

Temporal partitions in the grammaticalization of imperfective aspect markers

A formal semantic approach

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This article proposes a new account for the typologically uncommon grammaticalization path from an adjective meaning ‘tight’ to a progressive aspect marker in Cantonese. I take a formal approach to explain the cognitive foundations in such a grammaticalization path by using formal semantic theories and tools. There are two components in the meaning of the progressive aspect, i.e. temporal inclusion and dynamism. The meaning ‘tight’ is transferred from the spatial domain to describe the close succession of events, which gives rise to the dynamic meaning component. Furthermore, this eventual dynamism is mapped to the temporal domain, which corresponds to the regular partition of the time interval with an infinitesimal measure in the semantics proposed by Deo (2009). My analysis is extended to explain the Cantonese habitual marker with an original meaning ‘open’, and to the use of morphological reduplication to express the imperfective aspect in languages from the Austronesian and Pama-Nyungan families. The theoretical contribution of this article is that the grammaticalization paths of certain aspect markers share a common cognitive foundation in terms of space, events, and time, but they may take different trajectories of evolution that target different parts of a functional morpheme with complex meanings.

Keywords: imperfective aspect markers, progressive aspect markers, typology, Cantonese, Austronesian languages, Pama-Nyungan languages

1. Introduction

This study provides formal semantic analyses to the cognitive foundations of grammaticalization paths of imperfective aspect markers. Here I focus on the pro-

gressive aspect markers first and extend my analysis to other imperfective aspect markers. Example (1) illustrates what the progressive aspect is.

- (1) John was reading.

The meaning of the progressive aspect and the past tense in (1) can be sketched along the lines of Lin (2006: 16). Example (1) means that there is an event e of *reading by John*, there is a time t that precedes the speech time t_0 , and e holds at t . Here the term “holds” means that t is included in the event time t_e of e . In this interpretation, that t precedes t_0 is the tense semantics, while the meaning of e holding at t is part of the progressive aspect itself. Thus, one key semantic component of the progressive aspect is the relation between the event time t_e and the reference time t . Let us call it the *temporal inclusion* component of the progressive aspect.

Moreover, Bybee et al. (1994: 126) point out that “the progressive is typically used for actions that require a constant input of energy to be sustained”. Lin (2006: 16) incorporates this requirement in the semantics of the progressive aspect as “Dynamic(P)”. Thus, stative predicates are not allowed with the progressive aspect in *unmarked* contexts, as shown in (2).

- (2) *John is liking this idea.

The verb ‘like’ in (2) denotes a state, while the verb ‘read’ in (1) denotes a dynamic event. The unacceptability of (2) shows that, in addition to temporal inclusion, the progressive aspect contains a dynamic meaning.¹ I call it the *dynamism* component of the progressive aspect.

The dynamism component of the progressive aspect is associated with dynamic predicates, but dynamic predicates do not need to be used only in the progressive construction. For example, we can say “John often reads the newspaper in the morning.” The dynamic property of the predicate ‘read’ is simply not salient in such non-progressive constructions. Another clarification here is that my main focus in this article is how a lexical source is connected to the dynamic meaning component in the grammaticalization of progressive aspect markers. Therefore, I leave aside the issue of why sentences with stative predicates, e.g. as in (2), are not quite acceptable with the progressive aspect.

Therefore, the meaning of the progressive aspect has two components: *temporal inclusion* and *dynamism*. According to the typological survey by Bybee et al. (1994: 128–129), cross-linguistically, an overwhelming majority of the forms of

1. Stative predicates can be used with the progressive aspect, e.g. “I am loving it”, but in these cases, the stative predicates should be interpreted “dynamically”, which de Swart (1998) calls “aspectual coercion”.

the progressive aspect are derived from locative expressions. I briefly discuss in § 5 that the target of this grammaticalization path is the temporal inclusion component of the progressive aspect. But a formal analysis of such grammaticalization paths from locative expressions to progressive aspect markers is not the focus of this current study, and it will be dealt with elsewhere separately.

However, there is a progressive aspect marker in Cantonese, i.e. *-gán*, which is glossed as ‘be hard, be tight’ by Bybee et al. (1994: 129).² Typologically speaking, the survey data so far show that Cantonese is the only known language that uses such an adjective as the lexical source for the progressive marker. Clearly, the adjective ‘be hard, be tight’ is not a locative expression. Whereas Bybee et al. (1994) have a cognitive explanation for the locative expression as a source of the progressive aspect marker, they do not have an explanation for why adjectives such as ‘be hard, be tight’ can develop into an aspect marker. This is the key issue that I try to solve in this article. I show that spatial adjectives like ‘be tight’ target the dynamism component of the progressive aspect via a series of spatial and temporal inferences.

The remainder of this article is organized as follows. In § 2, I lay out the examples in Cantonese and discuss the semantics of three imperfective aspect markers in Cantonese. In § 3, I explain the connection between the lexical items and the aspect meanings in Cantonese. In § 4, I discuss morphological reduplication with regard to the imperfective aspect and show that it can be explained via the same cognitive and semantic analyses as given in the previous section. In § 5, I address the theoretical implications of my research and describe the larger research project.

2. Cantonese aspect markers

According to Comrie (1976), the various grammatical aspects can be classified as in Figure 1. The distinction between progressive and continuous is that the progressive aspect is typically used with predicates of activities, while continuous is compatible with both activities and states. The non-progressive is defined as continuous minus progressive, which yields the meaning of a continuous state. The habitual aspect describes a generalization.

