'reference frames' in order to describe space-to-time motion ascriptions.

Secondly, Moore introduces an important notion into the literature, that of 'temporal relation' (although Moore doesn't specifically use this term). In essence, Moore observes that the distinction between the example in (6) and those in (1) is that the latter denote a *future/past relation*. This relation relates to, and arises from, what I have dubbed psychological transience. That is, this temporal relation is a consequence of the type of transience arising from the phenomenologically real experience of a present which is ceaselessly updated. In contrast, the example in (6), according to Moore, denotes an *earlier/later relation*. This relation is grounded in the transience type: succession. After all, a salient feature of event sequences is the earlier/later relationship holding between two given events in the sequence.

Moore further observes that these distinct temporal relations—future/past and earlier/later—have different reference points (RP). In the examples in (1) the RP is the ego—the human egocentric experience of now—or more precisely the location here, which metaphorically corresponds to now, a distinction that is important as we shall see later. Christmas is conceptualised by virtue of whether it is set in the future or the past with respect to the ego. In (10), in contrast, the RP is not the ego, but rather an event, New Year's Eve, which serves to fix Christmas in time.

In addition to future/past and the earlier/later temporal relations, a third temporal relation suggests itself. This concerns the relation in which time constitutes *the event* in which all others occur. In earlier work (Evans 2004), I referred to this as the matrix conception of time: time forms a boundary relation, a matrix or manifold, which subsumes the beginning and ending of all of existence. Just as the future/past relation arises from psychological transience, and the earlier/later relation arises from succession, the matrix relation arises, I suggest, from durational transience, as I shall argue.

That said, the matrix relation is somewhat different from the previous two. Firstly, the future/past and earlier/later temporal relations appear to be grounded in phenomenologically real experience types. In contrast, it cannot be said that the matrix relation is similarly grounded in phenomenologically real experience. After all, the matrix relation concerns an elapse that is eternal in nature. Yet, as human life is clearly not eternal, it stands to reason that the matrix relation, while grounded in the transience type: duration, emerges from the prior conceptualisation of duration as an ontological category reified as an entity independent from the substrate that makes up the domain of time. In other words, the matrix relation emerges from a reified version of duration, conceived as being independent of events and available as a category for inter-subjective reflection in its own right.

Kranjec (2006) has provided behavioural evidence for thinking that there is a temporal reference strategy, what he dubs extrinsic, in which time is conceived as a field providing events with an ‘extrinsic’ frame of reference. My proposal is that this field arises from durational transience, and the temporal relation involved is the matrix relation.

Table 2 summarises the distinct types of transience, the temporal relations involved and the reference strategies that emerge.

TYPE OF TRANSCIENCE	TEMPORAL RELATION	NAME OF t-FoR
Psychological	Future/past	Deictic
Succession	Earlier/later	Sequential
Duration	Matrix	Extrinsic

Table 2. Temporal relations

3. The Nature of Temporal Frames of Reference (t-FoRs)

A t-FoR involves a coordinate system that gives rise to one of three types of temporal relation. A t-FoR identifies, or fixes, an event with respect to one of the three types of transience identified earlier, from which the temporal relation arises. In this section I present a detailed taxonomy of the three types of t-FoRs. My main line of evidence is language, and in particular English. My assumption is that language provides reflexes of each of the three distinct t-FoRs. These take the form of sentence-level constructions (in the sense of Goldberg 1995, 2006; see also Evans 2009) involving motion ascriptions of particular kinds. What the motion ascriptions achieve is the encoding a different kind of temporal relation, the hallmark, I suggest of a distinct t-FoR.⁴

In this section, I present an overview of the main elements that make up a t-FoR, and how these relate to temporal relations, and reference strategies. In later sections I argue for three distinct t-FoRs, presenting evidence to support my claims as I proceed.

3.1. Coordinates employed in t-FoRs

A t-FoR, as encoded linguistically, makes use of a number of coordinates in order to identify an event with respect to a specific transience type. As such, it constitutes a *coordinate system*. There are four coordinates that appear to be required to describe a linguistically-encoded t-FoR.

The first of these is a *target event* (TE). This is the event being identified with respect to transience. To illustrate, consider the following:

(7) We are fast approaching Christmas

⁴ In this discussion I am assuming the Cognitive Construction Grammar perspective of Goldberg (1995, 2006), and the approach to lexical semantics developed in Evans (2009), which draws upon Cognitive Construction Grammar. Briefly, this combined perspective assumes that grammatical knowledge consists of constructions. Constructions are form-meaning pairings that are mediated by a symbolic link holding between the two components, the form and the meaning. A construction can consist of bound morphemes, words, idiomatic expressions, or sentence-level constructions. Moreover, the form can be phonetically overt or phonetically implicit, while the meaning element takes the form of a lexical concept. A lexical concept constitutes a knowledge bundle involving semantic selectional tendencies, as well as an access point to conceptual knowledge (see Evans 2009). Nevertheless, the argument I make in this paper does not depend upon this theoretical perspective on linguistic organisation.

In this example, the TE is Christmas, encoded by the form *Christmas*. This is the event being fixed. In addition to a TE, a t-FoR has a *reference point* (RP), with respect to which the TE is fixed. In the example in (7), the RP is the location of the ego, encoded by *we*. A t-FoR also includes an *origo* (O). This provides a means of grounding the RP in the transience type that defines the specific t-FoR. In this example, the O is the egocentric experience of now, which constitutes the conscious experience of the present. As the ego's location correlates with the egocentric experience of now, this guarantees that the location of ego, which serves as the RP for identifying the TE, relates to a temporal—rather than a spatial—relation. In the example in (7) the temporal relation is future/past, anchored by the O, here the egocentric experience of now. By virtue of this, the TE, Christmas, is identified as being future-based with respect to the experience of transience. In other words, the metaphoric spatial relation, the relative approach of the experience with respect to a temporal landmark, can be used to 'compute' the temporal relation precisely because the O grounds the spatial relation to psychological transience: the temporal experience relevant here for fixing the event of Christmas.

Evidence for a disjunction between the constructs of an RP and an O, both of which are encoded by *we* in (7) follows from the following observation. The sentence encodes a *temporal scene* rather than a *spatial scene*. Sentence (7), despite employing the form *approaching*, is not taken to refer to veridical motion, but rather, the relative imminence of Christmas. That is, it concerns a temporal relation. For that to be the case there must be a means of fixing the TE, Christmas, with respect to the transience type that supports the temporal scene encoded by (11). The temporal relation that consequently arises—whether the TE is future or past-based with respect to the RP—must be grounded by the egocentric experience of now, the O. If that were not the case, the experiencer's location (RP) relative to Christmas, could not be interpreted in temporal terms.

A previously unremarked observation relates to 'spatial' sentences that parallel (7). Consider (8) by way of example.

(8) We are fast approaching London

One key difference between (8) and (7) is that (8) conveys veridical motion, as it must if it is to be taken to encode a spatial, rather than a temporal scene. However, in certain other respects the examples in (7) and (8) are analogous. For instance, in (8) *we* encodes location on a path relative to the landmark, London, which is the entity being approached. However, a consequence of undergoing motion, which, as noted earlier involves transience, is that the experiencer in (8) is also associated with the egocentric experience of now, which correlates with the experiencer's present location. In other words, in (8) London is located spatially ahead of the experiencer, *and* is situated in the future, given the experiencer's current apprehension of the present. Hence, what is common to both (7) and (8), and hence to both spatial and temporal scenes, is that there is a spatial location and an egocentric awareness of now associated with the experience, as encoded by *we*. Indeed, it is plausible that the reason relative motion constructions of the sort exemplified by (8) have been extended to temporal scenes as in (7) is precisely because there is a correlation in veridical motion between location and the experience of transience.⁵

That said, there is a key difference evident upon closer examination of these sentences. As noted by Clark (1973), and Lakoff (1993), sentences such as (7) can involve

⁵ In slightly different terms, Moore (2006) makes a related point with his discussion of the *grounding scenarios* for space-to-time motion metaphors.

figure-ground reversal, and provide a different perspective. Consider the example in (9) by way of contrast with (7):

(9) Christmas is fast approaching us.

In (9), the TE, the event being identified with respect to transience, remains the same; it is Christmas. Moreover, the RP remains as the experiencer's location, tied, by the O, to the egocentric experience of now. Yet, there is a difference in perspective point (PP). Indeed, PP is the fourth and final coordinate that makes up a t-FoR. In (9) the PP is fixed at the TE, which, in grammatical terms, is encoded in subject position in the sentence. That is, the relative imminence of Christmas, with respect to the egocentric experience of now is viewed from the perspective of the TE. In contrast, in (7) the PP is fixed at the RP. Hence, in (7) the scene is viewed from the perspective of the RP.

Unlike constructions encoding temporal scenes, relative motion constructions cannot take different PPs. For instance, the putative PP reversal of (8) is ungrammatical:

(10) *London is fast approaching us

This illustrates a key difference between s-FoRs and t-FoRs. Although spatial location plays a role in the way spatial relations are computed some types of t-FoR, the underlying relation is temporal. And as such, the PP can be switched in certain cases. In contrast, a s-FoR involves a spatial relation holding between a Figure (F) and a landmark (LM) or locatum. Moreover, the grammatical structure of language appears to pattern after the focal (perceptual prominence) afforded to figures, following perceptual principles of figure/ground segregation (see Evans and Green 2006; Langacker 1987, 2008; Talmy 1978). This appears to require that when encoding spatial scenes, the F occupies subject position, and precludes a reversal of PP. Because of this, spatial scenes cannot easily be encoded in language with the same degree of flexibility in terms of PPs that is evidence in t-FoRs.

In order to facilitate the discussion in the rest of the paper, Table 3 presents a summary of the key terms, relating to coordinates, employed in describing t-FoRs.

