A Semantic Analysis of Time Intervals — Core Senses and Relational Senses of a Time Interval[*]

Shu-Ling Huang[+] and Keh-Jiann Chen[++]

[+] Department of Language and Literature Studies, National Hsinchu University of Education, Hsinchu

[++]CKIP, Institute of Information Science, Academia Sinica, Taipei

E-mail: slhuang@mail.nhcue.edu.tw; kchen@iis.sinica.edu.tw

Abstract: Temporal relation, includes duration, aspect, frequency, time point and sequence etc., describes the relationship between time elements and events in complex knowledge networks. Logical compatibility between temporal elements and event types strongly influence semantic interpretation and grammaticality of sentences. It is one of the most complicated, frequently used, and not well understood topics in linguistics. In this paper, we focus our attention on duration only. We made fine-grain distinctions for time intervals and provided explanatory reasons for their common functionalities and idiosyncrasies. We pointed out that types of collocated events and semantic of time intervals are main factors which control the usage of time interval words. Furthermore, we also proved that morpho-syntactic structure of time interval words also reduces the flexibility of their usages. We had listed four different types of morpho-syntactic structures for duration expressions and provided the constraints of their usages.

Keywords: Time Intervals, semantic analysis, temporal relation, event type, MARVS (Module-Attribute Representation of Verbal Semantic) representation

時段詞的語義分析—從時段詞的核心語義與關係語義切入

黃淑齡[+]、陳克健[++]

[+]新竹教育大學中國語文學系　新竹、[++]中央研究院資訊科學研究所詞庫小組　台北

E-mail: slhuang@mail.nhcue.edu.tw; kchen@iis.sinica.edu.tw

摘　要：時間關係包括時貌、時點、時段、頻率及序列等等，它們在複雜的知識網絡中，被用來表達事件和時間成分之間的關係。時間成分與事件類型的合理搭配對語義的理解以及語法的正確性影響很大，這個既複雜又經常出現的語言學課題，尚未有從語義切入的完整分析。在本文中，我們只針對時間關係中的時段詞用法來作分析。我們區別出時段詞的細緻語義，說明它們的不同用法及區分原因。我們還指出時段詞所搭配的事件類型和語義內涵是影響它用法的主要因素。最後，我們提出時段詞的詞彙結構也影響了它的用法，我們共列出四種時段詞衍生的組成模型，並討論其語義及用法限制。

關鍵詞：時段詞, 語義分析, 時間關係, 事件類型, 動詞語義表達模式

1　Introduction

Temporal relation is one of the most complicated, frequently used, and not well understood topics in linguistics. It describes the relationship between time elements and events in complex knowledge networks. Temporal relations include duration, aspect, frequency, time point and sequence etc. For instances, '每天 *everyday*' denotes the temporal relation of frequency and '星期一 *Monday*' denotes the temporal relation

of time point. In the past, temporal words were often analyzed from the perspective of syntactic behavior, for example, dividing temporal words into nouns or adverbs, or distinguishing them into tense or aspect [Lu & Ma 1985]. Li *et al.* [2005] made clear-cut definitions for different types of temporal adverbs and studied logical compatibility between types and aspects. In this paper, we focus our attention on the temporal relations and grammatical functions of a particular type of temporal words called time intervals. A time interval in general is neutral in denoting temporal relation. Its core meaning expresses a certain length of time. For example, '三分鐘 *three minutes*' is a typical time interval. In '三分鐘吃光 *eating up in three minutes*', it functions as a pre-verbal adverbial and denotes the temporal relation of 'duration for event completion'. On the other hand, in '等三分鐘 *wait for three minutes*', the '三分鐘 *three minutes*' is a post-verbal nominal and denotes the temporal relation of 'duration of the event'. In other case like '一下子變天 *all of a sudden the weather changed*', the '一下子 *all of a sudden*' is a pre-verbal adverbial too, but its sense emphasizes 'situation change in a short duration'. There are similarity and idiosyncrasy among different words of time intervals. We like to provide explanatory reasons for their functionalities and idiosyncrasies. Previous studies have pointed out that event types and semantic attributes actually influence the syntactic grammar and semantic interpretation [Chang *et al.*, 2000], they are main factors which control the usage of time interval words. We will provide evidences in the following sections.