A language may have just one aspect marker for the imperfective, and this marker can have different readings ranging from the habitual to the progressive,

2. There is another progressive aspect marker in Cantonese, i.e. *háidouh*, which is essentially a locative expression with a literal meaning of ‘at place’. This progressive aspect marker conforms to the typologically common type of grammaticalization path.

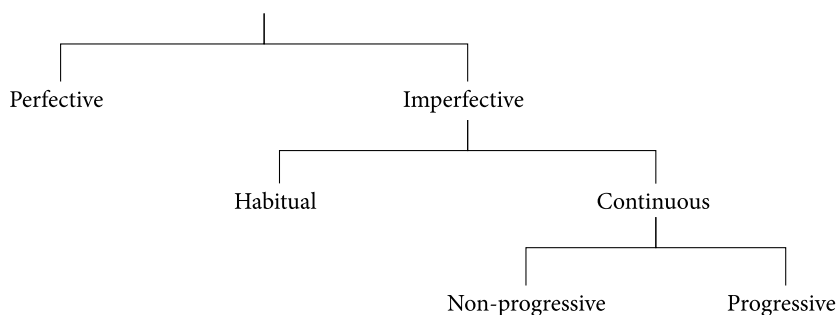


Figure 1. Classification of aspectual oppositions (Comrie 1976: 25)

depending on the context. Italian is such a language (Bonomi 1997: 472). On the other hand, a language may have more than one aspect marker for the imperfective, with different divisions of labor among the habitual, the progressive and the continuous aspects. Cantonese is such a language.

According to Chappell (1992), the following three aspect markers are related to the imperfective aspect in Cantonese: the progressive marker (PROG for short) *-gán*, the continuous marker (CONT for short) *-jyuh*, and the habitual aspect marker (HAB for short) *-hōi*.³ These can be illustrated with Examples (3)–(5), respectively, all taken from Matthews & Yip (1994).

- (3) *Chàhn Sāang taan-gán saigaai.*
 Chan Mr. enjoy-PROG world
 ‘Mr. Chan is having a good time.’ (Matthews & Yip 1994: 202)
- (4) *Gāan ūk deui-jyuh go hói.*
 CL house face-CONT CL sea
 ‘The house faces the sea.’ (Matthews & Yip 1994: 203)
- (5) *Kéuih jouh-hōi jūngdím ge.*
 s/he work-HAB part-time PRT
 ‘She normally works part-time.’ (Matthews & Yip 1994: 209)

The PROG *-gán*, as shown in (3), is a typical progressive marker, “used for dynamic ongoing activities, implying change over time” (Matthews & Yip 1994: 202). This suffix is glossed as ‘be hard, be tight’ in Table 5.1 from Bybee et al. (1994: 129), according to their source Kwok (1971: 104–105). Chappell (1992: 87) glosses it as ‘be tight, firm’. This suffix is written with almost the same character as the one for the word ‘be tight’. The only difference is that *-gán* is written with an extra

3. I follow the modified Yale system used by Matthews & Yip (1994: 7–9) to transcribe Cantonese.

“mouth” radical on the left. Chappell (1992: 87) cites Cheung (1972: 149), arguing that the two words are likely to have been the same in origin, and the slightly different written forms are only to distinguish the two meanings of the same word. Chappell (1992: 87) further speculates that “the semantic link between a resultative complement verb of enduring state meaning ‘be firm, tight’ and the progressive is a plausible one.” But how is this plausible? Chappell (1992) does not give any details. This is an issue that I address in this article.

The CONT *-jyuh* as shown in (4) is glossed as ‘stay, reside’ by Bybee et al. (1994: 128), following Kwok (1971). The grammatical meaning of *-jyuh* is to describe “a continuous activity or state without change” (Matthews & Yip 1994: 202). The connection between ‘reside’ and the continuous aspect is that to say a state holds at a place is metaphorically saying it resides there. Therefore, this is a case of a locative expression as the source for the aspect marker.⁴ Thus this *-jyuh* is an instance of the typologically widely-attested grammaticalization path from a locative expression to an aspect marker.

Example (5) contains the HAB *-hōi*, which denotes a habitual, regular activity. It is comparable to the English *used to* construction, but it is not restricted to a past habitual activity, and the typical use is for a current habitual activity (Matthews & Yip 1994: 209). In terms of its original lexical source, Cheung (1972) relates it to the verb meaning ‘to open’ and the adjective meaning ‘be open’. “Such a lexical source for an imperfective is not unexpected, given its stative nature”, notes Chappell (1992: 92). But quite contrary to Chappell’s (1992: 92) claim, the connection between the meaning of ‘open’ and habitual activities is actually quite unexpected and typologically uncommon. Thus, there needs to be a more systematic explanation. This is another issue that I solve in this article.

To sum up the data regarding Cantonese, the imperfective aspect is further distinguished among three specific aspect markers, i.e. the PROG *-gán*, the CONT *-jyuh*, and the HAB *-hōi*. Interestingly, the lexical sources for the PROG *-gán* and the HAB *-hōi* are quite puzzling from a typological perspective. I argue next that there is a well-defined cognitive connection in terms of the temporal partitions in the semantics of the imperfective aspect markers.

4. There is an alternative theory regarding the original lexical source of *-jyuh*. Mei (1981) relates it to a verb meaning ‘to adhere, to hold on to’. This origin is equally clear as a location where a state can hold.

3. Formal semantic analyses of the grammaticalization of *-gán* and *-hōi*

In this section I provide formal semantic analyses of the cognitive connection between the original lexical meanings of ‘be tight’ and ‘be open’ and their semantics of being a progressive or a habitual aspect marker respectively in Cantonese. I also compare these two meanings with the continuous aspect marker.

