On the Loss of Identity and Emergence of Order: 
Symmetry Breaking in Linguistic Theory

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1. Introduction
This article explores the topics of symmetry and symmetry breaking in linguistics, which have been relatively understudied concepts in theoretical linguistics, yet are considered essential and fundamental in many other theoretical sciences. These topics have gained attention in recent years, as a “biolinguistic” approach is adopted to study the design of language faculty.1 Echoing the central theme of this volume, we shall approach symmetry and symmetry breaking from the perspectives of identity and loss of identity, and the dynamics between the two conflicting forces. This approach can be directly carried over to a group theoretical consideration of symmetry, where the notion of symmetry is defined by the identity functions among a group of objects under transformations. We will show that when symmetry is understood in a group theoretical sense, symmetry and symmetry breaking can be more easily detected in linguistic patterns. We also apply Curie’s principles of symmetry and symmetry breaking in the theory of linguistics, and by doing so, we can more precisely characterize both the symmetric and the asymmetric sides in the design of the human language faculty. In this article, we claim that symmetry breaking can be adopted as a unified source for fundamental linguistic principles. More radically, we argue that the architecture of linguistic computation (or the “Y-model”) from the internal Narrow Syntax to the external linguistic interfaces is a natural reflection of the process of symmetry breaking; therefore, each linguistic pattern is a piece of the broken symmetry derived from the intrinsic symmetry of Narrow Syntax.

Before beginning the linguistic discussion, it is important to illustrate the notions of symmetry, symmetry breaking, and their relations to the loss of identity. For simplicity, we shall keep our discussion rather informal. Under group theoretical considerations, symmetry is defined by identity (or invariance) under transformation. To illustrate, as shown in (1), under a rotational transformation, an equilateral triangle has three members in its symmetry group (there will be more when other transformations are taken into consideration):

(1) The symmetry group of an equilateral triangle under rotation

\[
\begin{array}{ccc}
1 & 2 & 3 \\
3 & 2 & 2 \\
1 & 3 & 1
\end{array}
\]

Each 120-degree rotation results in an identical equilateral triangle (should we not mark the numerals for reference, it would be as if the transformations never took place).

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1 To my knowledge, Sportiche (1983) makes the first attempt at incorporating the concept of symmetry into transformational generative syntax. It is not until Kayne (1994), however, that the topics of symmetry and asymmetry are seriously examined in generative grammar (For topics related to (a)symmetry in (bio-)linguistics, see Brody 2003, Citko 2011, Di Sciullo 2002, Freidin and Vergnaud 2001, Hiraiwa 2005, Jenkins 2000, Moro 2000).
The above case illustrates a simpler case of symmetry group. Modern developments in theoretical physics further suggest that many apparent asymmetric patterns can actually be regarded as “broken” symmetry, in which the original symmetry seems to be lacking in each produced effect (like a broken mirror, we may only see its pieces). In such cases, however, the theory of symmetry (breaking) indicates that the underlying symmetry can be restored in more generalized forms, for example, when we consider global phenomena (sometimes, this is only possible in theory). To illustrate with a concrete example, we may think of a perfectly symmetric pencil standing on its lead tip on a flat surface — a highly symmetric (yet extremely unstable) state. With even a slight disturbance, the pencil will fall to one direction, and each observed falling event of the pencil is not symmetric (since every time the pencil falls down, it falls in a random direction) (see (2)). The symmetry in the original system is not lost, however. It is only hidden from view. If we consider all the possible falling events of the pencil and all the possible directions it may fall, we obtain another (more abstract) type of symmetry: a rotational symmetry (which can be represented by an imaginary circle). This generalized symmetry is transformed from the original symmetry in the system. The “broken” symmetry of the system is, therefore, restored by rotational symmetry (Lederman & Hill 2004: 191):

(2) The restored symmetry of the falling pencil

This type of hidden (broken) symmetry illustrates the “conservation” principle of symmetry (and lack of symmetry) pioneered by Pierre Curie in 1894. This principle is summarized in (3):

(3) **Curie’s Principle of Symmetry** (Curie 1894, Koptsik 1983, Stewart & Golubitsky 1992)
   a. If certain causes produce certain effects, then the symmetries of the causes reappear in the effects produced.
   b. Equivalently, if certain effects reveal a certain lack of symmetry, then the lack of symmetry will be reflected in the causes that give rise to it.