A temporal word might have multiple senses. They are not always easy to distinguish. For example, In *Modern Chinese Dictionary* [1996], there are four meanings for '一天 *yi tian*':

(1) a.　一晝夜　　'24 hours'
　　 b.　一個白天　'daytime'
　　 c.　泛指過去某一天　'one day in past'
　　 d.　一天到晚　'from day to night'

(1) a., b. and d. are all refer to nonspecific time intervals, but c. expresses a time point. A time point refers to a particular event time. The sense of being a time interval or a time point is resolved by the context. When it describes the 'quality of time', it's an interval, otherwise, it's a time point [Lee, 1998]. In this paper, when we refer to a word of time interval, we mean the word has core sense of time interval and use this sense in its contextual environment. In the next section, we'll discuss the semantic interpretation of time intervals and will address how the event type influences word sense. In section 3, we focus on the morpho-syntactic structures of time intervals and their effects to the usages before we made conclusions in section 4.

2　Temporal Relations and Semantic Interpretation of Time Intervals

To make the target of our study clear, we want to reiterate the definition of the class of time intervals. As we mentioned before, a word/expression of time interval has the core sense of denoting a certain length of time, such as '三分鐘 *three minutes*', '一會兒 *a while*', '三年 *three years*', and '長年 *yearlong*'. They don't specify particular time point on the time line. Hence we don't classified the words like '早上 *morning*', '星期日 *Sunday*' etc. as time intervals, since their core sense is to denote a particular time point. Although both time intervals and time points have the sense of time period, but they play different temporal relations and have different grammatical functions.

2.1 Temporal relations expressed by time intervals

In principle, generic time intervals may combine with prepositions and/or postpositions to make their sense and grammatical function unambiguous. For examples,

(2) 在廿分鐘後將火勢控制 *'After twenty minutes, the fire was controlled'*

(3) 在兩年內唸完大學 *'To graduate from the University within two years'*

These two sentences can be clearly understood as 'After twenty minutes, the fire was controlled' and 'To graduate from the University within two years'. But the semantic interpretation of a generic time interval is ambiguous; it may be interpreted as different fine-grained temporal relations and has co-occurrence constraints with different type of events. The following examples exemplify three different duration relations play by the same time interval.

(4) 八分鐘得十六分 *'to score sixteen points within eight minutes'*

(5) 陽光八分鐘抵達地球 *'after eight minutes the sunlight arrives at the Earth'*

(6) 表演八分鐘 *'perform eight minutes'*

Sentence (4) means 'to score sixteen points within eight minutes' and sentence (5) expresses 'after eight minutes the sunlight arrives at the Earth'. Sentence (6) means 'perform eight minutes.' Each expressed slightly different sense of durations. The first sense is 'duration for event completion' which emphasizes the event started and completed within the time period and the second is 'duration before state/situation change'. When time intervals appear after a verb, such as (6), it denotes the sense of 'duration of event'. In contrast to the sense of the first type, the third type events are not bound events, i.e. the events may not complete/terminate yet.

Typical time intervals share the same sense interpretations. Thus we also have examples of:

(7) 老半天泡一壺茶 *'take a long time to make a pot of tea'*

(8) 好一會兒睡著了 *'take quite a while to fall asleep'*

(9) 睡一下子 *'sleep for a short while'*

The time interval '老半天 *a long time*' in (7) refers to the event duration of completion, i.e. the duration of 'to make a pot of tea', while in (8), the time interval '好一會兒 *quite a while*' denotes the long duration before the event 'sleep' starts. Therefore pre-verbal time intervals have ambiguous sense interpretation.

2.2 Sense disambiguation and collocation relation with event types

We will show that the major feature influencing the sense and grammatical functions of a generic time interval isn't purely syntactic positions but also different event types. Take (10) for example:

(10) a.一下風雲變色 *'all of a sudden situation changes'*   vs.   a'.*風雲變色一下

     b.一下跌回到現實 *'all of a sudden fell back to reality'*   vs.   b'.*跌回到現實一下

     c.一下讀了三本書 *'reading three books within a short time'*   vs.   c'.*讀了三本書一下

     d.一下全吃光 *'to eat up within a short time'*   vs.   d'.*全吃光一下

(10) a. and b. express a short duration before changing state/situation; we find the co-occurrence event type can be a state or an activity. On the other hand, (10) c. and d. focus on the events completed within a period of time and hence the events should be bounded events, i.e. the end points of events are required, thus the perfective aspect particle '了 *le*' often appears concurrently, such as (10) c. The unbounded events will result improper usages like '*一下讀書 *a short time read*', '*好一會兒睡覺 *quite a while sleep*'. On the other hand, a post-verbal time interval denotes 'duration of a continuing event'. Therefore it cannot

co-occurred with any bounded or punctual event such as (10) a', b', c', and d'.