First, I argue that there is a plausible logical path of inference to deduce the dynamic meaning component of the progressive aspect marker from the original spatial closeness meaning of *-gán*.

But before I present the formal analysis, I need to clarify my methodological approach. As I discuss in §2, the current written forms of the aspect marker *-gán* and the adjective ‘be tight’ are different. Cheung (1972: 149) proposes that the origins of both morphemes could have been the same. Since there are no extensive historical written records that can be used to establish the change from the adjective ‘be tight’ to the aspect marker, Cheung’s (1972: 149) claim is only speculative given that intuitively there is no obvious connection between the two meanings. Such etymological uncertainties are quite common in Chinese dialectology when historical written records are scarce. In such cases, although the claims as to the etymological relations between different morphemes can only be speculative, we may nonetheless try to strengthen these claims if we can find some semantic connection between the two meanings via a series of logical inferences, especially when such a logical connection has underlying cognitive foundations. This, in my analyses here, is the role of formal semantics in such research of grammaticalization. The formal analyses here do not prove whether a claim is right, but rather the formal semantics supports or strengthens a certain claim, making it more plausible. While keeping this in mind, let us now turn to the original meaning of the adjective *gán* in Cantonese.

The word *gán*, meaning ‘tight’, in Cantonese can be traced back to the *Shuo wen jie zi*, a dictionary from the early 2nd century, in which it is explained that the word refers to ‘spinning silk threads closely’. Therefore, it originated as a word with the meaning of *spatial closeness*. Furthermore, in terms of the cognitive processes of language evolution, there is a natural connection between space, time and events, e.g. according to Bybee et al. (1994: 136). Originally the adjective ‘tight’ describes the small spacing between objects, and then it is metaphorically applied to the closeness of events. If a series of events are closely spaced temporally, then this gives rise to the dynamic meaning in the progressive aspect. Based

on this view, I sketch a formal inference pattern to bring about the dynamic meaning of the progressive aspect from the original meaning of spatial closeness.⁵

The semantics of the imperfective and progressive aspects can be formulated in many different ways. The key issue here is how the dynamic property of the progressive aspect can be formally defined. As we see in §2, Lin (2006: 16) describes such a property as “Dynamic(P)”. However, the notion of “*dynamic*” is still not formally defined in his semantics. In this article, I argue that *dynamism* can be defined in terms of temporal partitions of an infinitesimal measure in the semantic theory proposed by Deo (2009; 2015). Note that Deo (2009; 2015) does not directly define *dynamism* in her semantic system, although it seems quite reasonable to relate dynamism with temporal partitions.

Since the Cantonese data I discuss do not involve any intensionality, I only introduce a simplified version of Deo’s (2009; 2015) system here without the intensional semantics. Moreover, Deo (2009: 507–509) discusses two different versions of the semantics of both the imperfective and the progressive aspect markers in English. Deo (2015: 12–14) adopts the second version of the semantics of these aspect markers. Therefore, I use Deo’s (2009: 508–509) second version of the semantic system to illustrate the meaning of the Examples (6) and (7) here.

(6) John plays soccer.

(7) John is playing soccer.

In (6), it involves a present imperfective that expresses a generalization. Informally, what (6) means is that the reference interval $i = \text{now}$ is contained as an initial subinterval within a larger interval j . The interval j is further divided into subintervals k of an equal length, which is contextually determined, e.g. *a week* or some other such interval. The event of *John playing soccer* overlaps with each of these subintervals k . In (7), it is a present progressive construction that expresses a currently ongoing activity. The semantics is that the interval i , which is equal to the interval *now*, can be divided into subintervals k of an infinitesimal length, and for all such intervals k of an infinitesimally equal length, the event of *John playing soccer* overlaps with k . Note that in the semantics of the progressive aspect as formulated by Deo (2009: 509), it does not involve a superinterval j of i . It is the reference interval i itself that is the base of the partition, i.e. $i=j$. However, such a fine distinction in Deo’s (2009) semantic system does not affect my analysis. The

5. The same word ‘be tight’ is shared among many dialects of Chinese. But it did not grammaticalize into the progressive aspect marker in any other Chinese dialect, as far as I know. Therefore, although it is cognitively possible to derive the progressive meaning from the word ‘be tight’, it is by no means necessary that all languages actualize such a connection.

most relevant notion here is that of temporal partition of an interval into subintervals, defined by Deo (2009; 2015) as in (8) here.

(8) Regular partition

R_i is a regular partition of i if R_i is a set of intervals $\{j, k, \dots n\}$ such that

- a. $\cup\{j, k, \dots n\} = i$,
- b. $\forall j, k \in R_i \rightarrow j \cap k = \emptyset$ if $j \neq k$,
- c. $\forall j, k \in R_i \rightarrow \mu(j) = \mu(k)$

(where $\mu(x)$ stands for the Lebesgue measure of x). (Deo 2015: 12)

According to the definition in (8), clause (a) defines the joint exhaustivity of the partition; clause (b) defines the mutual exclusivity of the subintervals within a partition. Clause (c) defines the partition-measure, which determines the length of each subinterval, or equivalently, each cell within the partition. Deo (2009) ties the difference between the progressive aspect and the habitual aspect to the partition-measure. The event-in-progress meaning typical of the progressive aspect obtains “when the partition-measure is chosen from the set of infinitesimals, i.e. when the measure is set to an *infinitesimally small* length” (Deo 2009: 505). On the other hand, we get the habitual reading “when the context provides a partition-measure of a higher magnitude, one significantly larger than the normal interval for an event of the type denoted by the predicate” (Deo 2009: 510).⁶ In general, the partition-measure is determined via context. However, I argue here that the three aspect markers in Cantonese partially determine the partition-measure, lexically, as follows:

(9) Three types of intervals for the imperfective markers in Cantonese.