In other words, the underlying symmetry is never lost, although we are frequently misled by the apparent asymmetries in the produced effects. Another side of the principle of symmetry concerns the dynamics between symmetries and lack of symmetries in a system. According to the principle of symmetry, when different asymmetric causes are imposed on a system, they may accumulatively lower/break the symmetries in the observed effects, but they will only reflect the exact amounts of asymmetries in their causes. Therefore, no extra asymmetries will be imposed on the system. This amounts to saying that symmetries will be maximally preserved (but may be translated into another symmetrical form) outside those interfered by symmetry-breaking factors.

The concept of symmetry breaking has proven to be useful in many branches of sciences in uncovering the intrinsic symmetry from the apparent asymmetry and accounting for pattern...
formations (and crystallization) that result from the loss of symmetry and its transformation. The question that really concerns us here is whether symmetry breaking can also be adopted in theoretical linguistics to reconstruct the symmetry (and/or asymmetry) of language design and to describe the formation of linguistic patterns. In terms of identity and non-identity relations in linguistics, under the principle of symmetry, we predict that an identity relation in the input form should be conserved when its output form requires non-identity (for various reasons to be determined). The identity relation, however, may be preserved in a more abstract form, or perhaps translated into another form of identity, yet it will not be lost in the system. Researchers should bear in mind that, in the study of “symmetry breaking” in linguistics (and all other scientific branches), it is important not to be distracted by surface asymmetry (so as to look for a robust asymmetric cause), but rather to restore the intrinsic symmetry that is hidden in the seemingly asymmetric effects.\(^2\)

This paper is organized as follows. Section 2 discusses two major linguistic principles that can be rephrased under symmetry and symmetry breaking. The existence of symmetry conservation, under the Y-model of linguistic computation, provides an indication of intrinsic symmetry at Narrow Syntax. Section 3 extends the general ideas of Prinzhorn and Vergnaud (2004), and we reconstruct a possible form of symmetric syntax through the primitive syntactic relations that remain invariant under transformation. We also discuss an application of the symmetric syntax in the nominal domain, which provides a solution to a constituency paradox in the classifier constructions. Section 4 concludes the paper.

2. (Broken) Symmetry in Linguistic Patterns

Under the (inverted) Y-model in (4) (Chomsky 1995), linguistic computations are boiled down to three core components, including Narrow Syntax and the two interface levels, PF (phonetic forms) and LF (logical forms) (assume no articulated architecture in Lexicon, which simply provides atomic elements for linguistic computation). The linguistic objects built in Narrow Syntax are sent to the Interface Levels, the PF is an interface with the sensory-motor system, and the LF is an interface with the conceptual-intentional system. Instructions are then given to the interfaces according to the features of the lexical items with respect to sounds (or phonological gestures) at PF and meanings at LF:

(4) The Y-model

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Lexicon

Sensory-Motor Interface ↔ PF ↔ LF ↔ Conceptual-Intentional Interface

\{ Narrow Syntax \}
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Prinzhorn and Vergnaud (2004) and Leung (2007) point out that both of the interface levels, PF and LF, possess an asymmetry in their core operations. These are listed in (5a) and (5b), respectively:

(5) a. The elements concatenated by PF operations are non-commutative.

b. The elements concatenated by LF operations are non-associative.

\(^2\) See Stewart (1998) and Stewart and Golubitsky (1992), who point out that the term “symmetry breaking” can sometimes be misleading (which is often seen in linguistics as well; cf. Haider 2013). They suggest that the phenomenon be renamed “symmetry sharing” and should be understood as such.
Consider, for example, the simple English sentence *Every pug bit its owner*. PF defines the linear order of the phonological string. Therefore, *every* > *pug* > *bit* > *its* > *owner* is not equivalent to *its* > *owner* > *bit* > *every* > *pug*. The linear order is non-commutative. On the other hand, LF defines a hierarchical order with respect to the meaning of the sentence. The structural domination is non-associative since (*Every pug* (bit (its owner))) is not equivalent to (((*Every pug*) bit) its owner). In the former, *every pug* structurally contains *its owner* (and a bound variable reading is possible), while in the latter, the structural containment is a reversed one. The central question that remains at this point is, Under the Y-model, what are the (a)symmetric properties of Narrow Syntax? With respect to this question, two opposite conjectures of Narrow Syntax can be assumed. They are as listed in (6) below:

