Compositionality of NN Compounds: A Case Study on [N$_1$+Artifactual-Type Event Nouns]

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Abstract

Generative Lexicon theory (GL) establishes three mechanisms at work when a predicate selects an argument, i.e. pure selection, accommodation and type coercion. They are widely used in verbal selection of nouns in the entity domain. However, little attention has been devoted to the compositionality of [N$_1$+event noun] type NN compounds. This paper extends the usage of these mechanisms in two ways: 1) the eventive nominal head selection of a nominal modifier, and 2) their use in the eventive domain, through the case study on [N$_1$+比赛*bǐsài* 'competition']. Moreover, it reveals a new compositional mechanism sub-composition. It also discovers the domain contribution in type coercion. This work enriches the study on compositionality and GL.

1 Introduction

Event nouns in Mandarin Chinese have generated extensive interest (Han 2007, 2011; Liu 2004; Ma 1995; Wang & Huang 2011a, 2011b, 2012a, 2012c, 2012d). However, little research has concerned about the compositional mechanisms at work in [N$_1$+event noun] type [N$_1$N$_2$]$_N$ compounds.

Generative Lexicon theory (GL) provides a rich compositional representation through generative devices (Pustejovsky 1993, 2001, 2006, 2011; Pustejovsky & Jezek 2008). Under a tripartite system of the domain of individuals, including natural types, artifactual types and complex types (Pustejovsky 2001, 2006; Pustejovsky & Jezek 2008), GL establishes three mechanisms at work when a predicate selects an argument.

1) Pure Selection (Type Matching): the type a function requires is directly satisfied by the argument;

2) Accommodation: the type a function requires is inherited by the argument;

3) Type Coercion: the type a function requires is imposed on the argument type. This is accomplished by either:

> (i) Exploitation: taking a part of the argument's type to satisfy the function;
> (ii) Introduction: wrapping the argument with the type required by the function.

Following Pustejovsky (2001, 2006) and Pustejovsky & Jezek (2008), Wang & Huang (2012e) establish a type system for event nouns, including natural types, artifactual types, natural complex types and artifactual complex types. The current paper only focuses on *artifactual-type event nouns* and explores the compositional mechanisms of nominal modification to these nouns in NN compounds. Furthermore, the domain information contribution to the reading of a NN compound is surveyed.

2 Data Collection

The data of this study are mostly extracted from Chinese Gigaword (second edition)[1] and Sinica Corpus[2] accessed through Chinese Word Sketch Engine[3], with a few examples collected online through the search engines *Google* and *Baidu*.

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[1]http://www.ldc.upenn.edu/Catalog/catalogEntry.jsp?catalogId=LDC2009T14

[2] http://db1x.sinica.edu.tw/kiwi/mkiwi/

[3] http://158.132.124.36/, http://wordsketch.ling.sinica.edu.tw/

3 Compositional Mechanisms of [N₁ + Artifactual-Type Event Nouns]

The internal structure of NN compounds has been widely investigated (Jackendoff 1975; Laurie Bauer 2008; Packard 2004; Warren 1978). In recent years, some research uses GL to analyze the relation between N_1 and N_2 (Johnston & Busa 1996; Lee et al. 2010; Qi 2012). The research using the GL gives a compositional treatment to capture the N_1 and N_2 relations, but it only concerns the situation when N_1 is a qualia role of N_2. It does not explain cases when N_2 is a qualia role of N_1. Moreover, it does not give a generalization for the qualia modification relation.

The following section analyses the compositional mechanisms of NN compounds. To make the discussion more concentrate, Section 3.2 and 3.3 use [N₁+比賽 *bǐsài* 'competition'] as a case study. To introduce a new way of compositionality, *sub-composition*, Section 3.4 uses a wider range of data.

3.1 Interpreting 比賽 *bǐsài* 'competition'

A 比賽 *bǐsài* 'competition' is an activity in which one try to win against the opponents. Its semantic type system is depicted below.