Chang *et al*. [2000] listed five atomic event structures as (11) in the MARVS (Module-Attribute Representation of Verbal Semantic) representation.

(11)　· 　　　　Boundary (complete)　　e.g. die…
　　　 / 　　　　Punctuality　　　　　　e.g. plan…
　 //////　　　　Process (activity)　　　e.g. travel…
　 ——　　　　　State　　　　　　　　e.g. happy…
　 ^^^^　　　　Stage　　　　　　　　e.g. rise…

They mentioned if durations are involved within an event, the event types must be limited as process, stage or state, but not punctual or complete, since such events should be completed in an instant. Chang *et al*. also used time element as a criteria to identify event type. In this paper, we find more interesting linguistic phenomenon beyond Chang's prediction, since we had made the distinctions of three fine-grained duration types.

First of all, we use MARVS representation to check the post-verbal time intervals. We find no matter they denote long duration or short duration, they purely express the event duration. As Chang *et al*. predicted, they only collocate with processes, stages or states without end point. We also observed the types of punctual and bounded events are not allowed in this kind of constructions. The examples are shown below:

(12) 胃抽搐了一會兒　 *'Stomach convulses for a while'*　 · ////
(13) 忍耐片刻　 *'endure for a while'*　　　　　　　 ^^^^
(14) 快樂許久　 *'happy for a long time'*　　　　　 ——
(15) *死一下　 *'die a while'*　　　　　　　　　 /

Secondly, we examine the pre-verbal time intervals. They have two ambiguous senses. One denotes 'duration of event completion'. They collocate only with bounded type of events, and hence the perfective aspect particle '了' often appears concurrently. The examples are as below:

(16) 一下衰老了許多　 *'getting old suddenly'*　　　 ^^^^^ ·　vs.　*一下衰老
(17) 一下死去三百多人　 *'three hundred people died in a sudden'*　 / ·　vs.　*一下死
(18) 一下走十幾公里　 *'to walk a dozen kilometers in a short time'*　 //// ·　vs.　*一下走
(19) 一下摔破三個花瓶　 *'to break three vases in a short time'*　 /—— ·　vs.　*一下摔花瓶

For the other type pre-verbal time intervals, they denote the duration of state/situation change. They actually do not describe the duration of event time, but rather describe the duration time before events to start (or states to change) and hence generally are short durations. Thus, the five event modules in MARVS representation are all possible to collocate with them, including punctual and complete types, if the collocation events have starting points and without end points. Note that if collocation events are bounded (i.e. have end points), the time intervals should be interpreted as 'duration for event completion'. The examples are shown below:

(20) 一會兒見　 *'See you in a while'*.　　　　　　　　 · /
(21) 一下就出發　 *'Will be take off soon'*.　　　　　　 ·
(22) 一下子下雨了　 *'It will be raining soon'*.　　　　 · /////
(23) 一下就高興了　 *'Suddenly became happy'*.　　　 · ——
(24) 一下不知所措　 *'Suddenly do not know what to do'*.　 · ^^^^^

2.3 Time long and time short

In general, time intervals are further classified into short durations like '三秒鐘 *three seconds*' and long durations like '三年 *three years*'. Normally, long durations do not play the role of 'duration of situation/state change', since the resulting semantic will not be very logical, such as (25) b. In contrast, '三年後 *after three years*' is a time point but not a duration in (25) c.

(25) a. 一會兒見 '*See you in a while.*'

　　 b. *三年見 '*See you in three years.*'

　　 c. 三年後見 '*See you after three years.*'

　　We may intuitively think that we can distinguish a long duration or a short duration, in fact, the length of time is a relative concept. See (26), (27) below:

(26) 我三年就畢業 '*I will be graduated in three years.*'

(27) 他三分鐘才答完 '*It took him three minute long to answer the questions.*'

In Mandarin Chinese, '就 *jiu*' indicates an event that happens quicker than expected, thus no matter what duration expressions collocated with it, the durations all denote a short duration (than expected). On the contrary, '才 *cai*' indicates an event that happens slower than expected, thus no matter what duration expressions collocated with it, the durations all denote a long duration (than expected).

　　Other than the generic time intervals, there are some specific expressions in Mandarin only denoting short duration, such as '一下子 *a short while*' and '一眨眼 *while the twinkling of an eye*', and some only denoting long duration , such as '好一會兒 *a good while*' and '老半天 *for a long time*'. We cannot say the following sentences:

(28) *我老半天就畢業 '*I will be graduated in a long time.*'

(29) *他一下才答完 '*It took him a short time long to answer the questions.*'

We call them absolute long/short duration words for they own fixed long/short concepts and obviously the absolute long/short duration words impose additional constraints on their collocation events.