(6)  
a. Narrow syntax is both associative and commutative (and therefore highly symmetric), and the symmetry is broken in the interfaces (due to external factors).  
b. Narrow syntax is not associative or commutative (and inherently asymmetric), and each part of the asymmetries is reflected by PF and LF, respectively.

The anti-symmetric syntax in Kayne (1994) argues for the latter view. On the other hand, the alternative option in (6a) is pursued in this article. The conceptual reason for adopting the latter view is that linear orderings (e.g., precedence) and hierarchical orderings (e.g., c-command and structural dominance) may come external to Narrow Syntax.

Under the symmetry principle, traces can be found in support of our hypothesis by examining two properties of linguistic computations. First, we predict that it is possible to find a form of symmetry among different modules of linguistic computations, even when the inherent symmetry is broken. Second, we predict that the inherent symmetry is maximally preserved by transforming to another type of symmetry, except for those required by interface conditions. In this section, we discuss two well-grounded principles in syntactic theory to support our symmetric view, including the Mirror Principle in section 2.1 and X-bar theory in section 2.2.

2.1 Generalized Mirror Principle

Under its original formulation (Baker 1988), the Mirror Principle states that morphological affixation is a mirror image of the syntactic derivation, as in (7):

(7) Syntax:     [F1 [F2 [F3…V]]]  
Morphology:   [V…-AffF3-AffF2-AffF1]

A step beyond the Mirror Principle is found in Williams (2003), who argues that mirror effects are rooted in the more general principle of conservation (attributed to Panini). The general idea in Williams is that syntactic derivations can be viewed as mapping mechanisms among several sub-components in the computational system (or representational levels): Thematic Level, Case Level, Functional Level, etc. Each mapping between two adjacent

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3 The current minimalist syntactic theory, however, assumes that syntax is inherently non-associative and commutative, a bias towards LF. Syntactic derivations reflect the hierarchical structure that is to be linearized at PF at Spell-out, and then the hierarchical structure may need to be adjusted by (inaudible) LF rules that, in theory, behave exactly like syntactic rules (but may override syntactic locality constraints). This assumption hence provokes the consequence that syntax is not elegant enough due to the unwanted redundancy between syntax and LF (e.g., the redundancy between syntactic movements and LF chain formations; see Brody 1995 and subsequent works).
levels also represents the growth of syntactic structures. Williams argues that a shape conservation principle governs the mappings among different representation levels. Simply put, the principle says that when a representation level L1 is mapped to another level L2, use a representation in L2 that “best” conserves the original form in L1 at the “lowest” cost (subject to economy principle). To illustrate, let us consider an example in Williams (2003), reproduced as (8):

(8) Syntax:   \[\text{supply \{gun \{to an army\}\}}\] _VP_
Compounds: \[\text{army \{gun \{supply-er\}\}}\] _N_

Interestingly, a mirror image (a type of symmetry) is found in English compounds and their corresponding verb phrase. The question raised by Williams is what governs the mirror mapping in such cases. Specifically, why do we not find compounds such as *gun army supplier (while army supplier is also a legitimate compound in English). Williams argues that the mirror image in this case represents a best conservation of the original hierarchy of thematic structure in the two levels, as shown in (9):

(9) a. supply > theme > goal
b. [goal < theme < supply-er]

More generally, this shape conservation principle can be subsumed under the principle of symmetry and symmetry breaking. That is, when the asymmetry steps in (in this case, it is the suffix –er), the system conserves the symmetry by looking for the best alternative word order in the symmetry group that may keep the identical hierarchical relation. The best candidate that conserves the right ordering with minimal cost is then the mirror image of the other order, illustrated in (10):

(10) Mirror transformation
\[\text{[A > B > C]} \rightarrow \text{[C < B < A]}\]