$$
\begin{array}{l}
\text{比賽 } \textit{bǐsài} \text{ 'competition'} \\
\text{ARGSTR} = \begin{bmatrix} \text{D-ARG}_1 = \text{x: individual} \\ \text{D-ARG}_2 = \text{y: individual} \\ \text{D-ARG}_3 = \text{z: organizer} \\ \text{D-ARG}_4 = \text{r: rule} \end{bmatrix} \\
\text{EVENTSTR} = \begin{bmatrix} \text{E}_1 = \text{e}_1\text{: process} \end{bmatrix} \\
\text{QUALIA} = \begin{bmatrix} \text{FORMAL} = \text{a: activity} \\ \text{CONSTITUTIVE} = \{x, y, z, r, c\} \\ \text{TELIC} = [\text{e}_1 \text{ satisfies } r \rightarrow (x \vee y) \text{ win}] \\ \text{AGENTIVE} = \text{organize } (z, a) \end{bmatrix}
\end{array}
$$

A competition usually sets rules so that the participant who has the best performance will be the winner. Therefore, the purpose of 比賽 *bǐsài* 'competition', which is the telic role, is to win with some rules satisfied during the competing process e_1.

A competition could be either on the process of an event that participants involved in or the resultative product made during an event. In an [N₁+ 比賽 *bǐsài* 'competition'] compound, N_1 specifies the subject of the competition. That is, it signifies the process on which people are judged or the product that people create in a competition. Wang & Huang (2012b) classify nouns into pure event nouns, nominals (event nominals and result nominals) and entity nouns. Following this classification, the following will examine which kinds of nouns fit the N_1.

If the competition is about the process, then the competition is based on the behavior of participants during the event. Three kinds of N_1 fit this case: 1) pure event nouns: 體操 *tǐcāo* 'gymnastics', 馬術 *mǎshù* 'horsemanship', 雜技 *zájì* 'acrobatics', 圈操 *quāncāo* 'hoop gymnastics'; 2) event nominals: 舉重 *jǔzhòng* 'weightlifting', 賽艇 *sàitǐng* 'boat racing', 攀巖 *pānyán* 'rock climbing'; 3) entities: 龍舟 *lóngzhōu* 'dragon boat', 帆船 *fānchuán* 'yacht'[4].

If the competition is about the final product, then the rule to decide the winners will be based on the quality of the product. Two kinds of N_1 fit such as a case: 1) event nominals: 攝影 *shèyǐng* 'photography'; 2) entities: 書畫 *shūhuà* 'painting and calligraphy', 航模 *hángmó* 'model airplane'.

Summarizing, this section has illustrated the semantic type system of 比賽 *bǐsài* 'competition'. A competition can be either on the process or result. If the competition is about the process, N_1 can be a pure event noun, an event nominal or an entity. If the competition is about the result, N_1 can be an event nominal or an entity (coerced to be an event). To achieve the goal of a competition (the telic role), usually to win, one should satisfy some rules.

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[4]龍舟 *lóngzhōu* 'dragon boat' and 帆船 *fānchuán* 'yacht' can be treated either as an entity or activity in themselves. Here we treat them as an entity which is coerced to be an event through qualia exploitation. This is discussed in Section 3.3 in more details.

3.2 Pure Selection

When N_1 is an event nominal, the head 比賽 *bǐsài* 'competition' selects N_1 through pure selection. Because the verbal morpheme in the nominal N_1 already specifies what event it is. Examples are shown in Table 1 and Table 2.

Words	Pinyin	English	Frequency	Saliency
攝影	*shèyǐng*	photography	1074	51.01
舉重	*jǔzhòng*	weightlifting	957	48.31
賽艇	*sàitǐng*	boat racing	314	47.85
攀巖	*pānyán*	rock climbing	80	31.35
調酒	*tiáojiǔ*	wine mixing	13	20.26

Table 1: VO Type Event Nominals in Gigaword

For instance, in Table 1, within the N_1 攝影 *shèyǐng* 'photography', the verbal morpheme 攝 *shè* 'take a photograph of' is embedded in the photographing action.

Words	Pinyin	English	Frequency	Saliency
雙打	*shuāngdǎ*	doubles	1775	62.01
單打	*dāndǎ*	singles	1799	59.5

Table 2: Adj-V Type Event Nominals in Gigaword

Similarly, in Table 2, the verbal morpheme 打 *dǎ* 'play' in both 雙打 *shuāngdǎ* 'doubles' and 單打 *dāndǎ* 'singles' already specify the playing event.

3.3 Type Coercion through Qualia Exploitation of N_1

3.3.1 N_1 as an Entity

If N_1 is an entity, there will be two possibilities: 1) the competition is dependent on the process of a potential event that is related to the entity; 2) the competition is dependent on the final product N_1, where a potential event is also involved which is an agentive role of the entity. In both cases, we would like to say that there is type coercion from the entity to their potential events.