Coordinates	Description
Target event (TE)	The event, in a temporal scene, that is identified with respect to transience
Reference point (RP)	The point which is deployed to fix the TE
Origo (O)	The point that serves to ground the RP to the transience type that defines the t-FoR
Perspective point (PP)	The perspective from which the temporal scene is viewed, this can take the perspective of the TE or the RP

Table 3. Coordinates in t-FoRs

3.2. Temporal reference strategies

In this section I consider other aspects central to a description of t-FoRs. This includes, notably, the notion of a reference strategy. As each t-FoR identifies a TE with respect to a distinct type of transience, this gives rise to a distinct *reference strategy*: a unique approach to fixing reference.

Coordinate systems arise on the basis of how reference is fixed amongst the coordinates. In this respect, the relationship between the RP and O, which together serve to

fix reference, and hence identify the TE, is criterial. Each of the three t-FoRs identified exhibits a distinct type of reference, the consequence of a distinct reference strategy.

The deictic t-FoR involves a coordinate system that is egocentric. This follows as it is the egocentric experience of now which anchors reference to the psychological transience type. This provides an *experiencer-based* reference strategy, as temporal reference derives from the human experience of the present. A linguistic example of this type of reference strategy is exemplified by (7).

In contrast, the sequential t-FoR involves an allocentric coordinate system—one that is other-based—rather than being based on the experiencer in question. This is the case as reference is facilitated by events in a sequence, which gives rise to an earlier/later temporal relation. Because of this, the reference strategy can be classified as *event-based*. An example of this type of reference strategy is exemplified by the example in (11):

(11) Christmas precedes New Year's Eve

In this example, the TE, Christmas is fixed with respect to an event-based reference strategy. This involves relating the position of Christmas to other events in a sequence, and specifically, New Year's Eve, with respect to which Christmas is earlier.

Finally, the extrinsic t-FoR involves a field-based coordinate system. This follows as it provides a means of establishing an equably graduated field which anchors reference to a matrix—a conceptualisation of duration as an unending event in which all else occurs. The field is established by virtue of adopting a *periodicity-based* reference strategy. That is to say, reference is fixed by virtue of external periodicities—naturally recurring perceptual occurrences, of which there are many types—which can be measured in a variety of ways. Consider the following example:

(12) The time is approaching 11

In this example which relates to the 12 hour clock, a TE is identified. This is achieved by measuring the elapse associated with the periodic behaviour of a mechanical device (e.g., a watch), thereby relating the TE, the present moment, to the RP, which is the location of 11 on a clock 'face'.

Table 4 presents a summary of the different reference strategies and how they relate to other features of t-FoRs.

	Deictic t-FoR	Sequential t-FoR	Extrinsic t-FoR
Type of transience	Psychological	Succession	Duration
Temporal relation	Future/past	Earlier/later	Matrix
Type of coordinate system	Egocentric	Allocentric	Field-based
Reference strategy	Experiencer-based	Event-based	Periodicity-based

Table 4. Reference strategies and their relationship to t-FoRs

4. The deictic t-FoR

I now turn to a detailed discussion of individual t-FoRs, beginning with the deictic t-FoR. This t-FoR provides a temporal coordinate system that relates to psychological transience: the felt experience that time evolves from future to present to past. This arises from the phenomenologically real experience of a present which is in a perpetual state of modification. This subjective experience provides a basis for distinguishing between the anticipation of an

event's occurrence (the future), and the recollection of events that have occurred (the past). Hence, this type of transience gives rise to the temporal relation future/past. In this section I begin by briefly considering the neurological basis for the egocentric experience of now, from which the deictic t-FoR takes its reference (§4.1). I then consider in outline the nature of the deictic t-FoR, and on the basis of linguistic evidence, show how it is distinct from grammatical tense (§4.2). I then consider the different perspective points (PP) available, for the linguistic encoding of the deictic t-FoR (§4.3), before providing an overview of and the range of semantic clusters that show up in language (§4.4).

4.1. *The neurological basis for the deictic t-FoR*

The egocentric experience of 'now' appears to have a neurological basis. Specifically, it is likely that it arises from mechanisms that facilitate the binding of perceptual information derived from different brain modalities in the formation of a coherent percept. Before discussing the deictic t-FoR in more detail, I briefly discuss the provenance of the human experience of 'now'. The experience of 'nowness' relates to what James ([1890]/1950) referred to as the specious present "[T]he short duration of which we are immediately and incessantly sensible" (Ibid.: 631). This short duration is more commonly referred to as the *perceptual moment* and appears to have an outer limit of around 3 seconds (see Evans 2004 for review).

Cognitive neuroscientists have claimed that the perceptual moment arises from the perceptual process itself, which serves to update perceptual processing within a short window of attention. This, in turn, appears to be a consequence of distributed timing mechanisms across different regions of the brain. Research over the last two decades suggests that the perceptual moment arises due to the coordinated oscillation of neurons followed by a silent interval (Pöppel 1994, 2009; see also Crick and Koch 1990; Dennett 1991; Edelman 1992; Engel, König and Schillen 1992; Mauk and Buonomana 2004; Varela et al., 1991). Moreover, perceptual moments appear to be ubiquitous at the neurological level, occurring at all levels of processing. They range from a fraction of a second up to an outer limit of around three seconds (see Chafe 1994; Davies 1996; Pöppel 1994).

Pöppel (1994) has argued that perceptual moments can, in broad terms, be divided into two types. The first, what he refers to as *primordial events* last for a fraction of a second. These serve as a linking activity to integrate, or 'bind', spatially distributed information in the brain between and within different modalities. This facilitates perception of an entity, such as an object, in which sensory information is integrated, in order to create a coherent percept. The second type, with an outer window of 2-3 seconds, links these primordial events into a coherent unity. This type, he argues, involves temporal binding—as opposed to the binding of spatially-distributed activities. Pöppel proposes that it is the perceptual moment in this latter range to which our phenomenologically-real experience of now (and our concept of the present) can be traced.⁶

4.2. *The nature of the deictic t-FoR*

In the deictic t-FoR, the O constitutes the egocentric experience of now, anchoring the system to the phenomenologically real experience of the perceptual moment (psychological

⁶ The evidence for a perceptual moment having an outer limit of around 3 seconds is persuasive. Ambiguous figures such as Necker cubes have a reversal rate of about 2-3 seconds. This suggests that perceptual processes re-analyse input in a holistic way every 2-3 seconds. Similarly, there is strong evidence on short term memory that stimuli can only be retained for around 3 seconds if rehearsal is not permitted (Pöppel 1994). In addition, there is evidence that basic units of human poetry (the line) and language (the intonational unit) are segmented into intervals of up to 3 seconds, irrespective of speaker's age or cultural background (Chafe 1994, personal communication; see also Davies 1995; Pöppel 1994; Turner and Pöppel 1983).

transience). Indeed, it is this anchoring to subjectively real experience of now which is what makes this t-FoR deictic. One consequence of this is that the temporal relation captured by this t-FoR is a past/future relation. However, the linguistic evidence shows that the deictic t-FoR also makes use of spatial information as a representational medium, in computing the temporal relation holding between the target event (TE) and the O. That is, events are related to a physical reference point (RP). More specifically, they are located with respect to the experiencer's location in three dimensional space. Hence, the RP in a deictic t-FoR is the experiencer's location, anchored by the experiencer's awareness of now, the O, which is coincident with the experiencer's precise location. Consider the following example:

(13) We are moving closer to Christmas

In this example the TE is Christmas, the event being fixed with respect to the psychological experience of transience. Yet the way this is achieved is by relating the TE to a spatial RP, the experiencer encoded by *we*. But as the experiencer is coincident with the egocentric experience of now, the relative motion of the experiencer with respect to Christmas provides a means of computing the relative point in time of the TE with respect to the O. And in this way, the TE is fixed with respect to psychological transience, giving rise to a future relation, in this example. Hence, spatial information provides a means of supporting temporal reference in the deictic t-FoR.

Within this kind of t-FoR, events fixed as being in the future can be said to exhibit the property: *imminence*. Events that are fixed as being coincident with the experience of now, can be said to exhibit *synchronicity*. Those that are fixed as being in the past, can be said to exhibit the property: *occurrence*. Hence, this t-FoR provides a means of fixing events that is very much grounded in the human experience of future/present/past, corresponding to the tri-fold distinction between current perceptual processing (present), memory (past) and anticipation (future)—see Gell (1992) for discussion. Consider examples illustrating these relations below:

'Imminence'

(14) Christmas is approaching

'Synchronicity'

(15) Christmas has arrived

'Occurrence'

(16) Christmas has gone

In each of these, there is a TE, *Christmas*. The RP is the experiencer's location, not explicitly encoded, but implicit in the deictic motion relation (e.g., *approaching* vs. *arrived* vs. *gone*). The claim I am making is that these examples are linguistic reflexes of the deictic t-FoR. To demonstrate that this is so, we need to exclude the possibility that these relations are due to tense. While not all languages feature a tense system, many do. Tense morphologically encodes the time reference of an event with respect to *coding time*: the notion of when the utterance is being made. In this, tense is clearly a deictic phenomenon, and thus, ultimately, also related to the ability to form perceptual moments. While some languages exhibit reasonable complexity in terms of their tense systems—the most tenses exhibited by a single language is eleven (Evans 2009)—a language such as English only features two tenses—present and past (or not now). Some languages, in contrast, don't encode tense, such as Mandarin. Examples of English tense are given below:

- (17) John kicks the ball (present)
 (18) John kicked the ball (past)

In order to conclude that the examples in (14) to (16) exhibit a deictic t-FoR, we must be able to demonstrate that the readings relating to imminence/synchronicity/occurrence are independent of tense. To do so, consider the following sentences:

- (19) Christmas is getting close
 (20) Christmas is coming up
 (21) Christmas is drawing near

These sentences all appear to relate to the relative imminence of a specific TE—the occurrence of Christmas—with respect to an implicit RP—the event/location with respect to which Christmas is ‘moving’. Moreover, the semantic function of relative imminence is retained regardless of the tense of the verb phrase, as we can see by placing (21) in various (complex) past tense forms:

- (22) Christmas drew near
 (23) Christmas was drawing near

What we see in (22-3) is that the semantic function still relates to relative imminence, regardless of whether the sentence is set in the present or the past with respect to coding time.

