

# On Sequence of Location and Direction

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## Abstract

The notion of *sequence of tense* has received wide attention since its (re)discovery roughly 20 years ago. It has recently been argued in [7] that the idea of sequencing a parameter is not restricted to tense. He gives examples showing that there is also sequence of world and sequence of person. These three parameters suggest a close link to verbal morphology, where all three categories are cross-referenced (appearing as tense, aspect, mood, and person). In this paper we shall show that there is also sequence of location and direction. This adds a fourth parameter to the list, and moreover one that is not standardly associated with verbal morphology. We give examples from Pima to demonstrate that location and direction sequencing may be morphologically encoded.

## 1 Introduction

In pragmatic theory, the denotation of an item is a **character**, that is, a function from contexts to meanings. Meanings are types expressions of some sort, while contexts may be construed as sequences of values. More exactly, we think of a **context** as a function from **parameter names** (or just **parameters**) to values in

the model. One obvious candidate for a parameter name is *speaker*. We allow interdependencies: if *utterance* and *now* are further parameters, then  $c(\text{utterance})$  is that  $u$  which is uttered by  $c(\text{speaker})$  at  $c(\text{now})$ . Certain expressions make use of these parameters. Consider the meaning of English I. Its character is that function which assigns to a context  $c$  the value  $c(\text{speaker})$ . Similarly, *now* is a parameter name and the character of the word *now* is  $\lambda c.c(\text{now})$ .

In recent years the phenomenon of sequence of tense has received quite a lot of attention. Although originally a phenomenon associated with tenses, it has been found not to be restricted to tense alone; it also appears with tense adverbials in the same way. In a subordinate clause there is a difference between *yesterday* and *the day before*. The first makes the event time of the subordinate clause happen a day before utterance time, while the second makes it a day before event time. To capture this, let us introduce a parameter name *ev-time*. Let  $\Delta$  take as input an interval  $I$  and return the set of intervals that are one day before  $I$ . Then the characters can be brought out as follows. ( $[-]^\pi$  shall denote the pragmatic meaning of the expression.)

- (1)  $[\text{yesterday}]^\pi = \lambda c.\lambda Q.\lambda e.Q(e) \wedge \text{time}(e) \in \Delta(c(\text{now}))$
- (2)  $[\text{the day before}]^\pi = \lambda c.\lambda Q.\lambda e.Q(e) \wedge \text{time}(e) \in \Delta(c(\text{ev-time}))$

In principle, it is possible to extend this analysis to any parameter that  $c$  is a function of. From this perspective it is logical to expect that we have sequence of world, since the characters of expressions are obviously world dependent; and likewise for person. Inverting the logic of this, we can say that the phenomenon of sequence of  $X$  shows that  $X$  is a context parameter. It is our claim that there are parameters for location and direction, which are not reducible to any of the above.

This paper is organized as follows. First, we shall set up a type theoretic language for parameter sequencing. Then we turn to linguistic questions surrounding the notion of sequencing and location. In particular, we shall show that the apparent flexibility of meaning for items based on the so-called *relative frame* (like *left*) is a consequence of sequencing with respect to viewpoint, a phenomenon that is actually widespread. Finally, we shall present data from Pima (Uto-Aztecan), demonstrating that direction sequencing also exists.

## 2 Some Theoretical Background

In a recent paper, [8], Schlenker has proposed an account of sequencing that assumes an arbitrarily long history of values for variables that can be used in further

processing. So, for tense there is a potentially infinite list of time points to which one may connect in further discourse. This seems to be overkill, for it can be seen that grammaticised sequencing uses a bounded number of values for each type of variable that be a value of a parameter (four for tense), and if one ever needs to access a parameter value that has been lost, one must resort to a description. (See [2] on this.)

Above we said that characters are just functions from contexts to (semantic) meanings. Unfortunately, this picture is too simplistic. What it predicts is that ordinary expressions are incapable of resetting their values. There are several arguments against this. One relevant to the present subject matter is this: If parameters cannot be reset, then if a clause  $S_2$  is contained in a subordinate sentence  $S_1$ , an occurrence of *the day before* inside  $S_2$  could only be construed as relative to the event time of the main clause  $S_0$ , and not of the intermediate  $S_1$ . This means that in the examples below, the claim on behalf of Pete would be that he had lost his wallet on Saturday and not on Thursday, contrary to fact.

- (3) John told Sue on Sunday that Pete had complained to him  
on Friday that he had lost his wallet the day before.