Let us consider another possible output, in which theme and goal keep their original precedence, [[theme > goal] < supply-er] (output: gun army supplier). The latter form requires an additional mirror transformation targeting a sub-string of the input. This then involves an unnecessary loss of symmetry of the whole system (an asymmetry in the effect that does not find itself in the cause) (see (11)):

(11) a. Mirror Transformation: \[\text{[A > B > C]} \rightarrow \text{[C < B < A]}\]
b. Mirror Transformation on a sub-string: \[[\text{[C < B]} < \text{A}]\] \[\rightarrow \text{[B > C] < A]}\]

This case illustrates an underlying rule of symmetry and symmetry breaking. When asymmetries come to the system, the symmetries in the original system will be maximally “preserved” except for those interfered by the asymmetric causes.

This claim is further supported by evidence found when we remove the asymmetric causes. That is, we may expect that in languages without suffix forms like –er or –ing in English, the orders in syntax and in compound forms should be identical. This is true when we consider Chinese and Japanese V-O and O-V compounds. Chinese is a VO language, while Japanese is an OV language, and for these compounds, neither language has to employ a suffix such as –ing in English (e.g., water-spraying, gun-loading). As expected, Chinese V-O compounds predominantly have the order V-N (this syntax-morphology isomorphism is also found in
other types of compounds; see Liao (to appear), while (native) Japanese V-O compounds have the opposite order, N-V (Shibatani 1990: 240). Examples are listed in the table in (12).

(12) Chinese and Japanese compounds

<table>
<thead>
<tr>
<th>Chinese V-O compounds</th>
<th>Japanese O-V compounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. sha-ren</td>
<td>a. hito-gorosi</td>
</tr>
<tr>
<td>kill-man</td>
<td>man-kill</td>
</tr>
<tr>
<td>‘man-killing’</td>
<td></td>
</tr>
<tr>
<td>b. zhi-xie</td>
<td>b. ti-dome</td>
</tr>
<tr>
<td>stop-blood</td>
<td>blood-stop</td>
</tr>
<tr>
<td>‘blood-stopping’</td>
<td></td>
</tr>
<tr>
<td>c. guo-nian</td>
<td>c. tosi-kosi</td>
</tr>
<tr>
<td>pass-year</td>
<td>year-pass</td>
</tr>
<tr>
<td>‘year-passing, the New Year’</td>
<td></td>
</tr>
<tr>
<td>d. zhuo-se</td>
<td>d. iro-zuke</td>
</tr>
<tr>
<td>apply-color</td>
<td>color-apply</td>
</tr>
<tr>
<td>‘coloring’</td>
<td></td>
</tr>
</tbody>
</table>

Of course, there are exceptions to this perfect mirror parallelism. It is also possible to find V-N compounds in Japanese, but close scrutiny shows that, historically, they are in fact loan words from Chinese (i.e., the Sino-Japanese compounds, also from Shibatani 1990: 240):

(13) Sino-Japanese V-O compounds in Japanese

| a. satu-zin | b. si-ketu | c. etu-nen | d. tyaku-syoku |
| kill-man    | stop-blood | pass-year  | apply-color    |

Chinese also has O-V compounds, but only when the verbs and objects are both bi-syllabic (or longer). Again, these exceptions are limited. They generally occur in the marked conditions, and the reason they are marked (and needs explanations) is a good indication that they do not follow from the general principle of symmetry hidden in the underlying linguistic designs, and it is exactly the asymmetric factors that call for explanations in the theory:

(14) a. xiu-che     a’. qi.che-xiu.li
   car-fix       fix-car
   ‘car-fixing’  ‘car-fixing’

b. xi-yi        b’. yi.ifu-qing.xi
   wash-clothes  clothes-wash
   ‘laundry’     ‘laundry’

Another instance that illustrates symmetry breaking in linguistics comes from argument alignments in the causative constructions (also briefly discussed in Williams 2003). The causative constructions usually involve combinations of two verb phrases: \([\text{VP}_1 \text{make } \text{John}] + \text{[VP}_2 (\text{John} \text{read the book})] \). In French, this combination yields an output form where \text{VP}_2 “adjoins” to the causative verb, and the original object of the causative \text{VP}_1 (or the subject of \text{VP}_2) is dislocated to the end of the \text{VP} chunk with dative Case:

(15) \[
\text{[faire } \text{Jean] + [Jean lire ce livre] → [faire [lire ce livre] à } \text{Jean]}
\]
   ‘[make } \text{John] + [John read the book] → [make [read the book] to John]’
Williams argues that the shift of Case (Nominative → Accusative → Dative) and the new alignment of the dative argument (à Jean) can be attributed to the need to represent the complex theta structure by a simple Case frame. The theory is reminiscent of the analysis in Rouveret and Vergnaud (1980) in terms of Case Filters. Their idea is that the lower verb phrase raises to a position between the causative verb and its object [make [VP read the book] John tVP]. The raising transformation maintains the direction and adjacency of the Case assignment between the raised verb and its direct object, at the cost of losing the Case configuration between the causative verb and the inner subject. The subject is then supplied with an additional Case assigner (with dative Case). It is plausible that the two analyses can be bridged under the general principle of symmetry (breaking). In such an analysis, the verb raising to the causative verb is a cause of the loss of symmetry, and in order to maintain the maximal symmetry of the system, the common Case frame [V > Accusative > Dative] is adopted, and the dative argument is dislocated to the “mirror” position for the same consideration of global symmetry conservation.

We may find additional support for this claim from the East Asian languages. In Japanese and Korean causative constructions, where the typical word order is SOV, the verb is adjoined to the causative verbal suffix. Unlike in the Romance counterpart constructions, this “opposite” verb raising does not twist the original argument alignment and Case assignment configuration, and therefore, no special trick is needed to readjust the position of the dative argument. (16) shows an example from Japanese:

(16) a. [S [S O V] -CAUSE] → [S [S O] V-CAUSE]
   b. Taroo-ga pizza-o tabe-ta.
      Taroo-NOM pizza-ACC eat-PAST
      ‘Taroo ate pizza.’
   c. Hanako-ga Taroo-ni pizza-o tabe-sase-ta. (Miyagawa 1999)
      Hanako-NOM Taro-D AT pizza-ACC eat-CAUSE-PAST
      ‘Hanako made/let Taro eat pizza.’

Additionally, in Chinese (as well as in English), where the free standing causative verb does not trigger verb raising at all, the original word orders are well preserved in isomorphic symmetry, as illustrated in (17):

(17) a. [S CAUSE [S V O]] → [S CAUSE [S V O]]
   b. Zhangsan du-le na ben shu
      Zhangsan read-PERF that CL book
      ‘Zhangsan read that book.’
   c. Lisi rang Zhangsan du-le na ben shu.
      Lisi make/let Zhangsan read-PERF that CL book
      ‘Lisi made/had Zhangsan read that book.’

We may conclude that the Generalized Mirror Principle is essentially governed by the principles of symmetry and symmetry breaking. What is crucial to our assumption here is that symmetry, either in the form of isomorphism or mirror image, is found among different modules (or levels) of linguistic computations. Given the Y-model, we may view these symmetric patterns as a “restored” symmetry of the intrinsic symmetry of the core of computational system, that is, Narrow Syntax.
2.2  X-bar Theory: Ripples of Syntax

Another indication for an intrinsic symmetry of Narrow Syntax comes from X-bar theory. X-bar theory possesses both symmetric and asymmetric properties (to be discussed below), and therefore, it plays an important role in the discussion of symmetry and symmetry breaking in syntactic computation. On the side of symmetry, the X-bar theory dictates that architecture of phrase structure is a recursion of an invariant X-bar schema $[[X' X ZP]]$, which, in group-theoretical terms, is a form of translational symmetry. On the other hand, the internal structure of the X-bar phrase, as Kayne (1994) points out, is asymmetric. This is because the specifier phrase of XP always asymmetrically c-commands XP, which in turn asymmetrically c-commands its complement phrase. Therefore, according to Kayne’s (1994) Linear Correspondence Axiom (LCA), only the structures conforming to the X-bar schema can be legitimate syntactic objects (with well-defined linear and hierarchical ordering). We may therefore describe X-bar theory as being locally asymmetric yet globally symmetric.