Now let’s consider the situation with respect to occurrence:

- (24) a. Christmas has vanished
 b. Christmas has disappeared

The example sentences in (24) relate, in contrast, not to relative imminence, but to relative occurrence, and moreover, occurrence that is distant: if the TE is no longer ‘visible’, its occurrence must be relatively distant from the (implicit) RP. And as with imminence, the reading of occurrence in these sentences is independent of the tense involved:

- (25) a. Christmas is vanishing
 b. Christmas will vanish

In (25) the sentences still relate to occurrence, regardless of the tense—or modality, as signalled by the modal marker *will* in (25b)—involved. The fact that ‘imminence’ and ‘occurrence’ are semantically independent of tense (and futurity, signalled by a modal marker), demonstrates that they are independent of coding time.

In contrast, a sentence can involve tense without necessarily involving a t-FoR, in the sense developed in this paper. Let’s return to the example of ‘kicking the ball’:

- (26) John kicked the ball.

The event described in (26) is a kicking event. However, the event is not being anchored with respect to the psychological transience—the egocentric experience of now, achieved via a spatial RP with which it co-occurs. Rather, the event is being straightforwardly related to coding time: the point at which the utterance is made. Past tense signals that the event

occurred prior to coding time. While tense is presumably related to psychological transience, tense, as a system, provides a different semantic function from the deictic t-FoR.

4.3. Perspective points

A salient feature of the linguistic reflex of the deictic t-FoR is that the same temporal scene can be encoded from two distinct perspective points (PPs). The first type involves a PP fixed at the event being located in time, the TE. To illustrate, consider the following:

(27) Christmas is approaching

In this example, the temporal scene being encoded relates to a TE: Christmas, and an implicit RP: the experiencer's location. However, the TE, *Christmas*, occupies the subject position in the linguistic expression. This is the position identified by Langacker (1987, 2008), in his theory of Cognitive Grammar, as reserved for the participant that occupies focal prominence in an utterance. He uses the term *trajector* (TR) to refer to the participant in a scene that achieves focal attentional prominence. Hence, in (27), the TE achieves focal prominence by virtue of occupying subject position. Put another way, the temporal scene is being viewed from the perspective of the TE. This can be represented diagrammatically as in Figure 3.

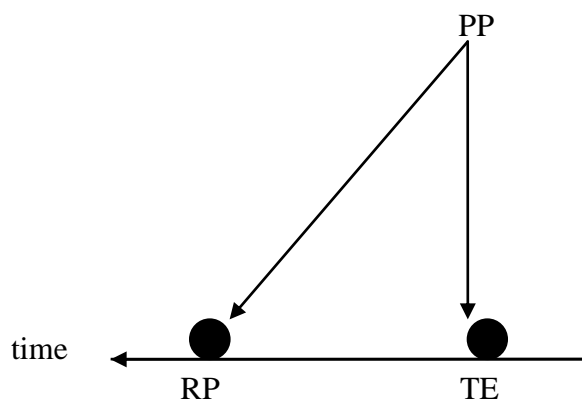


Figure 3. Target event perspective point

Figure 3 captures the following information with respect to the sentence in (27). There are two events set in time. The first serves as an RP. The second is the TE, the event being fixed with respect to the RP. In Figure 3 the perspective point (PP) is situated directly above the TE, which serves as the perspective from which the temporal relation is viewed, as indicated by the two arrows.

Now let's consider the second type of PP. This type involves a PP fixed at the RP. To illustrate, consider the following example:

(28) We are approaching Christmas

In this example, the temporal scene being encoded also relates to a TE: *Christmas*, and, in this example an explicitly encoded RP: the location of the experiencer, encoded by *we*, which is determined by the O, the egocentric experience of now. With respect to this RP, Christmas is set as future-based, and hence imminent. The two temporal events—the occurrence of Christmas (TE), and the location of the experiencer/experience of now (RP/O)—establish a relation whereby the TE is set in the future.

However, and in contrast to the example in (27), the RP occupies the subject position in (28), while the TE, Christmas, occupies the object position, and hence achieves secondary focal prominence. This is what Langacker refers to as the *landmark* (LM) (Ibid.: 1987; 2008). Accordingly, (28) provides evidence that the PP is set at the RP, rather than at the TE. Put another way, the temporal scene is being viewed from the perspective of the RP. This can be represented diagrammatically as in Figure 4.

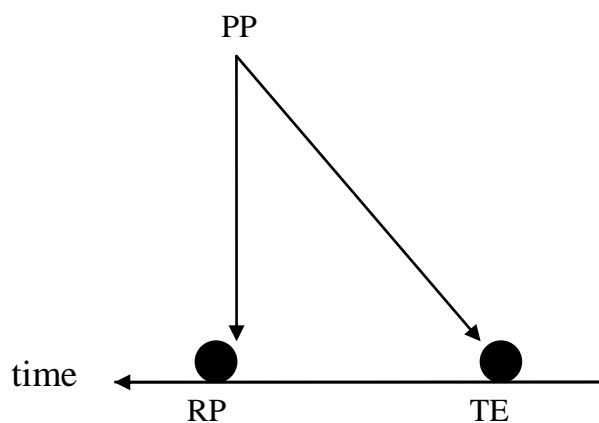


Figure 4. Reference point perspective point

Figure 4 captures the following information. There is an event, our experience of now, which is coincident with the location of the experiencer. The latter serves as the RP. There is also a TE: the event being located in the temporal scene. In Figure 4 the PP is situated directly above the RP, which serves as the perspective from which the relation is viewed, as indicated by the two arrows.

4.4. Types of deictic t-FoRs

In terms of linguistic encoding, it is possible to identify four distinct semantic clusters relating to the deictic t-FoR. In other words, the deictic t-FoR appears to be encoded by four distinct sorts of constructions. In general terms, deictic t-FoR constructions encode a relation between a TE and a RP. The RP encoded relates to the spatial location of the experiencer, and the TE is linguistically encoded as being located on either the anterior or posterior region of the sagittal (front/back) axis with respect to the experiencer. Hence, one type of distinction in linguistic encoding relates to whether an imminence (anterior) or occurrence (posterior) relation is being encoded. Another concerns the quality of the elapse involved, while a fourth type relates to the degree of remove holding between the RP and TE and appears to involve a greater degree of spatial language to encode this idea.

Consider, first of all, examples that relate to imminence:

‘Imminence’

- (29)
- a. Christmas is approaching (us)
 - b. Christmas is getting closer (to us)
 - c. Christmas is moving towards us
 - d. Christmas lies in front of us

Examples relating to imminence include an obligatory subject noun phrase (NP). This consists of, at the very least, a head noun, e.g., *Christmas*, although more complex NPs are possible, e.g., *The time for a decision*. Importantly, the temporal entities that fill the subject position must be a temporally discrete—which is to say a bounded event—and hence one that can be construed as one that can exhibit imminence. For instance, in an example such as the following:

(30) Time flows on forever

the use of the form *time* here relates to the matrix construal—time as the entity which subsumes all others. As such, imminence is not a relation that can relate to this temporal notion, as the event being described is one that is conceived as, in principle, unbounded.

The examples in (29) also include a verb phrase (VP), consisting of at least a head verb, e.g., *lies*, as in (29d). Again, more complex VPs are possible, e.g., *is getting closer*. In addition, examples can include an oblique object (OBL): an indirect object headed by a preposition and followed by an NP, e.g., *towards us* in (29c).

While the first three examples in (29) all relate to ascriptions of motion, imminence can also be encoded using a spatial path designation as in (39d). This encodes the imminence relation between the TE and RP by virtue of their relationship on a (linear) path, thereby making salient their relationship in terms of *where* on the path they lie. More specifically, the semantic arguments that fill the OBL element relate to the anterior region of the sagittal axis. This excludes semantic arguments relating to the lateral (left/right) or vertical (up/down) axes, as indicated by the hash sign preceding the following examples:

- (31) a. #Christmas is above us
b. #Christmas is right of us

Also excluded are semantic arguments that relate to other orientation systems such as cardinal points:

- (32) #Christmas is north of us.

The fact that a linear path is involved suggests that examples such as (29d), although designating a path relation, is based on, or is (at the very least) closely related to the motion ascriptions that appear to be the more frequently used ways of encoding deictic t-FoR in English—motion is path-based after all.

In addition to imminence, there appear to be a number of constructions for encoding occurrence. Consider the following examples. These encode a relation between a TE and the RP in which the TE has occurred, and is fixed as co-located with, or being located on the anterior region of the RP's sagittal axis.

‘Occurrence’

- (33) a. Christmas has gone by
b. Christmas has vanished (over the horizon)
c. Christmas lies behind us

In the first example, motion is ascribed such that the TE is set behind the RP. This corresponds to a past relation in terms of the O. The VP selects for semantic arguments relating to manner-neutral motion events that can be construed as giving rise to a location at or behind the RP (*go*, but also verbs such as *pass*, *move*, *etc.* are possible). Moreover, the

motion events selected for do not encode a terminal point (e.g., *approach* cannot be employed to encode occurrence). And, a directional semantic argument (as encoded by a particle) is selected for. It is by virtue of this directed motion event that the motion of the TE is thus distal (i.e., away from) the RP. The particle in (33a) is *by*, but others, such as *past*, *away*, and so on are also possible. Particles that are consistent with proximal-directed motion (e.g., *near*, *close*) are not selected for to express occurrence.