PROG: R_i where $\forall j \in R_i, \mu(j) < d$ and $\mu(j) \rightarrow 0$ (i.e. infinitesimal length)

CONT: R_i where $\forall j \in R_i, \mu(j) = d$

HAB: R_i where $\forall j \in R_i, \mu(j) > d$

In (9), d is a contextually-determined standard of comparison for the partition-measure. Each aspect marker in Cantonese poses a condition on the partition-measure via d . The PROG fixes the length to infinitesimals, the HAB fixes it to a length larger than the normal runtime of the event, while CONT yields a neutral partition-measure relative to the event type.

6. Originally in Deo's (2009: 505) version of the progressive aspect, the partition associated with the progressive aspect is fixed to an infinitesimally small length, noted as R_i^{inf} . This is likely based on how change and motion are modeled in mathematics. Although Deo (2015: 12) allows more flexibility for the partition, i.e. it is not necessarily infinitesimal, but just “small enough”, depending on the reference interval i and event type, the general idea that the cells in the partition associated with the progressive aspect in its strict sense should be quite small is still valid.

Therefore, we may define the dynamism associated with the progressive in a more general way by referring to the partition measure, as follows:

- (10) Definition of dynamism via partition measure
For any regular partition of an interval i , i.e. R_i , if the context yields a partition-measure of an infinitesimal length, then R_i is dynamic.

Thus, dynamism is defined as R_i^{inf} . One clarification is in order here regarding the difference between Deo (2009) and Deo (2015). In the earlier system, Deo (2009) proposes that the partition measure can be anaphorically retrieved from the context. Deo (2015: 12, Footnote 3) defines this context-dependence in terms of vagueness, relative to the length of the reference interval and the properties of the event description. Indeed, the data in Cantonese show that the partition-measure is not completely anaphoric, but is rather partially determined lexically, as proposed here in (9) above. Now we have a formal definition of the dynamic meaning of the progressive aspect as shown in (10), let us turn to the original lexical meanings of the Cantonese PROG *-gán* ('tight') and the HAB *-hōi*.

I treat the meanings of spatial closeness and openness as adjectival, which can be sketched by using the semantics proposed by Kennedy & McNally (2005), based on the notion of *degree*. Take the sentence in (11) as an example.

- (11) John is tall.

Schematically, the meaning of (11) can be represented as "TALL('John') > d ". It says that the degree of John's "tall-ness" is greater than d , i.e. the standard of comparison that is contextually appropriate. Similarly, when we say that the space between two objects is tight, it means that the degree of the "tight-ness" is greater than d . Suppose we are comparing the space between flower pots arranged on a shelf. If the space is smaller than usual, then the space is tight. If the space between the flower pots is larger than usual, then the space is open. Such situations can be conceptualized as objects arranged in a linear fashion, and the semantics can be represented as in (12).

- (12) Adjectival semantics of spatial closeness and openness
- There exists a sequence of objects $\langle x_1, x_2, \dots, x_n \rangle$, such that for all x_i in the sequence, the distance between two adjacent objects is smaller than the contextually determined neutral distance d , i.e. $\text{DIST}(x_i, x_{i-1}) < d$, where $1 < i \leq n$.
 - There exists a sequence of objects $\langle x_1, x_2, \dots, x_n \rangle$, such that for all x_i in the sequence, the distance between two adjacent objects is larger than the contextually determined neutral distance d , i.e. $\text{DIST}(x_i, x_{i-1}) > d$, where $1 < i \leq n$.

Suppose the contextually salient standard for the distance between flower pots that is neither tight nor far apart is one foot. Anything less than one foot would be considered tight, and anything more than one foot would be considered open. To be sure, the issue about vagueness (Graff & Williamson 2017[2002]) arises, but it is not a problem for my current theory *per se*, because similar problems exist for gradable adjectives in the general theory of adjectival semantics.

Now with the kind of semantics as in (12) in mind, we may give a similar semantic formulation to the use of the adjective ‘tight’ on events. Suppose we have a situation where John is urging me repeatedly to hurry up so that we will not be late to a party. We may conceptualize John’s urging as a series of closely-spaced events,⁷ as follows:

- (13) There exists a sequence of events $\langle e_1, e_2, \dots, e_n \rangle$ of the same type with the same participants, such that for all e_i in the sequence, $\text{DIST}(e_p, e_{i-1}) < d$, where $1 < i \leq n$.

Note that d here is a time interval. Therefore, now we have the formal characterizations of both the original lexical meaning of spatial closeness and the dynamic meaning of the progress aspect.

Next, I show an inferential path between these two meanings. Let us start with the basic eventual closeness meaning in (13) to draw the following inferences.