Chomsky (1995), however, contends that X-bar theory is an architectural principle, but he views linearization (or LCA) as an external PF property that is not inherent in Narrow Syntax. Let us assume Chomsky’s position on the external condition. Furthermore, we shall argue that the symmetry and asymmetry of the X-bar structure is fully expected under the principles of symmetry and symmetry breaking. Asymmetry that comes from PF would “minimally” break the symmetry of Narrow Syntax, which is nonetheless preserved in another form of symmetry (i.e., translational symmetry). Under this view, X-bar structures are consequences of symmetry breaking (rather than a principle of structure building). Each local X-bar domain is thus formed in order to satisfy the external condition required for linearization (and/or hierarchical relations), and subject to the principle of symmetry, the global symmetry is an indication of the intrinsic symmetry of syntax, displayed in a more general type of symmetry.

A physical analogy of this local asymmetry and global symmetry is the wave forms. When one throws a pebble into calm water (i.e., an asymmetric force is imposed on a highly symmetric surface), we see ripples. Like other types of wave forms, in an ideal condition, each wave is locally asymmetric because if we observe a certain point on the surface of water, we see that each wave is a continuous uni-directional movement of up and down. Unlike the original symmetric surface, its position is not invariant. On the other hand, if viewed globally, each wave takes the shape of a recursive form that occurs in an invariant period of time. Like the X-bar structures, the wave forms are locally asymmetric but globally symmetric. In the words of the symmetry principle, this is caused by breaking of the intrinsic symmetry; the asymmetry is observed in its pieces, but the symmetry can be discovered in a higher-ordered form (recall Curie’s principle).

The mirror and isomorphic patterns of symmetry of the Mirror Principles and the global symmetry of the X-bar theory, along with other types of symmetric patterns hidden in fundamental linguistic principles, serve as solid indications that the source of syntactic

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4 Dynamic antisymmetry in Moro (2000) is a theory that provides clear illustrations of the interplay between symmetry and asymmetry. According to Moro (2000), certain types of symmetric structures are allowed at Narrow Syntax, and due to the linearization purpose, these symmetric structures need to be “broken” (through syntactic movements). Our theory of symmetry breaking is along the same path, yet pursuing a more radical alternative. As will be developed in section 3, we take Narrow Syntax as a highly symmetric structure (not linearly or hierarchically defined) constructed by primitive syntactic relations, and these relations are broken in order to satisfy the asymmetric external conditions.
computation, i.e., Narrow Syntax, is highly symmetric. This hidden characteristic of Narrow Syntax is discussed in section 3.

3. **Underlying Symmetry in Syntax**
Recall that we opt for a symmetric view of Narrow Syntax in (6a), repeated as (18) below:

(18) Narrow Syntax is both associative and commutative (and therefore highly symmetric), and the symmetry is broken in the interfaces.

In this section, we conceptualize an approach to the intrinsic symmetric structures of Narrow Syntax through the recursive syntactic parallelisms, which reveal the primitive syntactic relations that remain invariant despite various syntactic transformations. Guided by the work by Prinzhorn and Vergnaud (2004), we shall reconstruct Narrow Syntax as a direct product of the syntactic relations (to be referred to as Merge-marker). Such markers of Narrow syntax are symmetric in a group-theoretic sense in the following two aspects. First, Merge-markers are not defined with respect to their linear or hierarchical ordering; they are Cartesian products that are not subject to a certain ordering of application. Linear and hierarchical orders are regarded as external conditions imposed on Narrow Syntax by interfaces. Merge-markers, therefore, need to be broken in order to satisfy the interface conditions. We shall argue that symmetry breaking is realized by imposing ordering on the primitive syntactic relations, from which different crosslinguistic syntactic patterns can be derived. Second, the primitive syntactic relations remain invariant in each cycle/phase of derivation (to be elaborated), and these syntactic relations are also invariant in different cross-linguistic patterns that result from symmetry breaking.