3.3.1.1 Type Coercion with Ordered Events (Type Coercion with Event Combination)

Pustejovsky (2000) finds that the qualia provide three relations: <, o and >. According to temporal properties, the partial orderings of qualia roles are: Agentive < Formal, Constitutive o Formal, and Formal < Telic. In [N_1+比賽 *bǐsài* 'competition'], N_1 can involve in more than one event. Type coercion of N_1 includes the combination of ordered events from different qualia roles. When N_1 is an entity, it sometimes requires the pre-existence of a creation event, which comes from the agentive role of N_1. The entity is produced through the creation event. 比賽 *bǐsài* 'competition' is to compare the quality of different products. The product quality can be decided according to either the formal or telic role.

In an art competition, what is being compared is the design, shape, color, etc., which are the formal role of the objects. These forms exist after the creation of the objects, which is the agentive role. Table 3 shows some examples.

Words	Pinyin	English	Frequency	Saliency	Qualia Roles
冰雕	*bīng diāo*	ice sculpture	73	35.35	agentive (做 *zuò* 'make') +formal
沙雕	*shā diāo*	sand sculpture	33	27.96	agentive (做 *zuò* 'make') +formal
花燈	*huā dēng*	lantern	59	26.56	agentive (做 *zuò* 'make') +formal
書畫	*shū huà*	painting and calligraphy	79	19.99	agentive (創作 *chuàngzuò* 'create') +formal

Table 3: Examples of Type Coercion with Ordered Events in Gigaword: Agentive > Formal

For instance, in table 3, 冰雕比賽 *bīngdiāo bǐsài* 'ice sculpture competition' involves an event of making ice sculpture (the agentive role), and then the quality of 冰雕 *bīngdiāo* 'ice sculpture' (the formal role) is compared to determine the winner.

In a competition of an application field, what is compared is the function of the objects, which is the telic role. The function exists after the creation of the objects. Examples are as shown in Table 4.

Words	Pinyin	English	Frequency	Saliency	Qualia Roles
航模	*háng mó*	model airpl	33	28.38	agentive (做 *zuò* 'make') +telic

		ane			
模型	*móxíng*	model	[111](#)	22.48	agentive (做 *zuò* 'make') +telic

Table 4: Examples of Type Coercion with Ordered Events: Agentive > Telic

For example, in Table 4, 航模比賽 *hángmó bǐsài* 'model airplane competition' first requires the creation of a model airplane (the agentive role), and then the function of different models (the telic role) is compared.

3.3.1.2 Type Coercion with one Individual Event

In 水餃比賽 *shuǐjiǎo bǐsài* 'dumpling competition', 水餃 *shuǐjiǎo* 'dumpling' can be coerced to three events, eating, making, or tasting through the telic role, agentive role, and formal role respectively, as illustrated below.

水餃 *shuǐjiǎo* 'dumpling'

$$\text{EVENTSTR} = \begin{bmatrix} E_1 = e_1: \text{process} \\ E_2 = e_2: \text{process} \\ \text{D-}E_3 = e_3: \text{state} \end{bmatrix}$$

$$\text{ARGSTR} = \begin{bmatrix} \text{ARG}_1 = x: \text{human} \\ \text{ARG}_2 = y: \text{dumplings} \end{bmatrix}$$

$$\text{QUALIA} = \begin{bmatrix} \text{TELIC} = \text{eat} (e_2, x, y) \\ \text{AGENTIVE} = \text{make} (e_1, x, y) \\ \text{FORMAL} = \text{taste} (e_3, y) \end{bmatrix}$$

水餃比賽 *shuǐjiǎo bǐsài* 'dumpling competition' has three readings through type coercion of dumplings' different qualia roles: 1) through the telic role: x wins if x eats most dumplings; 2) through the agentive role: x wins if x makes most dumplings; 3) through the formal role: x wins if x's dumplings tastes best. These readings indicate that the context for 水餃比賽 *shuǐjiǎo bǐsài* 'dumpling competition' is that if you meet some rules, then you win. This can be depicted below:

Telic role for 水餃比賽 *shuǐjiǎo bǐsài* 'dumpling competition': R → [φ] win

R: rules

For 水餃比賽 *shuǐjiǎo bǐsài* 'dumpling competition', [φ] is competing by eating or making or tasting. That is, 水餃 *shuǐjiǎo* 'dumpling' can be coerced to any of the three events. Reading 1) and

2) have only one event involved respectively, while reading 3) comprises of an agentive event and the following formal role related event.