- (14) $\exists s. s = \langle e_p, e_2, \dots, e_n \rangle \rightarrow \exists s'. s' = \langle t_p, t_2, \dots, t_n \rangle$

- (15) $\text{DIST}(e_p, e_{i-1}) < d$, where $1 < i \leq n \rightarrow \text{DIST}(t_p, t_{i-1}) < d$, where $1 < i \leq n$

The inference in (14) means that if there is a series of events, then there is a series of time intervals where the events hold respectively. This type of inference can be easily obtained via a function such as the τ function proposed by Deo (2009; 2015), which takes an event argument and gives its temporal trace. What (15) means is simply that the time intervals are spaced more tightly together than a contextually determined standard. Furthermore, by allowing the distance to be at

7. This definition works for activities and semelfactive events. But for accomplishment predicates, e.g. “eat an apple”, some modification is needed. One possibility is to say that the event of “eating an apple” consists of a sequence of subevents, none of which entail “eating one whole apple”. Another possibility is to say that the predicate “eating an apple” denote a more specific event, i.e. apple-eating. Thus, the sequence of events can be just a succession of apple-eating events. Whether either of these two solutions works here is probably not crucial, because as in many cognitive linguistic processes, the inference normally start with the proto-typical cases. Once the inference patterns bring about a new function, it may be extended to other cases. For example, here we may assume that the spatial closeness inference started with typical activity predicates.

the ‘tightest’, i.e. at a value of zero, we get a connected interval t , as shown in (16), such that for all sub-intervals in the interval, there is an event e and e holds at the sub-interval, and all these sub-intervals are non-overlapping as shown in (17).

$$(16) \text{ DIST}(t_p, t_{i-1}) = 0 \rightarrow \exists t.t = \cup \{ t_p, t_2, \dots, t_n \}$$

$$(17) \forall t_p, t_j, t_i \cap t_j = \emptyset \text{ if } i \neq j$$

Now if we take (16) and (17) together, and compare to the definition of partition in Deo’s (2015) system as shown in (8), it is clear that the time interval t in (16) and (17) is a partition, but it is not necessarily a regular partition. The regularity requirement is needed for the formal definition of a partition mathematically. Since we are following Deo’s (2009; 2015) semantics, we need to derive the regularity meaning in the partition semantics via inferences in a different direction.

Let us start from a series of events which are arranged on a time line closely, and if the number of events is fixed, the tighter the arrangement is, the shorter the time interval is. But conversely given a fixed time interval t , the more closely together the events are, the greater the number of events is within t . Let us use the notation $|E|$ to represent the number of events in the sequence, and this inference can be represented as in (18).

$$(18) \text{ For any given time interval } t, \text{ and a set } E \text{ of events } e, \text{ when } |E| \rightarrow \infty, \text{ we have } \tau(e) \rightarrow 0.$$

As the number of events increases within the time interval t , the subinterval where an event e holds becomes infinitesimally small. If we take all the inferences in (16), (17) and (18), we get the regular partition of an infinitesimal measure, which is the same as defined by Deo (2009) for the progressive marker, i.e. noted as R^{inf} .

To sum up this part of my semantic account for the connection between spatial closeness and the progressive aspect, I show that the meaning of ‘tightness’ can be applied to infer both the contiguity and the regularity of the partition. As shown in (16), when the focus is on the distance between events, reducing the ‘tightness’ to zero yields a contiguous set of intervals, and this gives rise to the ‘ongoing’ sense of the events, i.e. without any stop or pause. As shown in (18), focusing on the number of events that is related to how ‘tightly’ spaced they are within a given time interval, when the number increases infinitely, the time subintervals become more regular of an infinitesimal length. This gives rise to the dynamism of the progressive meaning. Thus, by taking both inferences together, we get a reading of *dynamic ongoingness*.

Now we are ready to explain the puzzle of the Cantonese habitual aspect marker *-hōi*, which originally means ‘open’. As I have shown in (12b), this adjectival meaning of ‘open-ness’ can refer to a spatial property, and it is the opposite of

'tight'. Thus, parallel to the use of 'tight' to indicate spatial closeness, the adjective 'open' can describe a series of events which are spaced out in time. I argue that this is exactly the case in Cantonese. Let us use the same kind of logical inference to show how the habitual aspect marker *-hōi* ('open') in Cantonese can be derived. Parallel to the definition in (13), which is the semantics of tight spacing of events, we may have the following semantics of open spacing of events.

- (19) For a predicate *P*, there exists a sequence of events $\langle e_1, e_2, \dots, e_n \rangle$ of type *P* with the same participants, such that $\text{DIST}(e_i, e_{i-1}) > d$, where $1 < i \leq n$.

This could be the starting point of the grammaticalization from 'open' to the habitual aspect. In order to get a regular partition, we need a stipulation on the distance between events in (19), as in (20).

- (20) For a predicate *P*, there exists a sequence of events $\langle e_1, e_2, \dots, e_n \rangle$ of type *P* with the same participants, and there exists a distance $d' > d$, such that $\text{DIST}(e_i, e_{i-1}) = d'$, where $1 < i \leq n$.

The definition in (19) is a natural step from the original lexical meaning to its description of events. The stipulation in (20) is conceptually needed for the further grammaticalization of the word. I view this stipulation as a kind of "narrowing-down" of the functional meaning from a more general one to a more specific one. This is a common process in grammaticalization when a certain construction is associated with a more specific type of contexts.

Now by using the same τ function, we can derive a set of time intervals of an equal length from (20). It is then a regular partition of an interval with the length of each cell greater than the contextual standard of a neutral length d , i.e. R_i where $\forall j \in R_i \rightarrow \mu(j) > d$.

I have contrasted the Cantonese PROG *-gán* with HAB *-hōi*, and have shown that both are transferred from the physical space to the eventual space via spatial metaphor, and a temporal inference about the spacing of time intervals is obtained, where *-gán* refers to the small space between events in a regular partition of time intervals, and *-hōi* refers to the large space between events in the habitual situation. Naturally we may now further argue that the event spacing in the CONT *-jyuh* should be neutral, i.e. neither 'tight' nor 'open', or put in an equivalent way, neither 'small' nor 'large'. This three-way contrast can be represented schematically as in Figure 2.