Another way in which occurrence can be encoded, as exemplified in the second example, is by virtue of verbal semantic arguments relating to events of visual imperceptibility, e.g., *vanished*. Moreover, in this case, the selectional restriction apparent in other ‘occurrence’ examples, relating to a location of the TE in the posterior region of the RP’s sagittal axis, appears not to hold. For instance, in the following example:

(34) Christmas is disappearing over the horizon

the canonical reading is that the disappearing event relates to the anterior region of the RP’s sagittal axis. The reason for this appears to be that a disappearing event requires an observer (the RP). And given the physiology of the human experiencer, we can only see, and thus perceive, a disappearing event in the anterior region of the sagittal axis. Hence, *Christmas*, in (34) is interpreted as ‘disappearing’ in the anterior, rather than posterior region of the experiencer’s sagittal space.

An example such as this demonstrates that language can encode the deictic t-FoR in diverse ways, reflecting the physiology of the human experience, the RP. When motion is being ascribed, then the directionality of motion is important. When perceptual events are being ascribed to understand the future/past relation, then the visual array becomes key, which impacts on which regions of the sagittal plane relate to future/past events.

The final example relates again to path:

- (35) a. Christmas lies/is behind us
b. Christmas lies/is in back of us (AmE only)

In examples such as these, the preposition is construed as relating to a vector on the posterior region of the RP’s sagittal axis. This excludes vectors relating to the lateral axis:

(36) #Christmas is left of us

and angles that relate to other orientational systems, such as cardinal points:

(37) #Christmas is south of us

The examples in (35) encode a relation between the TE and RP such that the TE is located along a path that is set in the posterior region of the RP’s sagittal axis. As such, the temporal relation—for English—is necessarily one of occurrence with respect to the O.

Another linguistic manifestation of the deictic t-FoR relates to what can be termed ‘quality of elapse’. Here, while an imminence/occurrence relation is being encoded, additional information relates to quality of the elapse that holds between the RP and TE.

- (38) a. Christmas is racing/speeding/whizzing/hurting past/by/towards us
b. Christmas is creeping past/by/towards us

That is, these examples encode durational quality: whether the elapse is protracted, or compressed. These qualities correspond to the phenomenologically real experiences of *protracted duration*, *temporal compression* or *normative duration* (see Evans 2004, 2009 for discussion).⁷

While the elapse holding between the TE and its occurrence at the RP can be judged as being compressed, as in (38a), it can also be judged to be protracted, as in (38b). Importantly, and unlike examples considered earlier, verbs of motion here are not manner-neutral: *whizzing* and *creeping*, for instance, involve very specific manners of motion. Moreover, the manner of motion involves a directional OBL, in which the RP is explicitly encoded. The directional oblique, moreover, can involve a path that is co-locational, proximal or distal. Hence, these ascriptions are not restricted to whether the quality of duration that holds between the RP and a TE is set in the future or the past: it can relate to either.

The fourth way in which deictic t-FoR appears to show up in language relates to what I term ‘degree of remove’. Consider the following representative examples:

- (39) a. Christmas is two days/months away
 b. Christmas is a long/short way off
 c. Christmas is near/close by/to us

What is common to these is they appear to encode a path relation on the sagittal axis in order to fix a TE with respect to the RP. Hence, while these examples are all related to path designations considered earlier, there is one key difference. Each of the examples can, in principle, relate to imminence or occurrence relations. For instance, Christmas could be described as being *two days away*, whether it is set in the past or the future with respect to the experiencer’s now.

What this brief discussion reveals is that there are distinct patterns in how English encodes the deictic t-FoR, and a number of commonalities emerge. The subject NP selected for always concerns a temporal event that can be construed as being (temporally) discrete. Moreover, the t-FoR form-meaning pairings appear to consistently draw on ascriptions deriving from motion in space, and to a lesser extent, ascriptions of visual (im)perceptibility and spatial path relations. When semantic arguments relating to motion events are selected for, the motion events can be manner-neutral (e.g., *pass*, *go*, *arrive*, *come*) or not (e.g., *whizz*, *speed*, *race*, *drag*). In both cases, the motion events are linear rather than curvilinear in nature. Language appears to adopt the sagittal (front/back) axis to metaphorically structure deictic t-FoRs. Whether the anterior/posterior regions relate to future/past is determined by the type of ascription involved. In English, motion ascriptions take the anterior portion as relating to the future. Visual perception ascriptions appear to take the anterior portion as relating to the past. This is a consequence of the differential aspects of the RP that are relevant as they emergence from the *semantic affordance* arising from the linguistic ascription.⁸

5. The sequential t-FoR

The sequential t-FoR provides a temporal coordinate system that relates to the transience type: succession. Recall that this involves the felt experience that time constitutes a sequence of events, one preceding another. This subjective experience provides the basis for

⁷ Protracted duration is the phenomenologically-real experience of time proceeding more ‘slowly’ than usual, while temporal compression is the phenomenologically-real experience of time proceeding more quickly than usual.

⁸ See discussion of the notion of ‘semantic affordance’ in Evans (2010).

distinguishing between an earlier event and a later event, and relating events to their position in a sequence. Hence, this type of transience gives rise to the temporal relation earlier/later. In this section I begin by briefly considering the neurological basis for the nature of a sequence, a fundamentally temporal notion, from which the sequential t-FoR takes its reference (§5.1). I then consider in outline the nature of the sequential t-FoR (§5.2), before considering the different perspective points (PP) available, for its linguistic encoding (§5.3). I then provide more detailed linguistic evidence for the existence of this t-FoR, and the range of semantic clusters that show up in language (§5.4).

5.1. *The neurological basis of the sequential t-FoR*

While a fair amount is now known about the smallest unit of duration to which we have conscious access, the perceptual moment—which, I have argued, underpins the deictic t-FoR—far less is known about the neurological basis of the transience type: succession. Pöppel (1978), in seminal work, identifies the phenomenological experience of succession (or event order), along with duration—to be considered later—as an *elementary time experience*. These are experience types that appear to be fundamental to the perceptual process, are likely to be hard-wired, and as such to be maintained by the neuro-biological system. The human ability to experience succession, is central to our ability to function successfully in the world, and is phenomenologically real. Without the means of recognising succession and hence event-sequences, humans would be unable to distinguish between causes and their effects with potentially disastrous consequences for learning and survival. That said, neuroscientists have identified the basal ganglia and cerebellum as possible regions of the brain that may have a role in our ability to perceive succession (Harrington et al. 1998). These areas of the brain appear to be implicated in the fundamental timekeeping operations responsible for the coordination of motor control, which necessarily involves processing complex sequences of activity in a specific chronological order.

The ability to experience and judge succession involves the ability to recognise events, and the ability to assign them an order in a sequence. Event recognition presumably requires the ability to form perceptual moments. This is required, as the perceptual moment provides a means of updating the perceptual array every 2-3 seconds, and hence identifying chunks of the perceptual array. A sequence also requires a means of coding events, and storing them in memory in a way such that they are related to one another by virtue of their ‘time-stamp’, the particular perceptual moment(s) that facilitates their apprehension. Hence, the perception of sequences logically presupposes a perceptual process built from durational episodes such as perceptual moments. The upshot of this discussion is that sequentiality, while a phenomenologically-real experience, is likely to be more complex than our ability to form perceptual moments.

5.2. *The nature of the sequential t-FoR*

In this type of t-FoR, the coordinate system is provided by a sequence of events. A given TE is fixed with respect to another event, the RP, with respect to which it is sequenced. A sequence of events is fixed with respect to an O, the first event, or a salient event, in the sequence, from which the RP takes its reference—note that the O can coincide with the RP. Accordingly, the O serves to anchor the RP to the transience type succession, from which the temporal relation earlier/later arises.

As with the deictic t-FoR, the primary way in which English encodes the sequential t-FoR is via ascriptions of motion. However, the motion ascriptions are quite different from deictic t-FoRs. Rather than relating to path-like motion on the sagittal axis they concern expressions concerning sequential motion. Consider the following examples:

‘Earlier’

(40) Christmas comes before New Year’s Eve

‘Later’

(41) New Year’s eve comes after Christmas

In these examples, there are two different TEs, Christmas, in (40), and New Year’s Eve in (41). These are the events which are being fixed, with respect to the transience type of succession. The RPs, in these examples are respectively New Year’s Eve, in (40) and Christmas in (41). In these examples, the RPs are also the Os, the points that anchor the events to the transience type involved here. The consequence of the two events in each example, the TE and the RP/O, being related by virtue of sequential motion (‘come before/after’) is the inference that there is a sequential temporal relation holding between the two events such that the TE, Christmas is earlier than the RP/O, New Year’s Eve in (40). In contrast, in (49), the TE, New Year’s Eve is later than the RP/O, Christmas.

In the sequential t-FoR, the RP and O do not have an egocentric basis, but inhere in the event sequence itself. As such, what makes examples such as (40) and (41) relate to the sequential t-FoR, rather than, for instance the deictic t-FoR, is that the earlier/later temporal relation that emerges does so as it is an inherent feature of the sequence of events, rather than when in time they are viewed. Consequently, the reference strategy adopted by this t-FoR is allocentric, as it involves reference between entities, in this case events, which are independent of the egocentric perspective of human experience of now.

One important difference between how language encodes the deictic versus the sequential t-FoRs is the following. In expressions relating to the deictic t-FoR, the TE is determined not by the position occupied by the event in the sentence, but by virtue of being the sole mention of a temporal event. Consider the following examples which relate to the deictic t-FoR:

- (42) a. Easter is moving towards us
b. We are moving towards Easter

The TE in each of these examples is that of Easter. However, Easter occupies the subject position in (42a), and OBL position in (42b). In contrast, the way English encodes the sequential t-FoR suggests that the TE can only occupy the sentence subject position. This presumably is a consequence of the fact that the sequential t-FoR explicitly encodes two (or more) discrete events. For this reason, there is greater flexibility as to where in the sentence the TE can appear in the deictic t-FoR.