A solution to this problem was proposed in [2]. We shall rephrase this approach in the style of Montague's intensional logic. Recall that in Montague grammar, intensions are functions from worlds to objects. In the present framework, meanings are now dependent on more than just the world; they are now dependent on all parameters. More exactly, say that a **context** is a function from parameter names to values. Parameter names are sortal, and the context has to comply with sortal restrictions. Let  $\gamma$  denote the type of contexts. Types are formed over basic types (or **sorts**) and  $\gamma$  in the usual way. For a standard type  $\mu$ , define the **pragmatic lift**  $\mu^\bullet$  as follows.  $b^\bullet := \gamma \rightarrow b$  if  $b$  is basic. An object  $m$  of type  $b$  is lifted to the function  $m^\heartsuit$  such that  $m^\heartsuit(c) := m$ .  $(\mu \rightarrow \nu)^\bullet := \mu^\bullet \rightarrow \nu^\bullet$ . An object  $m$  of type  $\mu \rightarrow \nu$  is lifted to the object  $m^\heartsuit := \lambda \mathcal{P}. \lambda c. m(\mathcal{P}(c))$ . Thus,  $(\mu \rightarrow \nu)^\bullet(\mu^\bullet) = \nu^\bullet$ , and  $m^\heartsuit(n^\heartsuit) = (\lambda \mathcal{P}. \lambda c. m(\mathcal{P}(c))) = \lambda c. m(n^\heartsuit(c))$ . One shows inductively that  $m^\heartsuit(c) = m$ . This embeds the original (non-pragmatic) language into the pragmatic language.

For a given sort (tense, person, world, location) there may be several names, but the list is finite and small for each sort. Expressions may make use of the context. In order to express the pragmatic meaning, we use the functions

- (4)  $\{\rho := a\} : \gamma \rightarrow \gamma$

The result  $\{\rho := a\}c$  is a context  $c'$  such that  $c(\rho) = a$ , but  $c(\rho') = c(\rho)$  for all  $\rho' \neq \rho$ . There are constants  $\rho_\nu$  for every parameter name  $\nu$ . (We use sans serife

plus mnemonic name to denote them.) The type of  $\rho_v$  is  $\gamma \rightarrow \alpha$  if  $v$  is a parameter for sort  $\alpha$ . So, *now* is of type  $\gamma \rightarrow \tau$ ,  $\tau$  the sort of time points.

In order to analyse the data on sequence of tense, we use three parameters, *now*, *ev-time*, and *p-time* (predication time). In the default or ‘null context’ they receive the same value. A sentence, main or subordinate, takes as input a context containing values for these three parameters and outputs against values for them.

Now, let us look at the expression *I said*    . Extensionally, it takes a proposition and returns a proposition, so, with pragmatic lift, is of type  $(\gamma \rightarrow t) \rightarrow (\gamma \rightarrow t)$ . The complement sentence denotes a function  $Q$  from contexts to truth values. The expression denoted by *I said* takes  $Q$  as argument and feeds it a revised context.

$$(5) \quad [\text{I said}]^\pi = \lambda Q. \lambda c. c(\text{p-time}) < c(\text{now}) \wedge \text{say}(c(\text{speaker}), c(\text{p-time}), \\ Q(\{\text{ev-time} := c(\text{p-time})\}(c)))$$

This means in ordinary terms: given the context  $c$ , *speaker-of- $c$*  says at *predication-time-of- $c$* , which is before *now-of- $c$* , that  $Q(c')$ , where  $c'$  is different from  $c$  in that *event-time-of- $c'$*  is the *predication-time-of- $c$* . Effectively, this allows the value of the predication time of the upper context  $c$  to be passed down as the event time of the subordinate clause.

We construe sequence of person and world, and sequence of location in a similar spirit. The proposal accounts not only for demonstratives like *here* and *there*. It specifically also accounts for *left* and *right* which are notoriously flexible in meaning.

### 3 Linguistic Facets of Sequencing

There are several questions one may raise concerning this approach.

- ❶ Is the trigger for sequencing syntactic in nature or semantic?
- ❷ Do all languages have sequencing and if so, do they display any differences?
- ❸ Is the triggering mechanism a global choice of a language or can items individually determine it?
- ❹ What parameters are subject to triggering?

We shall address these questions in due course. First, we argue that sequencing occurs in special circumstances only. It must be a consequence of the meaning of the item that the resetting of parameters takes place. Consider by way of example the case in Amharic discussed in [7]. The pronoun for ‘I’ in Amharic can mean ‘Peter’ in a sentence with an indirect quote like

(6) Peter says I do not like cigars.

This answers in some sense the second question: there are differences between languages in that most languages do not allow sequencing for pronouns but Amharic does. Similarly, there are languages that do not allow sequencing for locations, such as Tzeltal and Guugu-Yimithirr (see [4] for extensive discussion). However, person sequencing occurs only with verbs of saying. How come? If the pronoun ‘I’ actually means something like ‘speaker’ there is an implicit variable here that needs to be brought to light: speaker of the main utterance versus speaker of the utterance denoted by the embedded sentence. Thus, only if the verb supplies an additional speaker of the embedded clause is there any chance that it may become the denotation of ‘I’.