Furthermore, in terms of the formal definitions, I have shown that the progressive aspect requires the length of the cells in the partition to be smaller than d , and the habitual aspect requires the length of the cells in the partition to be greater than d . Now I argue that the continuous marker requires the length of the cells in

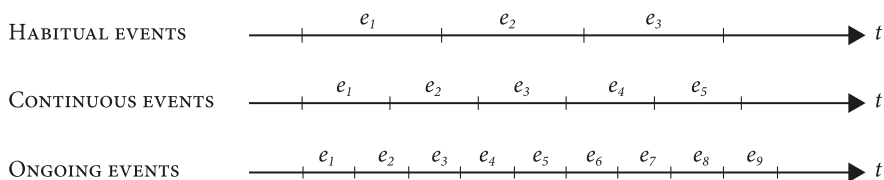


Figure 2. Spacing of events

the partition to be equal to d . We can formally represent the contrast in Figure 2 via different partition standards, as shown in (9) above, repeated here as (21).

(21) Three types of intervals for the imperfective markers.

PROG: R_i where $\forall j \in R_i, \mu(j) < d$ and $\mu(j) \rightarrow 0$ (i.e. infinitesimal length)

CONT: R_i where $\forall j \in R_i, \mu(j) = d$

HAB: R_i where $\forall j \in R_i, \mu(j) > d$

The length of the cells in the partition corresponds to the three different aspectual meanings. Note that the principal task in this article is the dynamic property of the progressive aspect, which is defined via a temporal partition of an infinitesimal length. The notion of temporal partition is also extended to related issues with the continuous and habitual aspects, as shown in (21) above, but the continuous and habitual aspects do not have any dynamic property in its semantics, which can be seen from the definition in (10). However, the formal definition of the CONT *-jyuh* in (21) might need more supporting evidence, although the neat three-way contrast does suggest that the CONT *-jyuh* should have a neutral standard of comparison, compared to the other two aspect markers. Since the focus of this article is the grammaticalization paths of imperfective markers, I leave aside the issue of the theoretical and empirical implications of the proposal that CONT *-jyuh* corresponds to a temporal partition of a neutral length.

In summary, we see how the spatial meaning of ‘tightness’ and ‘openness’ can be applied to events via spatial metaphor. Then inferences are drawn based upon different configurations of the situations. The temporal inferences are especially made via the τ function. The end result of these inferences gives us a regular partition with differing cell lengths that correspond to the different types of imperfective markers. This shows how a formal semantic theory such as the one proposed by Deo (2009; 2015) can help us understand the cognitive connections between the lexical source and the grammatical target in the process of a common grammaticalization path. In the next section, I show that another set of phenomena from Bybee et al. (1994) can also be accounted for with a similar mechanism.

4. Reduplication and morphological iconicity

In this section, I discuss reduplication as a device to indicate an imperfective aspect, including the progressive, the continuous and the habitual aspect markers. I show that such morphological devices target the temporal partition part of the semantics of the imperfective aspect marker.

Bybee et al. (1994:128) list the following four languages in the category of “Reduplication”: Motu, Nakanai, Pangasinan, and Gugu-Yalanji.⁸

According to Lister-Turner & Clark (n.d.), Motu uses two verbal suffixes to indicate “continuous action”, i.e. *-va* for past progressive, and *-mu* for present progressive.⁹ Take the verb base *gini* ‘to stand’ as an example. The expression *na ginimu* means ‘I am standing’. Correspondingly *na giniva* would be ‘I was standing’. But in sentences with a plural subject, the first syllable of the verb base can be reduplicated to indicate the “immediate present”. For example, *ita gigini* ‘we are standing here now’, *idia gigini* ‘they are standing there now’. Such verbal reduplications can be regarded as related to pluractionality primarily, although it may be alternatively interpreted as an aspect-marking morphological device.

The reduplication in Nakanai is described by Johnston (1980). For example, *ragaraga* ‘jumping’, *osaosa* ‘flirting’. The meaning of these reduplicated forms can mean “continuative habitative” according to Spaelti (1997:76).

Besides Motu, Nakanai, and Pangasinan, many other Austronesian languages use morphological reduplication to express grammatical aspects. Palmer (2009:233) describes reduplicated verbs in Kokota¹⁰ as “in some instances, a verb may also be derived from a verb root giving habitual, ongoing, or diminutive verbs”. For example:

(22) Reduplication in Kokota

/m̩ayʉ/ ‘be afraid’ → /m̩a~m̩ayʉ/ ‘be habitually fearful’
 /safra/ ‘miss’ → /sa~safra/ ‘always miss’

(Palmer 2009:27)

8. Motu and Nakanai are both Austronesian languages in Papua New Guinea. Pangasinan is an Austronesian language spoken in the Philippines. Gugu-Yalanji is a Pama-Nyungan language in Australia.

9. The lexical sources for these aspect markers are not given in Lister-Turner & Clark (n.d.). There is another morpheme *ina* used in Motu to express the Immediate Present, e.g. *Lau ina gini* ‘I am standing here now’ (Lister-Turner & Clark (n.d.):14). According to the description of *ina*, it is a demonstrative, meaning ‘here now’ or ‘there now’, and it varies according to person and number, e.g. *ena* (2nd sg.), *ene* (2nd pl.). As I note earlier, the Cantonese progressive marker *hāidouh* has a similar meaning. Therefore, it is actually similar to the Motu *ina*, and both can be regarded as locative expressions. This is probably also why *ina* is considered as “Location” in Bybee et al.’s (1994) classification, in addition to “Reduplication”.