5.3. *Perspective points*

As with the deictic t-FoR, there is a broad two-way distinction that is exhibited by constructions that encode sequential temporal reference. This relates to the PP from which the temporal scene being encoded is viewed.

The first type of PP relates to a relationship between two events, the TE and a RP, where the perspective point is fixed at the earlier event. This is illustrated by the example in (40), above. In this example, the TE, the event that receives focal prominence by virtue of being in subject position, is Christmas. It is being fixed in time with respect to a second event, New Year’s Eve, which constitutes the RP. The relationship established between the TE and the RP is an earlier relation: it is with respect to New Year’s Eve that Christmas, the TE, is earlier. And as the earlier event achieves focal prominence here, the perspective point

is *prospective*: the relation is viewed from the perspective of the earlier event. This is captured diagrammatically in Figure 5.

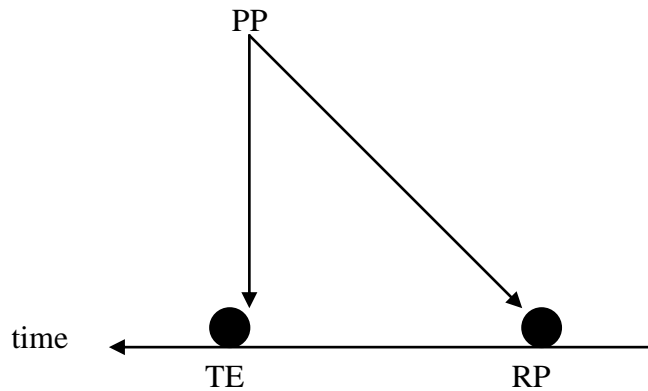


Figure 5. Prospective perspective point

In Figure 5 there is a directed time line, indicating an earlier/later relation continuum regardless of when the temporal scene is viewed (by an experiencer), or when it occurs (against some extrinsic temporal reference system). The circles marked TE and RP constitute the target and reference point events respectively. However, the relation is viewed from the PP of the earlier event, as indicated by the arrows. Hence the perspective point is prospective.

The second type of perspective point is *retrospective*. In this scenario, the earlier/later relation is viewed from the perspective point of the later event, as illustrated by the example in (41), above. In this example, the TE, the event that receives focal prominence by virtue of being in subject position, is New Year's Eve. It is being fixed, in relation to succession, with respect to a second event, Christmas which, in this example, constitutes the RP. The relationship established between the TE and the RP is a later relation: it is with respect to Christmas that New Year's Eve, the TE, is later. And as the later event achieves focal prominence in (41), the PP is retrospective: the relation is viewed from the perspective of the later event. This is captured diagrammatically in Figure 6.

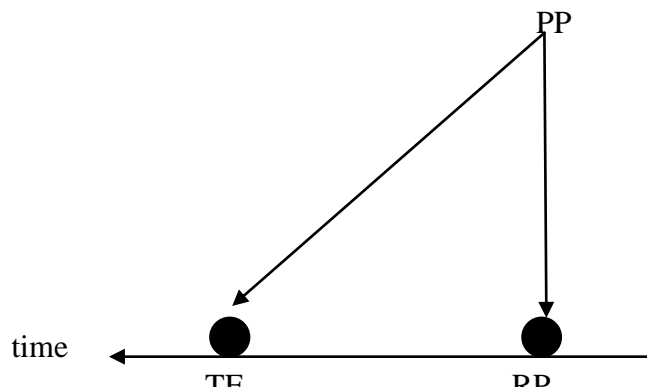


Figure 6. Retrospective perspective point

As in the previous figure, there is a directed time line, indicating an intrinsic temporal (i.e., earlier/later) relation continuum. The circles marked TE and RP constitute the target event and reference point events respectively. However, the relation is viewed from the PP of the later event, as indicated by the arrows. Hence the PP is retrospective.

5.4. *Types of sequential t-FoR.*

I now briefly consider two broad patterns in the linguistic encoding of the sequential t-FoR. This distinction relates to what can be classed as ‘sequential salience’ versus ‘positional salience’. To illustrate, consider the following examples:

‘Sequential salience’

- (43) a. Christmas precedes New Year’s Eve
b. New Year’s Eve follows Christmas

‘Positional salience’

- (44) a. Christmas is/comes before/ahead of New Year’s Eve
b. New Year’s Eve is/comes after/behind Christmas

While the examples in both (43) and (44) relate to the sequential t-FoR, the linguistic encoding makes salient slightly different aspects of succession. Succession can be conveyed by focusing on the relationship between entities involved in a sequential relation, or the position of an entity in a sequence. The examples in (43) adopt the former strategy, by using verbal forms relating to sequence (precede/follow). In contrast, the examples in (44) make use of language relating to the position in a sequence, making explicit a path-like sequential ordering. The consequence is that English appears to have conventionalised two slightly different construals of the sequential t-FoR.

6. **The Extrinsic t-FoR**

In this part of the paper I consider the third and final t-FoR that I argue for. The extrinsic t-FoR relates to the transience type: duration, and is closely associated with time measurement systems such as calendars and clocks. The temporal relation that emerges from the phenomenologically-real experience of duration is, nevertheless, qualitatively different from the temporal relations that underpin the previous t-FoRs discussed. The temporal relations arising from transience types that anchor the deictic and sequential t-FoRs are phenomenologically real: the relations future/past and earlier/later. In contrast, the temporal relation arising from the transience type duration is the matrix relation, a conception of duration as providing a manifold or frame which subsumes all other events. In other words, the transience type duration is conceived, in the extrinsic t-FoR, as being just that, an extrinsic matrix or reference frame which can be deployed to fix events in time. This type of relation, therefore, appears to involve the reification of the transience type, duration, as a property that is abstracted away from, and is in principle, independent of the events that it is part and parcel of. This reification gives rise to a conception of duration as a matrix, whereby duration is conceived as an ontological entity in its own right that provides a manifold which structures all else. In short, while the extrinsic t-FoR derives from a phenomenologically real transience type, duration, the temporal relation that emerges, is a cognitive achievement in the way that the temporal relations associated with the deictic and sequential t-FoRs are not.

As a consequence, while the ability to fix events by virtue of the future/past and earlier/later relations may be, therefore, unavoidable—something we just do by virtue of having the neuro-anatomical structures we have—it is plausible that using extrinsic temporal reference may not be something that all humans do. After all, if developing an extrinsic t-

FoR is a cognitive achievement, rather than being something that arises as a consequence of subjective experience, then it is plausible not all cultures have developed an extrinsic t-FoR. Indeed, preliminary findings relating to fieldwork on the Amondawa language and culture—a remote agrarian tribe in Western Amazonia—suggests that this language may not have anything akin to the extrinsic t-FoR being described here (see Sinha et al. 2011).

In this section I first discuss the neurological basis of the extrinsic t-FoR (§6.1). I then discuss a broad distinction that can be made in extrinsic t-FoRs, what I refer to as *event-reckoning* versus *time-reckoning* (§6.2). And finally, I provide linguistic evidence from English to support the distinction in types of extrinsic reference strategies (§6.3).

6.1. *The neurological basis*

Extrinsic temporal reference relates to the phenomenologically real, albeit neuro-cognitively complex experience of duration. Research on the perception of duration has a venerable tradition in psychology dating back to the 19th century. The robust finding from this tradition is that human subjects do indeed perceive duration, they can estimate it in inter-subjectively reliable ways, and, it appears to have a subjective, rather than external basis. For instance, as demonstrated by classic studies, the phenomenologically-real experience of duration appears to be a consequence of physiological mechanisms. For instance, if vital functioning is accelerated by the consumption of stimulants such as amphetamines, or due to increased body temperature, this results in an overestimation of duration amongst subjects (Fraisse 1963). In contrast, reduced body temperature leads to an underestimation of duration (Baddeley 1966). In general, an increase or decrease in vital function consistently leads to overestimation and underestimations of duration respectively (see Wearden and Penton-Voak 1995 for review).

In addition, the experience of duration appears to be independent of external stimuli; it arises from the way in which the neuro-biological system responds to these stimuli. For instance, Flaherty (1999) found that our perception of duration is a function of how familiar subjects are with particular tasks: training can influence our experience of task duration. Ornstein ([1969]/1997) has demonstrated that the complexity of a given perceptual array influences perception of duration, while Zakay and Block (1997) found that judgements of duration are influenced by how interesting a particular activity is judged to be.

The neurological basis of duration is likely to be closely tied to the experience of the perceptual moment discussed under the aegis of the deictic t-FoR. The perceptual moment underpins our experience of the present, and, arguably provides the smallest consciously-available unit of duration (Pöppel 1994, 2009). It is likely that the felt experience of duration involves, amongst other things, the integration of perceptual moments forming an ordered sequence, and hence involves both psychological and succession transience types.

6.2. *The nature of the extrinsic t-FoR*

The extrinsic t-FoR is arguably the most complex of the three temporal frames of reference. Extrinsic temporal reference, like other t-FoRs, serves to fix an event in time. This is achieved by virtue of being anchored to the transience type: duration. However, due to reification of this transience type, the temporal relation that arises is an ‘encompassing’ *temporal matrix*, which fixes an event with respect to the system being used, regardless of one event’s relationship with respect to another, or regardless of the individual human experience of time. In this way, the extrinsic t-FoR provides a means of fixing an event in an ‘absolute’ way, without reference to an observer. A further feature of extrinsic temporal reference is that whatever the system deployed, naturally-occurring periodicities are harnessed. The consequence is that the reference strategy is *periodicity-based*, in contrast to the egocentric and allocentric reference strategies of the deictic and sequential t-FoRs.