3.3.2 N₁ as a Pure Event Noun

Similar to N_1 as a entity in Section 3.3.1, when N_1 is a pure event noun, coercion is still at work. That is because just like an entity, an artifactual event comes into being (the agentive role) for some purpose (the telic role). Different from the diversity of N_1-as-an-entity coercion (including ordered events or an individual event), in [N_1+比賽 *bǐsài* 'competition'], N_1-as-a-pure event noun coercion normally only has one coerced event through the agentive role.

For example, in 體操比賽 *tǐcāo bǐsài* 'gymnastics competition', the coerced event 'perform gymnastics' is through exploiting the agentive role of 體操 *tǐcāo* 'gymnastics'. During a gymnastics competition, the existence of the gymnastics is the same as the process of the performance. Other examples of such N_1 include 馬術 *mǎshù* 'horsemanship', 雜技 *zájì* 'acrobatics', and 圈操 *quāncāo* 'hoop gymnastics'.

Summarizing, pure selection and type coercion have been used in verbal selection of nouns in the entity domain (Pustejovsky 1993, 2001, 2006, 2011; Pustejovsky & Jezek 2008). Section 3.2 and 3.3 have extended their usage in two ways: 1) nominal head selection of a nominal modifier, and 2) their use in the eventive domain, though a case study on [N_1+ 比賽 *bǐsài* 'competition']. The results are shown in Table 5.

[N₁+比賽 *bǐsài* 'competition']	比賽 *bǐsài* 'competition': Process or Result	Compositional Mechanism: Pure Selection or Type Coercion
Pure Event Noun+比賽 *bǐsài* 'competition'	Process	Type Coercion
Event Nominal+比賽 *bǐsài* 'competition'	Process or Result	Pure Selection
Entity+比賽 *bǐsài* 'competition'	Process or Result	Type Coercion

Table 5: Interpreting 比賽 *bǐsài* 'competition'

Table 5 shows that a competition can be either about the process or the result. For a process competition, N_1 can be a pure event noun, an event nominal or an entity. For a result competition, N_1 can be an event nominal or an entity. When N_1 is an event nominal, pure selection is usually at work, while when N_1 is a pure event noun or an entity, type coercion happens.

3.4 Sub-Composition

Pustejovsky (1995, 2012) introduces co-compostion. A typical example is *bake the cake*. The operation of co-composition results in a qualia structure for the VP that reflects aspects of both constituents. These include: 1) the governing verb *bake* applies to its complement; 2) the complement co-specifies the verb; 3) the composition of qualia structures results in a derived sense of the verb, where the verbal and complement agentive roles match, and the complement formal quale becomes the formal role for the entire VP.

This section introduces a new way of compositionality, *sub-composition*, through exploring [N_1+Artifactual-Type Event Noun]. There are two types of sub-composition: 1) N_1 as an argument and N_2 as a function, and 2) N_1 as a function and N_2 as an argument.

$$y = f(x)$$

A function *f* is a relationship which links a set of input and a set of potential output. The input *x* is called a variable or an argument, while the output *y* is named as a dependent variable. The requirement of a function is that each variable should have and only have exactly one output.

We define the qualia role of a word as a function. Pustejovsky (1995) analyses how lexical items encode semantic information in the qualia structure. This structure has four roles, each with some values. 1) The constitutive role is about the relation between an object and its constituents or parts. Its role values include material, weight, parts and component elements. 2) The formal role can distinguish an object within a larger domain. Orientation, magnitude, shape, dimensionality,

color, and position are its role values. 3) The telic role is about the purpose and function of the object. 4) The agentive role describes factors involved in the origin of an object, such as creator, artifact, natural kind, and causal chain.

We treat the four qualia roles as the four functions of a word:

f_1 : FORMAL

f_2 : CONSTITUTIVE

f_3 : TELIC

f_4 : AGENTIVE

In some cases, there is a verb in the telic or agentive role. For example, the telic role of 選拔賽 *xuǎnbásài* 'selection contest' is [*TELIC=select(x)*], where x is an argument that is selected. Therefore the function of 選拔賽 *xuǎnbásài* 'selection contest' is f_i:[*TELIC=select(x)*]. For convenience, we will hide the predicate '*select*' and use the qualia role to represent the function, i.e. f_i:*TELIC(x)*.