3.1 **Symmetry of Syntactic Relations: Parallelisms in Syntax**
A plausible way to look for symmetry in Narrow Syntax is through the recursive patterns in the observable syntax. Former attempts at looking for structural invariances can be found in pioneering works such as Sportiche (1983), Riemsdijk (1998), Bowers (2001), and Hiraiwa (2005), in which invariant transformational principles, meta-features, abstract relations, and super-categories are sought to regulate the syntactic computations. Here, we attempt to look for the intrinsic symmetry of Narrow Syntax through invariant syntactic relations, which we take to be the hidden constants that underlie Narrow Syntax. The general ideas presented in this section are originally proposed in Prinzhorn and Vergnaud (2004) and Vergnaud (2009), who hypothesize that Narrow Syntax is a Cartesian product of the primitive syntactic coupled domains (CDs), and standard phrase structures are then constructed from the Cartesian product (in ways that are not explicitly discussed). In what follows, we shall elaborate them in a more precise way from the perspectives of symmetry and symmetry breaking.

We shall refer to a core hypothesis developed in Prinzhorn and Vergnaud (2004) as the Prinzhorn-Vergnaud Conjectures, summarized in (19):

(19) The Prinzhorn-Vergnaud Conjectures
    a. Narrow Syntax is a Cartesian product of the primitive syntactic coupled domains (CDₙ):
       Narrow Syntax = CD₁ ⊗ CD₂ ⊗ CD₃

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5 See Sportiche (1983) for a discussion the Projection Principle from the perspective of invariance and symmetry of syntactic transformation, and see Freidin and Vergnaud (2001) for an analysis to derive the Binding Principle C from the perspective of symmetry.
b. Merge reflects the relation between any two adjacent nodes in Narrow Syntax, and each node defines a syntactic role for the inserted lexical items.

c. Phrase structures are constructed from the abstract Narrow Syntax.

We argue that the primitive relations include (i) the nominal-verbal domain, represented as \{N, V\}, (ii) the functional-substantive domain, represented as \{Fn, Sb\} (by which each substantive item is given a syntactic role), and (iii) a connective pair \{k, k’\}, which extends the structures. Narrow syntax is therefore a Cartesian product as in (20a), whose graph representation is shown in (20b). We shall refer to the graph structure in (20b) as a Merge-marker, in contrast to the Phrase-marker (P-marker) in the standard assumptions:

\[(20)\]

a. Narrow Syntax = \{N, V\} \odot \{Fn, Sb\} \odot \{k, k’\} =
\{(N,Fn,k),(N,Fn,k’),(N,Sb,k),(N,Sb,k’),(V,Fn,k),(V,Fn,k’),(V,Sb,k),(V,Sb,k’)\}.

b. M(erge)-Marker

Each node in the M-markers can be realized by a lexical item through lexical insertion, depending on the feature matrix of the given node. For example, (N,Sb,k) defines a nominal substantive item, and (N,Fn,k) defines a nominal functional item. Note that the strict locality of the core syntactic relations is directly derived from this theory because each coupled relation is, by definition, computed in a local fashion. This is illustrated by the structure in (21), which focuses on the bottom dimension:

\[(21)\]

First of all, the one-dimensionally contrastive pair, (N, Sb, k) and (V, Sb, k), reflects the N-V relation between a substantive V and a substantive N, which plays a role in the theta relations, one of the set of strictly local relations (Williams 1994). Another one-dimensionally contrastive pair, (V, Fn, k) = Asp and (V, Sb, k) = V, reflects the Substantive-Functional
relation between a functional V (e.g., Asp) and a substantive V that is paired with Asp. Similarly, the minimally contrastive pair \((N, Fn, k) = D\) and \((N, Sb, k) = N\) represents the relation between the functional D and the substantive N. In this respect, the proposed theory differs from the standard assumption that a substantive element is embedded under a series of functional projections. However, we argue that each functional projection is coupled with a substantive item, and it is the functional item that defines the LF role (and the syntactic category) played by the substantive item. It is thus predicted that a substantive item may occur in many functional environments and play the grammatical role as a functional item. This analysis thus gives us the novel direction of looking at “grammaticalization” in synchronic linguistics. Examples of this type are abundant in an analytical language like Chinese (see section 3.2). The other fundamental relation involves grammatical connective pairs (cf. den Dikken 2006, Kayne 2005, Larson 2009), represented here as \(\{k, k'\}\). We argue that the parallelisms of the Chomskyan derivational phrases (i.e., the selections between C-T and the v-V in Chomsky 2001) should reflect a dimension of the couplings of \(\{k, k'\}\) (please refer to Liao 2011 for details).