10. Kokota is an Austronesian language spoken on Santa Isabel of the Solomon Islands.

Additionally, Zeitoun et al. (2015) give a very detailed study of the Saisiyat language, an Austronesian language spoken in Taiwan. According to them, the “continuative aspect” can be expressed via partial reduplication (Zeitoun et al. 2015: 339), and the progressive can also be expressed by CV-reduplication (Zeitoun et al. 2015: 340).

In terms of Gugu-Yalanji, or Kuku Yalanji, Patz (2002) gives these examples:

(23) Reduplication in Kuku Yalanji

warri-y ‘run’ → *warri-n-warri-y* ‘continuous running by human or animal’

bunda-y ‘sit down’ → *bundanda-y* ‘keep sitting’

(Patz 2002: 107)

In the Wik-Munkan, or Wik Mungkan language, another Pama-Nyungan language in Queensland, Australia, Sayers & Godfrey (1964: 75) indicate briefly that “verb roots, may be reduplicated to express continuous action: *mo’-mo’a-na* ‘I (am) running’.

Thus cross-linguistically in many Austronesian and Pama-Nyungan languages, verb reduplication can be used to express progressive, continuous, or habitual aspectual meanings. Iconicity has been one of the major topics of cognitive linguistics (see, for example, Moravcsik 1978), and reduplication is a typical iconicity device. I argue that the use of verbal reduplication morphology for the imperfective markers is a result of abstraction and semanticization of part of the meaning derived from morphological iconicity.

The first stage in this process of transformation via iconicity is a repetition strategy to mimic a sequence of events. In Kuku Yalanji, according to Hershberger (1964: 46–47), verb phrases are the only phrase type that can be reduplicated to show emphasis, as shown here in (24).

(24) Kuku Yalanji

Eric nugal baja nugal baja

Eric drinks INTENSIFIER drinks INTENSIFIER

‘Eric drinks and drinks and drinks.’

(Hershberger 1964: 47)

The function of the repetition is to emphasize, but it can also be reanalyzed as a sequence of continuous activity. Although theoretically speaking there is no limit to the number of repetitions in such structures, practically and schematically, the least number of repetitions is two, and the least unit to repeat is part of the verb itself. The process described here is the start of the abstraction of the meaning of reduplication. From the purely concatenative structure in repetitions, a more grammaticalized form of reduplicative verbal morphology can be derived, as shown in (25).

(25) The semantics of reduplicative verbal morphology

$$\llbracket \text{reduplicated-form of } P \rrbracket = \exists P. \exists s. [s = \langle e_1, e_2, \dots, e_n \rangle \wedge \forall e_i \in s. P(e_i)]$$

According to (25), the meaning of verbal reduplication is that there is a sequence of events of type P . If we use the τ function on (25), we will get (26).

$$(26) \quad \exists s. s = \langle e_1, e_2, \dots, e_n \rangle \rightarrow \exists t. t = \langle t_1, t_2, \dots, t_n \rangle$$

The inference in (26) provides the basis for further deriving the partition of the time interval. The full specification of the progressive aspect meaning will have to be derived via the same “narrowing-down” process as I describe with regard to the stipulation in (20). Here it is because verbal reduplication can only go as far as shown in (26) in the semanticization process. Actually, this conforms to how reduplication is used in different languages, because it can express a wide array of aspectual meanings from the progressive, the continuous to the habitual.

The main point of this section is that the use of reduplication for the imperfective aspect can be explained in a fashion similar to the use of spatial adjectives ‘tight’ and ‘open’ in terms of the partition of the relevant time interval. Thus, the same kind of cognitive process is at work here too, just as in the case of the grammaticalization of the spatial adjectives in Cantonese. In both cases, the formal inferences that are sketched in this article target the partition meaning component in the semantics of various imperfective aspect markers, albeit via different morphological processes. Such grammaticalization paths that target the temporal partition semantics contrast with the more common grammaticalization paths that target the temporal inclusion relation via locative expressions, which I discuss in more detail in §5.

5. Theoretical implications and conclusions

Traugott & Dasher (2001) explore regularity in semantic change by identifying the common patterns across different languages. The underlying motivation for these common patterns is rooted in the cognitive connections between different linguistic ontological entities. Eckardt (2006: 91), studying the grammaticalization of the “be going to” construction used in future contexts in English, argues that “we can better understand this development in the history of English on the basis of a detailed semantic analysis of the stages of the development in question”. Similarly, I have tried to explain the seemingly different types of grammaticalization paths in a unified account by combining the cognitive explanations with the analytical tools in formal semantics. I have shown that the typologically uncommon linguistic phenomena in Cantonese and the related morphological

devices used in Austronesian and Pama-Nyungan languages can be accounted for by resorting to the notion of temporal partition in Deo's (2009; 2015) semantic system. This formal account helps us to draw a series of inferences to explain the connections between the original lexical semantics and the target grammatical functional meaning. Note that the formal semantics provided here is not meant to be an exact modeling of the cognitive processes involved in grammaticalization. But rather, it is to lend support to proposals of grammaticalization paths that are not quite obvious on the surface. For example, the connection between the meaning of 'tight' and the progressive aspect in Cantonese is suggested to be a possible grammaticalization path by Chappell (1992). But only when we consider the formal semantic analyses provided in this article do we see how cognitively plausible this proposal is. Thus, my formal approach aims to strengthen the validity of claims about certain puzzling linguistic phenomena when sufficient historical data are unavailable.