In a sub-compositional NN compound, either N_1 or N_2 can be a function, remaining the other as an argument (variable). The following section examines both Argument-Function Type and Function-Argument Type [N_1+Artifactual-Type Event Noun].

3.4.1 Argument-Function Type [N_1+ Artifactual-Type Event Noun]

Qualia structure encodes the lexical information of a lexical item. When N_1 has qualia modification to an NN, N_1 is the argument and N_2 is function.

1) $f_{i, N2}$: FORMAL

N_1N_2 = N_2[FORMAL (N_1)]

泰式拳擊 *tàishì quánjí* 'Thai-style boxing'

λx∃y [boxing (x) ∧ Tai-style(y) ∧ a style of (y, x)]

拳擊 *quánjí* 'boxing'

$$\text{QUALIA} = [\text{FORMAL} = \text{style}]$$

A style is a formal role of boxing. Thus in the compound 泰式拳擊 *tàishì quánjí* 'Thai-style boxing', the N_1 泰式 *tàishì* 'Thai-style' is the formal role of the N_2 拳擊 *quánjí* 'boxing'. This compound can be represented as Boxing [FORMAL (Tai-Style)].

2) $f_{i, N2}$: CONSTITUTIVE

$N_1N_2 = N_2[CONSTITUTIVE (N_1)]$

闖關遊戲 *chuǎngguān yóuxì* 'crashing-through-barrier game'

λx∃y [game (x) ∧ crashing-through-barriers (y) ∧ subevent-of (y, x)]

$$\left. \begin{array}{l} 遊戲\ \textit{yóuxì}\ \text{'game'} \\ \text{EVENTSTR}= \left[E_1=e_1:\text{process}=\{\text{subevent}_1,\text{subevent}_2, ...\} \right] \\ \text{QUALIA} = \text{CONSTITUTIVE} = e_1 \end{array} \right)$$

A 遊戲 *yóuxì* 'game' is an activity that is composed of some subevents. In the above compound, the N_1 闖關 *chuǎngguān* 'crashing through a barrier' is a subevent of the N_2 遊戲 *yóuxì* 'game', so this compound can be represented as Competition [CONSTITUTIVE (Crashing-through-Barriers)].

3) $f_{i, N2}$: TELIC

$N_1N_2 = N_2 [TELIC (N_1)]$

慶功儀式 *qìnggōng yíshì* 'celebrating-victory ceremony'

λx∃y [ceremony (x) ∧ celebrating-a-victory (y) ∧ purpose-of (y, x)]

A ceremony is a formal event held with certain purpose. In the compound 慶功儀式 *qìnggōng yíshì* 'celebrating-victory ceremony', the N_1 慶功 *qìnggōng* 'celebrating a victory' states the aim of the N_2 儀式 *yíshì* 'ceremony', so N_1 is the telic role of N_2. This compound can be represented as Ceremony [TELIC (Celebrating-a-Victory)].

4) $f_{i, N2}$: AGENTIVE

$N_1N_2 = N_2[AGENTIVE (N_1)]$

職業病 *zhíyè bìng* 'occupational disease'

λx∃y [disease (x) ∧ occupation (y) ∧ cause (y, x)]

A disease is an illness caused by some reasons. In the compound 職業病 *zhíyè bìng* 'occupational disease', the N_1 職業 *zhíyè* ''occupation' is the cause of the N_2 病 *bìng* 'disease', so N_1 acts as the agentive role of N_2. This compound can be represented as Disease [AGENTIVE (Occupation)].

1)-4) illustrate four types of argument-function type N_1N_2, with N_1 as an argument and N_2 as a function. N_1 is a qualia role of N_2 and thus has qualia modification to N_2.

3.4.2 Function-Argument Type [N₁ + Artifactual-Type Event Noun]

When N_2 is a qualia role of N_1, N_1 is the function and N_2 is the argument.

1) $f_{i, N1}$: FORMAL

$N_1N_2 = N_1[FORMAL (N_2)]$

校慶活動 *xiàoqìng huódòng* 'school celebration activity'

λx∃y[activity(x) ∧ school-celebration (y) ∧ a kind of (y, x)]

$$\left. \begin{array}{l} 校慶\ \textit{xiàoqìng}\ \text{'school celebration'} \\ \text{QUALIA} = \left[\text{FORMAL} = \text{activity} \right] \end{array} \right)$$

The N_1 校慶 *xiàoqìng* 'school celebration' is a kind of activity, so it has a formal role 'activity', which is the N_2 活動 *huódòng* 'activity'. This compound can be represented as School-Celebration [FORMAL (Activity)].