This answers the first question: The nature of the trigger is not syntactic in that it cannot be tied to a specific syntactic category. Some items trigger sequencing, some do not. On the other hand, whether the pronoun ‘I’ is subject to sequencing is an individual choice languages make. Sequencing is therefore not predictable on the basis of meaning alone.

## 4 Location and Direction

We claim that location and direction are also context parameters and therefore subject to sequencing. Below we shall present some data from actual field research. Before doing that, we shall first sketch some details on location and direction in language. First, by **location** we mean a path connected subset of the ordinary space we live in ( $\mathbb{R}^3$ ). A material object has a location at every given time point of its existence. To make matters simple, locations are simply points. A **direction** is a vector (which can also be construed as a point of  $\mathbb{R}^3$ ). For example, if I say

(7) Campbell Hall is 200 m to the left.

then the truth of that sentence depends, among other things, on my location and the direction I am facing. Note that this is a feature of the word `left`. Had I used `north` then the direction I was facing would be irrelevant.

In the literature it has been observed that there are various ways in which locative expressions can be sensitive to their syntactic environment. The **absolute type** pays no attention to the directionality relative to any object; **north** always refers to the same direction. The non-absolute types allow dependencies on directionality. This could be the direction of a complement (**intrinsic**) or the vector from some other object to the complement (**extrinsic**). This other object is called the **viewpoint** (see [3]). The expression *to the left of the chair*, when used by Paul with Paul standing opposite of the chair and facing it, can be used to denote a location to Paul's right (= the chair's left; intrinsic) or to his left (= the chair's right; extrinsic). Our specific suggestion here is that these types square well with the kinds of sequencing behavior that we expect with tense and person. The specific differences are attributable mainly to the fact that locations are of a different nature than tenses and worlds.

The viewpoint is not necessarily identical to utterance location. This is needed to account for the meaning of *come* in cases like

(8) *I will come to Paris.*

uttered by Paul on occasion when he is actually not in Paris. The use of the notion of coming is appropriate e.g. if he shall be approaching the viewpoint-at-predication time, and this latter location is inside Paris. (See [1] for a similar phenomenon in Ambae (Oceanic).) A similar intuition underlies the analysis of *come* and *go* postulated in [11].

The shiftability of the viewpoint seen above seems to be language specific. It has been reported that Lakhota has two kinds of prepositions with virtually identical distribution and meaning, differing only in that one suggests that the trajector is approaching or at the viewpoint, while the other suggests it is not (see [6]). The fact that these two sets are interchangeable in any context derives from the fact that viewpoint can be shifted very easily in Lakhota. Japanese and Kiche', on the other hand, are reported to have stricter requirements regarding the identity of the viewpoint and the location of speaker. (See [9] and [5], respectively.)

To make matters concrete, we shall give an analysis of English *north* and *left*. Let *north* be a function that takes a point and returns a direction vector. Let  $\text{loc}(x, t)$  be the location of  $x$  at  $t$ .

(9)  $[\text{to the north of}]^{\pi} = \lambda c. \lambda x. \text{north}(\text{loc}(x, c(\text{p-time})))$

This analysis determines the direction on the basis of the predication time location of  $x$ , which is the object denoted by the complement PP. Now, let  $\rightarrow$  ( $\vec{v}$ ) be the

direction at  $90^\circ$  counterclockwise from  $\vec{v}$ . Let  $\text{vec}(x, y)$  be the vector defined by  $x$  as origin, and  $y$  as end. Then one meaning of `left` is given by

$$(10) \text{ [to the left}_1 \text{ of]}^\pi = \lambda c. \lambda x. \text{+} (\text{vec}(c(\text{viewpoint}), \text{loc}(x, c(\text{p-time}))))$$

We have construed the meaning of `left` to be dependent on the viewpoint, see [3]. To the extent that the latter is subject to sequencing, this makes the actual direction that is being denoted also subject to sequencing effects. This is needed in sentences such as

$$(11) \text{ I told you that the book is to the left of the chair.}$$

which allows ‘left of’ to be construed using either the axis between speaker and the chair or the axis between addressee and chair, depending on whether the viewpoint is shifted or not. A third reading is the **intrinsic** meaning, wherein the direction is determined relative to the intrinsic axis of the chair. This axis is denoted by  $\text{face}(x, t)$ , the direction of the intrinsic axis of  $x$  at  $t$ :

$$(12) \text{ [to the left}_2 \text{ of]}^\pi = \lambda c. \lambda x. \text{+} (\text{face}(x, c(\text{p-time})))$$

The intrinsic meaning is unavailable if there is no intrinsic axis. The availability of an intrinsic axis is subject to cross-linguistic variation, see [3] and references therein.