There is a broad distinction that can be made in terms of extrinsic temporal reference between *event-reckoning systems* (e.g., calendars), and *time-reckoning systems* (e.g., clocks). While both fix events with respect to the matrix—a reified version of duration—they do so in qualitatively different ways. Both types of system serve to count *periodicities*. That is, they are essentially counting systems, and thereby use the count of periodicities in order to mark when in the temporal matrix an event has occurred (e.g., *The feast occurred in November 1907*, or *The feast started at 11am*), and for how long (e.g., *The feast lasted for two days/hours*). The distinction between the two comes from their relative complexity, which allows time-reckoning systems (clocks) to facilitate counts of smaller units, thereby fixing events with finer precision against the temporal matrix. I very briefly introduce both types of extrinsic t-FoRs.

EVENT-RECKONING SYSTEMS

An event-reckoning system has an O, which serves as the initial point for setting the system in operation—i.e., the point from which counting begins—a RP, which serves to ‘locate’ a given event, and a TE, the event being fixed against the coordinate system. Event-reckoning systems count units, which are of equal length. This is achieved by making use (and so counting) naturally-occurring periodicities: a recurring event of a fixed period. Periodicities can be of different kinds, such as the solar cycle—the period required for the Earth to orbit the Sun—the period between vernal and/or spring equinoxes, lunar phases, and so on. However, the most common periodicity used is the day/night cycle.⁹

In such a system, the periodicities that are being counted (e.g., the day/night cycle) are assigned a unique position in the system, for instance, by assigning numerals to the periodicities. Further groupings of periodicities are also common in systems of this kind. For example, in the Gregorian calendar, days are grouped into weeks and months. In this system, once the sequence has been completed, it is repeated. Such an event-reckoning system can thus be dubbed *repeatable*. In the main event-reckoning system in Mayan culture, for instance, which consists of 260 days, each successive day is numbered 1 to 13, before beginning again at 1. In addition, each day in each 13 day cycle is given a name taken from an inventory of 20 names. As each day number across the 13 day cycles has a different name from its corresponding number, this allows 20 cycles of 13 days (hence a total of 260 days). Each day has a unique identifier consisting of a number (from 1-13) and name (from the set of 20). In other words, no day in the 260 day sequence shares both the same number and day name. (Coe 1992; Gell 1994; Whitrow 1988).

As with the other t-FoRs, the extrinsic t-FoR is anchored to its transience type by virtue of its O. This is achieved by establishing the O as the point at which the counting of periodicities begins. In some variants of event-reckoning systems, ones that are *open-ended* rather than repeatable, the O is often provided by a salient historical or mythical event. For instance, in the Anno Domini dating system, the O is set by the traditional date for the incarnation of Jesus Christ. Such a system is open-ended as counting proceeds ad infinitum.

In event-reckoning systems which are repeatable, such as the Mayan 260 day calendar, a periodicity external to the system defines the extent of the count (260 days), and hence the origo. While it is not exactly clear what provided the 260-day Mayan calendar with its O—day 1 of a sequence of 260—one plausible explanation is the following. The

⁹ The day-night cycle is an extremely salient periodicity in human experience. Indeed, its importance is such that humans deploy it in order to determine essential neuro-physical functioning. For instance, the ‘master’ circadian rhythm, the wake-sleep cycle, is tied very closely to the 24 hour day-night cycle, constituting a hard-wired response to this predictable aspect of our physical environment (see Evans 2004). The phenomenon of jet-lag, for instance, results from a discrepancy between the wake-sleep cycle and day-night cycle, due to sudden removal from the location to which an individual’s wake-sleep cycle is entrained.

Mesoamerican calendar, upon which the Mayan system is based, is likely to have originated at a settlement based at Izapa sometime before 1200 BCE, in what is now southeast Chiapas, Mexico. At the latitude there, the vernal and autumnal equinoxes are separated by a period of 260 days (Coe 1992). This may have provided the external periodicity that set the system, providing it with its origo.

TIME-RECKONING SYSTEMS

Like event-based systems, time-reckoning harnesses the physical manifestation of natural periodicities. However, it does so by making use of material artefacts to perform the counting, thereby facilitating finer gradations in the count. Time-reckoning involves a material artefact which either embodies (as in flowing sand in an hour glass) or symbolises (as in the hands moving around a clock face) the periodicity. This serves to represent the periodic behaviour, and more precisely, the durational elapse that coincides with the physical periodicity.

The sorts of naturally occurring periodicities that are employed in time-reckoning has evolved over the course of several thousand years. These have ranged from the changing length or angle of a shadow as the sun moves across the sky in ancient Egypt, the use of water clocks in various cultures, including Egypt (the oldest discovered date to around 1500 BC), and classical Greece, to the flow of sand in an hour glass, to the burning of candles of the same length and substance, to the swinging of a pendulum in a pendulum clock invented in 1656 by Dutch scientist Christiaan Huygens, to the oscillation of quartz crystals in the twentieth century, to the decay of atoms in modern atomic clocks today (see Barnett 1998 for discussion). Crucially, as the periodicity employed has a constant phase of operation, it provides a reliable record of the duration which correlates with it.

In a time-reckoning system, periodic behaviour is measured in order to represent a temporal elapse. This representation can be employed to fix an event that coincides with it in time. For instance, in a traditional hour glass, sand flows from one chamber to another. However, the amount of sand inside the apparatus is such that when it is upturned exactly an hour is required for the sand to flow from one chamber to another. In analogous fashion, in a spring-driven analogue watch, cogs inside the watch, which are attached to the hour hand on the outer face, are operated by an uncoiling spring. The rate at which the spring uncoils, thus turning the cogs, is such that it takes exactly one hour for the hour hand to move once around the face of the watch. Hence, time-reckoning systems use materials artefacts in order to measure and represent the elapse of time. And these time-keeping devices can then be ‘read’ in order to ‘tell’ the time.

Like event-reckoning systems, time-reckoning systems exhibit a number of different types, tailored to fulfil specific functions. A *repeatable time-reckoning system*, such as the 24 hour clock, is a system that derives its O from a periodicity external to the system itself. This system measures hours, and there is a sequence of 24 in total, with the O taken at midnight, represented by the numerals 00.00. The other very common type of time-reckoning system is the *closed time-reckoning system*. This measures a finite period of time, for instance, the countdown until an important event that is time-sensitive, such as a space rocket launch.

6.3. Linguistic evidence for the extrinsic T-FoR

Consider the following example:

(45) His Birthday is/falls on September the 14th.

In this sentence, there is a TE, *his birthday*. This is being fixed with respect to the RP, *September the 14th*, which is set with respect to some O, in this case January 1st. That is, January 1st grounds the TE with respect to the transience type: duration, and the matrix relation that arises. Hence, the temporal matrix provides an encompassing manifold in which *his birthday* occupies a specific position, and is thereby fixed.

The example in (45) relates, of course, to an event-reckoning system. Consider, by way of contrast, examples that relate to a repeatable time-reckoning system:

- (46) a. The time is (a) quarter to/of/til/before eight
b. The time is (a) quarter after eight

In these examples the TE is the present moment, *the time*, which is being fixed with respect to an RP, *quarter to/of/til/before eight* anchored, via the O, to duration, and hence a temporal matrix. The O is the originating point in the 12 hour clock, namely 12.

An interesting point of difference between the extrinsic t-FoR and other t-FoRs concerns the ascription of motion. Consider the following example:

- (47) The time is approaching midnight

On the face of it, the use of *approaching* here appears analogous to ascriptions of motion in the linguistic manifestation of the deictic t-FoR, for instance. However, the basis for the motion ascription in (47) appears to be modelled on veridical motion of ‘hands’ on a clock ‘face’, unlike the motion ascriptions in deictic temporal reference. Consider Figure 7.

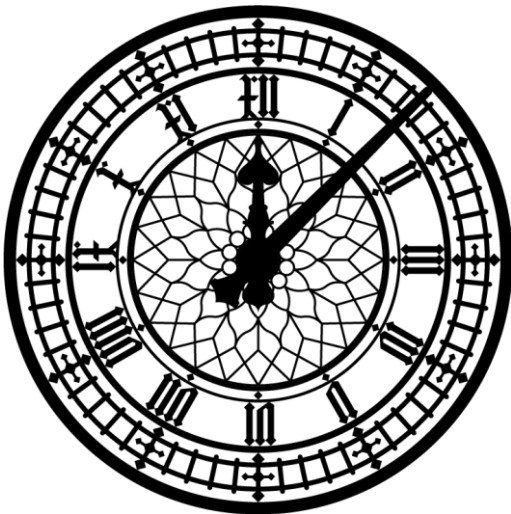


Figure 7. The Big Ben clock face

The clock face in Figure 7 represents the elapse of duration. This is achieved by virtue of the movement of two ‘hands’, such that the position of the big hand, with respect to the little hand, which indicates a given hour, is reflected linguistically. The example in (47) shows that the linguistically-mediated representation of time reflects the spatial representation of time captured by the material artefact that is the clock face. In other words, the motion of hands around a clock face is a metonymic representation for the elapse of time. And this metonymic representation is captured linguistically, providing evidence for the linguistically-mediated representation of extrinsic temporal reference.

7. The relationship between space and time

I have argued, in this paper, that spatial and temporal reference are incommensurable. This claim is not, however, inconsistent with the observation that space is useful, and indeed, consistently used, in order to support temporal reasoning and temporal language, including temporal reference. My claim is that it is incorrect to assume that temporal reference patterns after, and hence can be modelled utilising, spatial frames of reference, just because space appears to be implicated in the representation of temporal reference. After all, temporal reference relates to transience, whilst spatial reference does not.