2) $f_{i, N1}$: CONSTITUTIVE

$N_1N_2 = N_1[CONSTITUTIVE (N_2)]$

運動會開幕式 *yùndònghuì kāimùshì* 'sports meet opening ceremony'

λx∃y[opening ceremony (x) ∧ sports meet (y) ∧ part of (x, y)]

$$\left. \begin{array}{l} 運動會\ \textit{yùndònghuì}\ \text{'sports meet'} \\ \text{QUALIA}=\left[\text{CONSTITUTIVE}=\{\text{opening ceremony, ...}\}\right] \end{array} \right)$$

運動會 *yùndònghuì* 'sports meet' is an event that includes many subevents, such as the opening ceremony, competitions and the closing ceremony. Therefore, in the compound 運動會開幕式 *yùndònghuì kāimùshì* 'sports meet opening ceremony', the N_2 開幕式 *kāimùshì* 'opening ceremony' is a constituent of the N_1 運動會 *yùndònghuì* 'sports meet'. This compound can be represented as Sports-Meet [CONSTITUTIVE (Opening-Ceremony)].

3) $f_{i, N2}$: TELIC

$N_1N_2 = N_1[TELIC (N_2)]$

火車運輸 *huǒchē yùnshū* 'train transportation'

λx∃y[transportation (x) ∧ train (y) ∧ purpose-of (x, y)]

$$\left. \begin{array}{l} 火車\ \textit{huǒchē}\ \text{'train'} \\ \text{ARGSTR} = \left[\text{D-ARG}_1 = z: \text{entity} \right] \\ \text{QUALIA} = \left[\begin{array}{l} \text{FORMAL} = r: \text{vehicle} \\ \text{TELIC} = \text{transport (r, z)} \end{array} \right] \end{array} \right)$$

火車 *huǒchē* 'train' is a vehicle that is usually used for transportation, carrying people and goods from one place to another. Thus, in the compound 火車運輸 *huǒchē yùnshū* 'train transportation', the N₂ 運輸 *yùnshū* 'transportation' is the telic role of the N₁ 火車 *huǒchē* 'train'. This compound can be represented as Train [TELIC (Transportation)].

4) $f_{i, N2}$: AGENTIVE

$N_1N_2 = N_1[\text{AGENTIVE} (N_2)]$

電影拍攝 *diànyǐng pāishè* 'movie shooting'

$\lambda x \exists y[\text{shooting} (x) \wedge \text{movie} (y) \wedge \text{produce} (x, y)]$

$$
\begin{bmatrix}
電影\ \textit{diànyǐng}\ \text{'movie'} \\
\text{ARGSTR} = [\text{D-ARG}_1 = z: \text{human}] \\
\text{QUALIA} = \begin{bmatrix} \text{FORMAL} = r: \text{event·physobj} \\ \text{AGENTIVE} = \text{shoot} (z, r) \end{bmatrix}
\end{bmatrix}
$$

電影 *diànyǐng* 'movie' is produced by the shooting action. Hence in the compound 電影拍攝 *diànyǐng pāishè* 'movie shooting', the N₂ 拍攝 *pāishè* 'shooting' is the agentive role of the N₁ 電影 *diànyǐng* 'movie'. This compound can be represented as Movie [AGENTIVE (Shooting)].

It is common that NN compounds are ambiguous. For example, 火車運輸 *huǒchē yùnshū* 'train transportation' may have these readings: 1) trains are used for transportation; and 2) trains are a means of transportation.

Section 3.4.2 of this paper has dealt with the reading 1), treating it as a Function-Argument relation. The semantic representation is Train [TELIC (Transportation)]. For reading 2), the N₁ 火車 *huǒchē* 'train' is taken as the formal role of N₂ 運輸 *yùnshū* 'transportation'. Thus this is an Argument-Function relation, and this compound can be represented as Transportation [FORMAL (Train)].

In sum, this section has introduced a new mechanism of compositionality *sub-composition*. The structure N₁N₂ has two ways of sub-composition: 1) argument-function, when N₁ has qualia modification to N₂; and 2) function-argument, when N₂ is a qualia role of N₁. Because NN compounds are often ambiguous, they can have various relations according to different readings.