Even when historical data are abundantly available, such as in the case of Mandarin Chinese vernacular writing, formal analyses can still help us better understand the process of grammaticalization and to refine our synchronic analysis. I have used formal semantics to study the grammaticalization of sentence-final particles such as *-ne* and *-ma* (Dong 2018). The formal semantic tools can analyze the detailed stages of grammaticalization with much precision and rigor. Thus, I believe formal semantics can be applied to diachronic data to yield very exciting theoretical and empirical results.

Another contribution of my approach here is that almost all of the data in Table 5.1 of Bybee et al. (1994: 129) can be connected to the same cognitive processes in terms of spatial metaphor and temporal inference, although their semantic targets are different components of a complex meaning such as the progressive which consists of temporal inclusion and dynamism. To be more specific, let us consider the most common type of grammaticalization path from a locative expression to an imperfective marker. For example, the Cantonese progressive aspect marker *háidouh* is essentially a locative expression, with a literal meaning of 'at place'. In terms of the explanation for this common grammaticalization path from a locative expression to a progressive aspect marker, Bybee et al. (1994: 136) propose that "the original meaning of the progressive construction is 'the subject is located in the midst of doing something'", and the whole construction "contains either explicitly or implicitly the following elements of meaning": an agent is located spatially in the midst of an activity at a reference time. Thus, this common grammaticalization path is founded upon the cognitive connections between space, events, and time. But a more detailed formal semantic characterization of such grammaticalization paths is beyond the scope of this article.

One key feature of the progressive aspect is that it is a complex semantic structure which includes at least two properties: temporal inclusion (or rather simultaneity) and dynamism. Therefore, the grammaticalization from a lexical item to a progressive aspect marker may target either one of these two properties. On the one hand, in the case of locative expressions, the path leads to the simultaneity property which is semantically a temporal inclusion relation, i.e. “in the midst of doing something”. On the other hand, spatial adjectives lead to a regular partition of the relevant time interval. Furthermore, verbal reduplication also yields a basis for temporal partition semantics. This multiple-path grammaticalization situation can be represented as in Figure 3.

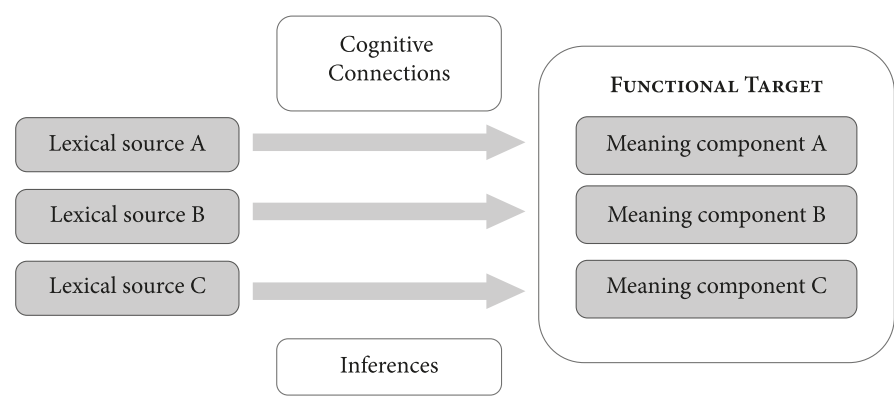


Figure 3. Multiple paths of grammaticalization

Typologically speaking, verbal reduplication is a common morphological device in many languages, and further studies of more language families will help us refine our analyses of the connection between reduplication and aspect markers.

What is even more interesting is the use of spatial adjectives to indicate aspectual meanings, such as ‘tight’ and ‘open’. Thus far, Cantonese is the only known language that uses such a grammaticalization path for their progressive and habitual aspect markers. As I point out above, dynamism is one of the two major meaning components of the progressive aspect, and thus it is reasonable to assume that there are other languages that target the dynamic meaning component in their grammaticalization, either by using spatial adjectives, or similar lexical items.

There are at least two directions for further research, in connection with the main topics of this article. On the one hand, we may try to see if formal semantic analyses can be applied to other plausible proposals that are yet speculative due to lack of historical data for the grammaticalization process. The formal analyses can lend further support to these proposals from the perspective of semantic inferences. On the other hand, further research on the typology of languages in terms

of the lexical sources of their aspect markers will be interesting, e.g. to find more languages that are like Cantonese in using spatial adjectives. Such research will not only help to validate the formal semantic approach taken in this article but will also lead to a better understanding of certain typological generalizations.

Some remaining issues to be addressed are related to the synchronic semantics of the three aspect markers in Cantonese that are mentioned in this article. As I suggest in (21), the main difference among these three aspect markers is the length of the temporal partition. While it is empirically true that the habitual aspect marker refers to larger subintervals than the other two aspect markers, it is not quite clear whether the progressive and the continuous aspect markers differ mostly in terms of the length of the temporal partition. For example:¹¹

- (27) #*Kéuih jeuk-jyuh sēutsāam, dahnhaih kéuih yìhgā jeuk-gán*
 he wear-CONT shirt but he now wear-PROG
wahnduhngsāam.
 sportswear

Intended meaning: ‘He usually wears a shirt, but he’s now wearing sportswear.’

If the continuous aspect marker *-jyuh* refers to a larger subinterval than the progressive aspect marker *-gán*, then there should not be an issue with (27). Thus, if we want to maintain the neat contrast in (21), such synchronic semantic issues need to be addressed in future research projects.

To conclude this article, formal semantics as applied to diachronic data can help us better understand relevant linguistic phenomena and point to new theories and empirical findings.

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Abbreviations

CL	classifier	PROG	progressive aspect marker
CONT	continuous aspect marker	PRT	sentence-final particle
HAB	habitual aspect marker		

11. Thanks to a reviewer for this example and the issue raised here.

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