But if temporal reference is wholly distinct from spatial reference, an outstanding question remains: why does space appear to be recruited to structure and support some aspects of temporal reasoning. I argue, below, that this is likely to be due to time being fundamental to the perception of sensory-motor experience, and more precisely, the construction of events, which constitute our units of perception.

A robust finding from recent work on the neurobiology of time is that temporal processing is widely distributed across brain structures and appears to be intrinsic to neural function (e.g., Mauk and Buonomano 2004). Moreover, temporal processing also appears to be fundamental to cognitive function (Varela 1999), being implicated in the performance of a raft of cognitive functions such as motor control, and perception and may provide the cognitive ‘glue’ that facilitates learning and memory, behaviour planning, awareness, imagination and creativity (Pouthas and Perbal 2004; Pöppel 2009; Rubia et al. 2009). Temporal processing also appears to be fundamental to distinctively human symbolic behaviours including speech (Chafe 1994), music (Davies 1996), and poetry (Turner and Pöppel 1983). In short, the fact that the human brain does not have a single centralised timing mechanism suggests that temporal processing is likely to play a role in virtually all aspects of neuro-cognitive function (Ivry and Spencer 2004). And in so doing, the highly distributed nature of temporal processing in the brain is likely to be a key contributor to the human awareness of time (see Evans 2004).

I argued earlier in the paper that the substrate that comprises spatial experience is matter, while in the domain of time it relates to action. I also noted that units of action constitute ‘events’. In fact, the latter claim requires qualification. Events are more than simply units relating to the substrate of temporal experience. Events are widely acknowledged to be the units of perception (Cutting 1981; Gibson 1979; Heider 1959; Johansson et al., 1980; Pittenger and Shaw 1975; Zacks et al., 2001). Indeed, Cutting (1981: 71) describes events as “our very units of existence.”

Events appear to be centred on object/action units that are goal directed (Zacks et al., 2001; Zacks et al. 2007). That is, they involve correlated aspects of both space and time. A number of taxonomies for events have been provided in the perceptual psychology literature (e.g., Cutting 1981; Gibson 1979; Heider 1959; Johansson et al., 1980; Pittenger and Shaw 1975). Notable amongst these is a consensus that events consist of structure of two sorts: topographic (spatial) and dynamic (temporal). Köhler (1947) argued that the topographic structure of events involves perception of structural ratios in space, relating parts of objects—and indeed other entities—with respect to each other. These ratios arise from ecological affordances (Gibson 1979) in the environment which provide topographic invariants (Cutting 1981).

In relative terms, far less work has been conducted on the dynamic aspects of the perception of events. Nevertheless, there is growing consensus that timing mechanisms in the brain, that guide the formation of percepts, are likely to underpin the formation of events, and hence, facilitate perception. In seminal work aimed ultimately at modelling the provenance of conscious awareness, Crick and Koch (1990) argued that the so-called ‘binding problem’—how percepts are formed in the absence of a central association area for

the integration of perceptual information in the brain—is achieved via the coordinated oscillation of neurons. That is, perceptual binding may result from temporal activities which ‘binds’ perceptual information; binding arises via temporally coordinated activity, rather than integrating information at a specific ‘association’ site in the brain. Moreover, the coordinated oscillation of neurons may be what contributes to the perceptual moment as discussed earlier (see §4.1). Such a view suggests that the perceptual moment may play a pivotal role in giving an event its structure.

Furthermore, the dynamic quality of events appears to be dividable into parts and subparts (Cutting 1981; Zacks et al., 2001), providing a nested dynamic quality to their perception. In other words, events have an underlying structure, derived from the perception of sensory-motor experience, which is unpacked in, and according to the prescribed dimensions of space and time, a consequence of the innate (top-down) principles that govern our perceptual neuro-biological apparatus, i.e., our sensory systems and brain structures. In short, there is a rather large body of behavioural and neurological evidence (e.g., Kurby and Zacks 2008; Rinck, and Bower 2000; Zacks et al., 2007) that time and space are in fact perceptually as well as psychologically distinct. Moreover, under certain circumstances, people are more sensitive to temporal change than spatial change (Zwaan, Magliano and Graesser 1995; Magliano, Miller and Zwaan 2001).

Our experience of the world comes to us via the perception of events, and events are temporally structured—their very essence appears to be temporal. As such, it is this temporal structuring that facilitates the perception of our world of sensory experience. Hence, spatial awareness is facilitated by temporal mechanisms which control and facilitate perception. Gell (1992) puts this situation as follows: “[T]ime arises as an inescapable feature of the perceptual process itself, which enters into the perception of anything whatsoever.” In short, not only is there an inevitable correlation between invariant aspects of sensory-motor experience, and time, but temporal experience appears to arise, in part (perhaps large part), so that the sensory world around us can be perceived in the first place.

This thesis provides a way of accounting for the observations, deriving from both linguistic and behavioural data, that time and space are correlated and structured asymmetrically. As has been oft noted, time tends to be more often structured in terms of space, rather than vice versa (e.g., Boroditsky 2000; Casasanto and Boroditsky 2008; Lakoff and Johnson 1980, 1999). If temporal mechanisms facilitate event perception, and are central to the structure of an event, then it stands to reason that temporal reflexes of sensory-motor experience are likely to be activated by representations of space, when we talk and reason. Moreover, given that temporal processing facilitates sensory-motor perception, in the guise of perceiving events, then conscious temporal awareness is a consequence, perhaps an epiphenomenal one, of spatial perception. Put another way, our conscious awareness of time, and the various transience types associated with it, is a subjective response to the perception of spatial substrate upon which our evolutionary success depends. Because of this, representations for space and time are likely to be asymmetrically organised such that time is activated automatically by space, but not vice versa, a finding that emerges most evidently in the psychophysical tasks reported by Casasanto and Boroditsky (2008).

8. Conclusion

Recent research has observed that space-to-time motion ascriptions in language can be thought of in terms of temporal frames of reference (Moore 2000, 2006, 2011; Nunez and Sweetser 2006; Zinken 2010). A parallel development has been the proposal that FoRs from the domain of space (s-FoRs) can be employed to model temporal reference (Bender et al., 2005; Kranjec 2006). Two recent accounts, Bender et al. (2010) and Tenbrink (2011) have

attempted exactly this. The most detailed of the two is Tenbrink, although unlike Bender et al, Tenbrink does not model what I am terming the extrinsic t-FoR.

However, space-to-time t-FoR approaches, while insightful, focus on the parallels between time and space, by virtue of understanding time in terms of spatial reference. In the case of the highly detailed taxonomy provided by Tenbrink, this essentially means studying the nature of the spatial language used, ostensibly to refer to time.

In this paper I have argued that temporal reference is not akin to spatial reference; studying the use of spatial language in temporal reference, by applying findings from research on s-FoRs won't reveal, I claim, deep insight into the nature and operation of t-FoRs. To support this, I have introduced and developed the notion of temporal relations, which are tied to the property of temporal experience. It is this property, namely transience, which is what makes time fundamentally different from space. I have developed a taxonomy of t-FoRs, and demonstrated how they are realised in language. The way in which t-FoRs are realised linguistically is quite different from how spatial relations are realised, not least with respect to the perspective points involved; both the deictic and sequential t-FoRs provide a means to encode alternative perspective points on the temporal relations involved. In the case of s-FoRs, due to the patterning following attentional figure-ground segregation, there are restrictions on which entities can occupy the sentence subject position.

A further point of difference relates to the extrinsic t-FoR. There is nothing like this in the domain of space, precisely because this t-FoR, although grounded in our experience of duration, gives rise to a relation that is a cognitive achievement. This is the notion of a temporal matrix: an ontological entity in its own right, independent from the phenomenological experience that gives rise to it. Moreover, such a cognitive achievement requires complex event and time-reckoning systems, including material artefacts, in order to make use of it. Indeed, it is this cognitive feat that makes time-measurement systems possible.

References

- Baddeley, A. (1966). Time estimation at reduced body temperature. *American Journal of Psychology*, 79 (3): 475–9.
- Barnett, J. (1998). *Time's Pendulum: The Quest to Capture Time*. New York: Plenum.
- Bender, A., B. Giovanni, and B. Sieghard. (2005). Spatial frames of reference for temporal relations: A conceptual analysis in English, German, and Tongan. In B. G. Bara, L. Barsalou, and M. Bucciarelli (eds), *Proceedings of the Twenty-Seventh Annual Conference of the Cognitive Science Society*, 220–225. Mahwah, NJ: Lawrence Erlbaum.
- Bender, A., S. Beller, & G. Bennardo. (2010). Temporal frames of reference: Conceptual analysis and empirical evidence from German, English, Mandarin Chinese, and Tongan. *Journal of Cognition and Culture*, 10, 283-307.
- Boroditsky, L. (2000). Metaphoric structuring: Understanding time through spatial metaphors. *Cognition*, 75 (1): 1–28.
- Casasanto, D. and Boroditsky, L. (2008). Time in the mind: Using space to think about time. *Cognition*, 106: 579–93.
- Chafe, W. (1994). *Discourse, Consciousness, and Time: The Flow and Displacement of Conscious Experience in Speaking and Writing*. Chicago: University of Chicago Press.
- Clark, H. (1973). Space, time, semantics, and the child. In T. Moore (ed.), *Cognitive Development and the Acquisition of Language*, 27–63. New York: Academic Press.