4 Domain Relevance of Type Coercion

Wang & Huang (2011a) has established the relation between type coercion and domain information. They reveal that type coercion can be dependent on a specific domain, because 1) intuitively, each domain often establishes a different type of event convention and NN compounds are always domain specific terms; 2) domain information can help to predict coercion types. Following this analysis, we argue that the coerced event is also domain relevant for eventive NN. We further observe that some domains have well-known conventional events, while some others do not. The former leads to a most probable and default reading, while the latter results in ambiguity. This point can be explained by the examples 足球比賽 *zúqiú bǐsài* 'football competition' and 湯圓比賽 *tāngyuán bǐsài* 'rice ball competition'.

Through qualia exploitation, both 足球 *zúqiú* 'football'[5] and 湯圓 *tāngyuán* 'rice ball' have the events demonstrated by the telic and agentive role. 足球 *zúqiú* 'football' has the playing event and producing event, while 湯圓 *tāngyuán* 'rice ball' has the eating event and making event as illustrated below.

$$
\begin{bmatrix}
足球\ \textit{zúqiú}\ \text{'football'} \\
\text{ARGSTR} = \begin{bmatrix} \text{D-ARG}_1 = y: \text{manufacturer} \\ \text{D-ARG}_2 = z: \text{human} \end{bmatrix} \\
\text{QUALIA} = \begin{bmatrix} \text{FORMAL} = x: \text{ball} \\ \text{TELIC} = \text{play} (z, x) \\ \text{AGENTIVE} = \text{produce} (y, x) \end{bmatrix}
\end{bmatrix}
$$

---

[5] In Mandarin Chinese, 足球 *zúqiú* 'football' can be treated either as an activity or an entity. When it is treated as an activity, 足球比賽 *zúqiú bǐsài* 'football competition' combines through pure selection and there is no type coercion. When it is treated as an entity, there is type coercion through qualia exploitation. In this section, we treat it in the second way.

湯圓 *tāngyuán* 'rice ball'

$$\text{ARGSTR} = \begin{bmatrix} \text{D-ARG}_1 = \text{y: individual} \\ \text{D-ARG}_2 = \text{z: individual} \end{bmatrix}$$

$$\text{QUALIA} = \begin{bmatrix} \text{FORMAL} = \text{x: food} \\ \text{TELIC} = \text{eat (y, x)} \\ \text{AGENTIVE} = \text{make (z, x)} \end{bmatrix}$$

Corpus data support the above analysis. Table 6 demonstrates [Verb+ 足球 *zúqiú* 'football'] in Gigaword. 踢 *tī* 'kick', 玩 *wán* 'play with', 打 *dǎ* 'play', 踢過 *tīguò* 'kick-experiential ASPECT', and 踢入 *tīrù* 'kick into' are the telic role of 足球 *zúqiú* 'football', while 製 *zhì* 'make', 縫製 *féngzhì* 'sew', and 生產 *shēngchǎn* 'produce' are the agentive role.

Words	*Pinyin*	English	Frequency	Saliency	Qualia Role
踢	*tī*	kick	199	74.33	telic
玩	*wán*	play with	37	36.25	telic
打	*dǎ*	play	15	17.04	telic
踢過	*tīguò*	kick-experiential ASPECT	2	15.04	telic
踢入	*tīrù*	kick into	1	8.18	telic
製	*zhì*	make	4	11.46	agentive
縫製	*féngzhì*	sew	2	10.83	agentive
生產	*shēngchǎn*	produce	7	7.51	agentive

Table 6: 足球 *zúqiú* 'football' as Objects in Gigaword

Table 7 shows [Verb+湯圓 *tāngyuán* 'rice ball'] in Gigaword. 吃 *chī* 'eat', 品嘗 *pǐncháng* 'taste', 食用 *shíyòng* 'eat and use', and so on are the telic role of 湯圓 *tāngyuán* 'rice ball', while 製作 *zhìzuò* 'make', 包 *bāo* 'wrap', and 搓 *cuō* 'knead', and so on are the agentive role.