This analysis of `left` accords well with intuitions regarding potential confusions behind uses of relative directions: it is unclear what perspective on the event is to be taken. Thus, the classic question: “Your left or my left?”

## 5 Location and Direction Marking in Pima

Pima has a series of deictic particles that encode distance and direction holding between an event participant and a viewpoint (see [10]). The particles used here are ‘`ab`’ ‘towards’, ‘`am`’ ‘away’, and ‘`an`’ ‘parallel, perpendicular’, all distals. (There are others with the same properties.) The typical situation is for the speaker to be the viewpoint, and to specify the direction of an event participant relative to the

speaker (13), (14).

Keli 'at 'ab 'i'iho.  
 (13) man AUX:PF D:FR cough  
*'The man coughed (while facing me).'*

Keli 'at 'am 'i'iho.  
 (14) man AUX:PF D:BK cough  
*'The man coughed (while facing away from me).'*

When such particles occur in an embedded clause, the viewpoint is identified with an argument of the matrix clause. Thus, in (15), the first particle 'an specifies that Bart is facing sideways relative to the speaker, while the second specifies that the dog is facing sideways relative to Bart, even if the dog is facing the speaker. If the dog were facing Bart, on the other hand, then the second particle would be 'ab (16).

Bart 'o 'an 'aagid heg Lisa mash heg gogs  
 Bart AUX D:SD tell DET Lisa C:AUX DET dog  
 'an keek Homer veegaj.  
 (15) D:SD stand Homer behind  
*'Bart (who is looking to my side) is telling Lisa that the dog  
 (which is facing to Bart's side) is standing behind Homer.'*

Bart 'o 'an 'aagid heg Lisa mash heg gogs  
 Bart AUX D:SD tell DET Lisa C:AUX DET dog  
 'ab keek Homer veegaj.  
 (16) D:FR stand Homer behind  
*'Bart (who is looking to my side) is telling Lisa that the dog  
 (which is facing to Bart's side) is standing behind Homer.'*

This shift also occurs with perception verbs: in (17), the deictic center for the particle 'ab is Marge, not the speaker. The sequencing in these examples is obligatory: the embedded deictics in (15), (16), and (17) cannot be interpreted with the speaker as deictic center. Since the specification of a location is dependent on the perception of it, the deictic center can be reset with predicates that report (directly or indirectly) an individual's perception.

Marge 'o ñeid heg gogs mo 'ab ki'ikash  
 Marge AUX see DET dog C:AUX D:FR bite  
 (17) heg viappoi.  
 DET boy  
*'Marge sees the dog that bit the boy (while facing her).'*

The data is analysed as follows. The particles indicate a relationship between an actant and a viewer. The default case is for the viewer to be the speaker. Predicates that directly or indirectly report another’s perceptions reset the viewer value for the embedded context. Verbs of perception, like ñeid ‘see’, directly report the subject’s perception of the event, and thus any embedded clause takes the subject of the matrix clause as its viewer. Verbs of communication indirectly report the perceptions, so the same resetting happens.

We define *here* as a set of points in  $\mathbb{R}^3$  encompassing the viewpoint. Similar to  $\vdash(\vec{v})$ , we let  $\top(\vec{v})$  be the direction  $180^\circ$  from  $\vec{v}$  and  $+(\vec{v})$  be the set of directions  $90^\circ$  clockwise or counterclockwise to  $\vec{v}$ . We then define the particles ‘ab and ‘an as

- (18) [*’ab*] $^\pi = \lambda c.\lambda x.\text{loc}(x, c(\text{ev-time})) \notin c(\text{here})$   
 $\wedge \text{face}(x, c(\text{ev-time})) = \top(\text{vec}(c(\text{viewpoint}), \text{loc}(x, c(\text{ev-time}))))$
- (19) [*’am*] $^\pi = \lambda c.\lambda x.\text{loc}(x, c(\text{ev-time})) \notin c(\text{here})$   
 $\wedge \text{face}(x, c(\text{ev-time})) \in +(\text{vec}(c(\text{viewpoint}), \text{loc}(x, c(\text{ev-time}))))$

## 6 Conclusion

In order to account for sequencing in general, we have introduced the notion of a parameter name. For each sort (time, location, world etc.) there are up to four parameter names on which the context is defined. Meanings are ‘intensionalised’ with respect to contexts. The difference in sequencing behavior can be attributed to the way in which values for parameter names get reassigned. English *come* and *go* depend on the viewpoint. We have presented data in Pima to show that sequence of location and direction phenomena can be observed that are quite like those of tense and person.

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