- Coe, M. (1992). *Breaking the Maya Code*. New York: Thames and Hudson.
- Coveney, P. and R. Highfield. (1991). *The Arrow of Time: The Quest to Solve Science's Greatest Mystery*. London: Flamingo.
- Crick, F. and C. Koch. (1990). Towards a Neurobiological Theory of Consciousness. *Seminars in the Neurosciences*, 2: 263–275.
- Cutting, J. (1981). Six tenets for event perception. *Cognition*, 10, 71–78.
- Davies, P. (1996). *About Time: Einstein's Unfinished Revolution*. London: Penguin.
- Dennett, D. (1991). *Consciousness Explained*. London: Penguin.
- Edelman, G. (1992). *Bright Air, Brilliant Fire*. London: Penguin.
- Eddington, A. (1928). *The Nature of the Physical World*. London: Macmillan
- Engel A., P. König & T. Schillen. (1992). Why does the cortex oscillate? *Current Biology*, 2(6):332–334.
- Evans, V. (2004). *The Structure of Time: Language, Meaning and Temporal Cognition*. Amsterdam: John Benjamins.
- Evans, V. (2009). *How Words Mean: Lexical Concepts, Cognitive Models and Meaning Construction*. Oxford: Oxford University Press.
- Evans, V. (2010). Figurative language understanding in LCCM Theory. *Cognitive Linguistics*, 21 (4): 601–662.
- Evans, V. and M. Green. (2006). *Cognitive Linguistics: An Introduction*. Edinburgh: Edinburgh University Press.
- Flaherty, M. (1999). *A Watched Pot: How We Experience Time*. New York, NY: New York University Press.
- Fraisse, P. (1963). *The Psychology of Time*. New York: Harper and Row.
- Galton, A. (2011). Time flies but space doesn't: Limits to the spatialization of time. *Journal of Pragmatics*, 43, 695–703.
- Gell, A. (1992). *The Anthropology of Time: Cultural Constructions of Temporal Maps and Images*. Oxford: Berg
- Gentner, D., M. Imai and L. Boroditsky. (2002). As time goes by: Evidence for two systems in processing space time metaphors. *Language and Cognitive Processes*, 17 (5): 537–65.
- Gibson, J. (1979). *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin.
- Goldberg, A. (1995). *Constructions. A Construction Grammar Approach to Argument Structure*. Chicago: University of Chicago Press.
- Goldberg, A. (2006). *Constructions at Work: The Nature of Generalization in Language*. Oxford: Oxford University Press.
- Harrington, D., K. Haaland and R. Knight. (1998). Cortical networks underlying mechanisms of time perception. *Journal of Neuroscience*, 18 (3): 1085–95.
- Heider, F. (1959). On perception, event structure and psychological environment. *Psychological Issues*, 1/3: 1–123.
- Ivry, R. and R. Spencer. (2004). The neural representation of time. *Current Opinion in Neurobiology*, 14 (2): 225–32.
- James, W. ([1890] 1950). *The Principles of Psychology*. New York: Dover.
- Johansson, G, C. von Hofsten and G. Jansson. (1980). Event perception. *Annual Review of Psychology*, 21, 27–66.
- Majid, A., M. Bowerman, S. Kita, D. Haun and S. Levinson, S. (2004). Can language restructure cognition? The case for space. *Trends in Cognitive Sciences*, 8, 108–114.
- Köhler, W. (1947). *Gestalt psychology*. New York: Liveright.
- Kranjec, A. (2006). Extending Spatial Frames of Reference to Temporal Concepts.

- Proceedings of the 28th Annual Conference of the Cognitive Science Society*, 447-452.
- Kurby, C. A., & Zacks, J. M. (2008). Segmentation in the perception and memory of events. *Trends in Cognitive Sciences*, 12, 72-79.
- Lakoff, G. (1993). The contemporary theory of metaphor. In A. Ortony (ed.) *Metaphor and Thought* (2nd edition). Cambridge: Cambridge University Press, 202-251.
- Lakoff, G. and M. Johnson. (1980). *Metaphors We Live By*. Chicago: University of Chicago Press.
- Lakoff, G. and M. Johnson. (1999). *Philosophy in the Flesh*. New York: Basic Books.
- Langacker, R.W. (1987). *Foundations of Cognitive Grammar: Volume I Theoretical Prerequisites*. Stanford: Stanford University Press.
- Langacker, R.W. (2008). *Cognitive Grammar: A Basic Introduction*. Oxford: Oxford University Press.
- Le Poidevin, R. (2003). *Travels in Four Dimensions: The Enigmas of Space and Time*. Oxford University Press, Oxford.
- Levinson, S. (2003). *Space in Language and Cognition: Explorations in Linguistic Diversity*. Cambridge: Cambridge University Press.
- Magliano, J. P., Miller, J. and Zwaan, R. A. (2001), Indexing space and time in film understanding. *Applied Cognitive Psychology*, 15: 533–545.
- Mauk, M. and D. Buonomano. (2004). The neural basis of temporal processing. *The Annual Review of Neuroscience*, 27: 307–40.
- McGlone, M., and J.L. Harding. (1998). Back (or forward?) to the future: The role of perspective in temporal language comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 24 (5), 1211–1223.
- Moore, K. (2000). *Spatial experience and temporal metaphors in Wolof: Point of view, conceptual mapping, and linguistic practice*. Doctoral dissertation, University of California, Berkeley.
- Moore, K. (2006). Space-to-time mappings and temporal concepts. *Cognitive Linguistics*, 17–2: 199–244.
- Moore, K. (2011). Ego-perspective and field-based frames of reference: Temporal meanings of FRONT in Japanese, Wolof, and Aymara. *Journal of Pragmatics*, 43, 759-776.
- Núñez, R., B. Motz and U. Teuscher. (2006). Time after time: The psychological reality of the Ego- and Time-Reference-Point distinction in metaphorical construals of time. *Metaphor and Symbol*, 21: 133–46.
- Núñez, R. and E. Sweetser. (2006). With the future behind them: Convergent evidence from Aymara language and gesture in the crosslinguistic comparison of spatial construals of time. *Cognitive Science*, 30: 401–50.
- Ornstein, R. ([1969]/1997). *On the experience of time*. Boulder, CO: Westview Press.
- Pittenger, J.B., R.E. Shaw. (1975). Aging faces as visual-elastic events: Implications for a theory of nonrigid shape perception. *Journal of Experimental Psychology: Human Perception Performance*, 1, 374-382.
- Pöppel, E. (1978). Time Perception. In R. Held, H. W. Leibowitz, and H.-L. Teuber (eds), *Handbook of Sensory Physiology*, 713–29. Heidelberg: Springer.
- Pöppel, E. (1994). Temporal mechanisms in perception. In O. Sporns and G. Tononi (eds), *Selectionism and the Brain: International Review of Neurobiology*, 37: 185–201.
- Pöppel, E. (2009). Pre-semantically defined temporal windows for cognitive processing. *Philosophical Transactions of the Royal Society B*, 364, 1887-1896.
- Pouthas V. and S. Perbal. (2004). Time perception does not only depend on accurate clock

- mechanisms but also on unimpaired attention and memory processes. *Acta Neurobiologiae Experimentalis*, 64: 367-385.
- Rinck, M., & Bower, G. (2000). Temporal and spatial distance in situation models. *Memory and Cognition*, 28, 1310-1320.
- Rubia K, R. Halari, A. Christakou and E. Taylor. (2009). Impulsiveness as a timing disturbance: Neurocognitive abnormalities in attention-deficit hyperactivity disorder during temporal processes and normalization with methylphenidate. *Philosophical Transactions of the Royal Society*, B 364, 1919-1931.
- Sinha, C., V. da Silva Sinha, J. Zinken and Sampaio, Wany. (2011). When Time is not Space: The social and linguistic construction of time intervals in an Amazonian culture. *Language and Cognition*, 3/1: 137-169.
- Smart, J. C. (1949). The River of Time. *Mind* 58/232:483-494.
- Talmy, L. (1978). Figure and ground in complex sentences. In J.H. Greenberg, C.A.. Ferguson and E.A. Moravcsik (eds.), *Universals of Human Language*, Vol. 4: *Syntax*, 625-649. Stanford, CA: Stanford University Press
- Talmy, L. (2000). *Toward a Cognitive Semantics* (2 volumes). Cambridge, MA: MIT Press.
- Tenbrink, T. (2011). Reference frames of space and time in language. *Journal of Pragmatics*, 43, 704–722.
- Traugott, E. C. (1978). On the expression of spatio-temporal relations in language. In J. Greenberg (ed.), *Universals of Human Language*, 369–400. Stanford, CA: Stanford University Press.
- Turner, F. And E. Pöppel. (1983). The neural lyre: Poetic meter, the brain and time. *Poetry*, 142 (5): 277–309.
- Varela, F. (1999). Present-time consciousness. *Journal of Consciousness Studies*, 6 (2-3), 111-140.
- Varela, F., E. Thompson and E. Rosch. (1991). *The Embodied Mind*. Cambridge, MA: MIT Press
- Wearden, J. and I. Penton-Voak. (1995). Feeling the heat: Body temperature and the rate of subjective time, revisited. *Quarterly Journal of Experimental Psychology*, 48B: 129–41.
- Whitrow, G.J. (1988). *Time in History*. Oxford: Oxford University Press.
- Zacks, J., B. Tversky and G. Iyer. (2001). Perceiving, remembering, and communicating structure in events. *Journal of Experimental Psychology: General*, 130, 29-58.
- Zacks, J. M., Speer, N. K., Swallow, K. M., Braver, T. S., & Reynolds, J. R. (2007). Event perception: A mind/brain perspective. *Psychological Bulletin*, 133, 273-293.
- Zakay, D. and R. Block. (1997). Temporal cognition. *Current Directions in Psychological Science*, 6: 12–16.
- Zinken, J. (2010). Temporal frames of reference. In V. Evans and P. Chilton (eds), *Language, Cognition and Space: The State of the Art and New Directions*, 479-498. London: Equinox Publishing.
- Zwaan, R. A., Magliano, J. P., & Graesser, A. C. (1995). Dimensions of situation model construction in narrative comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21, 386-397.