Words	*Pinyin*	English	Frequency	Saliency	Qualia Role
吃	*chī*	eat	152	56.04	telic
品嘗	*pǐncháng*	taste	10	24.5	telic
食用	*shíyòng*	eat and use	9	20.73	telic
吃到	*chīdào*	Eat-RVC	3	14.22	telic
煮食	*zhǔshí*	cook and eat	2	14.17	telic
享用	*xiǎngyòng*	enjoy	3	12.96	telic
吃吃	*chīchī*	eat eat	1	8.27	telic
嘗	*cháng*	taste	1	6.18	telic
共用	*gòngxiǎng*	share	1	5.06	telic
享受	*xiǎngshòu*	enjoy	1	3.48	telic
製作	*zhìzuò*	make	18	24.15	agentive
包	*bāo*	wrap	9	21.89	agentive
搓成	*cuōchéng*	knead-RVC	2	17.73	agentive
搓搖出	*cuōyáochū*	knead and shake out	1	13.06	agentive
搓	*cuō*	knead	1	13.06	agentive
捏	*niē*	pinch	2	12.32	agentive
搓出	*cuōchū*	knead-RVC	1	11.45	agentive
搓好	*cuōhǎo*	knead well	1	11.45	agentive
做	*zuò*	make	7	9.61	agentive
搓揉	*cuōróu*	knead and rub	1	9.07	agentive
自製	*zìzhì*	self-made	1	4.77	agentive
製成	*zhìchéng*	make-RVC	1	4.77	agentive

Table 7: 湯圓 *tāngyuán* 'rice ball' as Objects in Gigaword

However, as modifiers of 比賽 *bǐsài* 'competition', their activated coercions are different. 足球比賽 *zúqiú bǐsài* 'football competition' has a strong convention of occurring in the sports domain, so the most possible reading comes from the telic role. That is, a competition of playing football rather than producing a football. By contrast, 湯圓比賽 *tāngyuán bǐsài* 'rice ball competition' does not show a preference for either the telic or agentive event, which renders both eating and making rice balls as possible readings.

This finding is confirmed by corpus data of Gigaword Corpus. We set window size as 5 tokens between N_1 and N_2. The result is indicated in Table 8.

NN	Telic Event	Agentive	To

			Event		tal Hits
	Hits	Frequency	Hits	Frequency	
足球 比賽 *zúqiú bǐsài* 'football competition'	4432	100.00%	0	0.00%	4432
湯圓 比賽 *tāngyuán bǐsài* 'rice ball competition'	2	28.57%	5	71.43%	7

Table 8: Coerced Event Difference in Gigaword

In Table 8, 足球比賽 *zúqiú bǐsài* 'football competition' has 4432 occurrences, with all of them indicating telic events and none as agentive events. 湯圓比賽 *tāngyuán bǐsài* 'rice ball competition' has seven hits in total, with two as telic events and five as agentive events, so this compound do not show strong tendency towards any of the two events.

5 Conclusions and Future Work

This paper discovers that [N_1+Artifactual-Type Event Noun] type compounds usually get a syntagmatic relation through three mechanisms: pure selection, type coercion and sub-composition.

In GL, pure selection and type coercion have been used when a predicate selects an argument (Pustejovsky 1993, 2001, 2006, 2011; Pustejovsky & Jezek 2008). This paper extends their usage in two directions: 1) nominal head selection of a nominal modifier, and 2) their usage in the nominal event domain, though the case study on [N_1+比賽 *bǐsài* 'competition'].

Moreover, this paper proposes a new compositional mechanism *sub-composition*. It is a relation between a function and an argument. The four qualia roles are treated as four functions. Two kinds of [N_1+ artifactual-type event noun] type [N_1N_2] compounds are composed through *sub-composition*: 1) N_1 as an argument and N_2 as a function, and 2) N_1 as a function and N_2 as an argument. In type 1), N_1 is a qualia role of N_2, and thus N_1 has enriched the function behavior; in type 2), N_2 is a qualia role of N_1, and thus N_2 has enriched the function behavior. Because a NN compound is often ambiguous, it may have several kinds of relations. The theorem for *sub-composition* can be generalized as follows.

In order for α and β to combine as [αβ], you need to extract some sub-elements from α or β depending on which is the function. If [αβ] is an argument-function relation, then [αβ] = β [f_i (α)]. If [αβ] is a function-argument relation, then [αβ] = α [f_i (β)].

Following Wang & Huang (2011a), this paper further demonstrates that some domains have strong conventional events, while some others do not. The former gives a default reading, while the latter brings about ambiguity.

This research has not only enriches the study on compositionality and GL, but also reveals the domain information contribution in type coercion. In future work, we would extend the compositional mechanisms discussed here in two directions: 1) their usage to other types of event nouns, i.e., natural types, natural complex types and artifactual complex types, and 2) their usage to other constructions, such as 'adjective + noun'.

Acknowledgements

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