3　Morpho-syntactic Structures of Time Intervals

Other than the semantic constraints imposed to collocation events, the morpho-syntactic structures of time words/expressions also limit their functionalities. For instances, few short duration words like '一轉眼 *in a wink*', '不一會兒 *in a moment*', etc., are never used to denote 'duration of events', while long duration words like '經年累月 *for months and years*', '一年到頭 *throughout the year*' are never used to denote 'situation change'. What are underline reasons of causing such differences? We believe that in addition to sense differences, it is due to their morpho-syntactic structures. According to our observation, there are at least four kinds of morpho-syntactic structures of time interval words which are described below:

3.1 '一'＋Verb　=Verb+ '(之)間'

In mandarin Chinese,'一 *one*' can be an adverb of the sense of 'as soon as'. For example, in '一哭就喘 *as soon as one cries, panting follows*', '一哭' means 'as soon as one cries', and its syntactic feature is also an adverb which modifies the event 'pant'.　Naturally, many time interval words are coined by '一' and a complete type of verb such as '一轉眼 *in a wink*', '一轉念 *in a momentary thought*', '一彈指 *as soon as snapping of the fingers*', '一眨眼 *in the twinkling of an eye*', '一轉瞬 *in a flash*' etc. Because of the sense of '一', they all denote short durations. In addition, they all have synonyms of the form 'Verb+(之)間'

because the word '(之)間 *between*' denotes the duration time of completion of the Verb. This type of time interval words plays only pre-verbal adverbials and cannot function as post-verbal durations for their VP-like structure.

3.2 Negation + Time Intervals

There are other short duration expressions are formed by a negation word and a time interval word, such as '沒多久 *not too long*', '不一會兒 *not a while*', '不多會兒 *not a while*', '不到一天 *no more than a day*', '不旋踵 *not long*' etc. By negating the time intervals, they denote a short duration which is not long as the negated intervals. Not like the above discussed VP-like structures, this type of words occurs in dual-positions either pre-verbal or post-verbal. For examples,

(30) a. 抵達家鄉不到一天 *'arrive home no more than a day.'*

    b. 不到一天抵達家鄉 *'takes no more than a day to arrive home.'*

(31) a. 他走了沒多久 *'He has gone not too long ago.'*

    b. 沒多久他走了 *'Soon he left.'*

3.3 Degree Adverb +Time Intervals

Some long duration intervals are combinations of a degree adverb and a time interval word, such as '好一會兒 *quite a while*', '老半天 *a long time*', '長年 *yearlong*', '多時 *for a good while*', and only adverbs denoting high degrees are used, so when they combine with intervals, the new temporal words means long duration. These words are durations of dual-positions.

3.4 Time intervals of conjunct structures

To conjunct time intervals is a way to create durations of very long time. There are two ways of doing it. The first one is simply piling the intervals, such as '日日夜夜 *day and night*', '三年五載 *some years*', '朝朝暮暮 *day and night*', '生生世世 *generation after generation*' etc. The second one is using phrase patterns to produce them. The patterns are '…到…', '…(以)來', '經(積)…累…', '…復一…' etc. and the examples are '一天到晚 *from morning till night*', '一年到頭 *whole year*', '經年累月 *months and years*', '年復一年 *year after year*' etc. Most of these intervals are allowed pre-verbal position only.

4 Summary and Future Works

In this paper, we made fine-grain distinctions for durations. Durations are expressed by a class of words called time intervals. There are functional similarity and idiosyncrasy among different time interval words. We provide explanatory reasons for their common functionalities and idiosyncrasies and pointed out that MARVS types of collocated events and semantic of time intervals actually dominate the syntactic grammar and semantic interpretation. They are main features which control the usage of time interval words. Furthermore, we also proved that morpho-syntactic structure of time intervals also reduces the flexibility of their usages. We had listed four different types of morpho-syntactic structures for duration expressions and provided constraints of their usages.

    Since the number of expressions for time interval is unlimited, our study not only provides a way of interpreting their fine-grained semantic and syntactic properties but also contributes computational feasibility in dealing with new time interval expressions.

Temporal relation includes duration, aspect, frequency, time point and sequence etc. In this paper, we focus our attention on duration only. In the future, we will aim to clarify the other temporal relations and to study their syntactic and semantic interactions.

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