Turning back to the structure in (21), as predicted, a non-connected pair that is contrastive in two dimensions (e.g., a substantive N \((N, Sb, k) = \text{‘the N Root’}\) and a functional verbal projection \((V, Fn, k') = \text{Aspect}\) do not engage in a direct syntactic relation, and any relations between them must be associated by the intermediate elements (through D or the root V). The principle in (22) is therefore derived:

(22) **The Locality Principle of Syntactic Relations**
A syntactic relation \(R\) between the node \(X\) and the node \(Y\) is established if \(X\) and \(Y\) are adjacent nodes in a Merge-marker. That is, \(X\) and \(Y\) are a one-dimensionally contrastive pair.
- e.g., \(X = (A, B, C)\) and \(Y = (A', B, C)\).

Essentially, the proposed theory argues that the “Narrowest” Syntax consists of a set of Merge-markers, each of which represents a domain in which the primitive syntactic relations are satisfied. For example, a simple sentence should involve at least the two M-markers shown in (23) in its base structure:

(23) a. The C-T domain

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6 The functional items may be morphologically realized as independent lexical items (as the grammaticalized items in an analytical language like Chinese), or they may be uniformly realized by the same lexical items, giving rise to the effect of verb-raising in the highly inflectional languages. The choice between the two strategies is likely to follow the macro-parameters discussed in Huang (2005).
b. The v-V domain

Turning back to the hypothesis in (19c), Prinzhorn and Vergnaud (2004) point out that phrase structures can actually be translated to a multi-linear ordered structure. In our language of symmetry breaking, this is a point where the asymmetries of the “output conditions” step in and break the underlying symmetry in Narrow Syntax. Consider the standard representation in (24a):

(24) \[ Z \ (Z = X \text{ or } Y) \]
X \quad Y

The structure in (24) contains three components: X, Y, and its projection label Z, where Z is always identified as X or as Y, and nothing else. The structure, therefore, can be alternatively represented in (25), which is formally equivalent to (24) (cf. also Boeckx 2008):

(25) a. \[ X \rightarrow Y \] (where X and Y merge and Y projects)
   b. \[ X \leftarrow Y \] (where X and Y merge and X projects)

A standard X-bar structure, as in (26a), then, can also be represented in the given fashion, with the added brackets that keep the derivational history in (26b). We represent the ordering in the convention of (26c), where the Head-Complement structure is generated earlier than the Spec-Head structure (the double arrow >>> represents the sequence of structural generations):

(26) a. \[ XP \]
   b. \[ [Z \rightarrow [X \leftarrow Y]] \]
   c. Head-Complement (H-C) >> Spec-Head (S-H)

The symmetry breaking process, in which P-markers are constructed from M-markers, proceeds in the same fashion if we replace the H-C relation and S-H relation with the primitive syntactic relations. One asymmetric direction is defined between the primitive pair, and the other asymmetry is defined among primitive relations. Let us assume that in English, the relevant orderings of the primitive syntactic relations are (N → V), (Subt → Func), and (k → k’), and the relevant orderings among the relations are (Subt, Func) >> (N, V) >> (k, k’) (where (X,Y) = X → Y). The asymmetric phrase structures that are constructed from the M-markers are displayed as follow in (27), taking the C-T domain for example:7

Note that in the P-markers, the linear order between N and V is free/unspecified.

7
(27) a. The C-T domain

b. First, applying (Subt→Func) to (a):

c. Second, applying (N→V) to (b)

d. Third, applying the connective \{k, k'\} to (c)

The structural extension pair \{k, k'\} has a function similar to the Transformational markers in early generative grammar (Chomsky 1964, 1965). They introduce a certain transformational relations to the base structures. Suppose then, the pair \{k, k'\} is mapped to embedding structures (which is assumed to be the default case; Williams 2003). Then, we derive the following representation, where the empty set indicates that further embedding is possible:
If we apply the same operation to the v-V domain, we can derive a similar structure, with Mod replacing C and Asp replacing T:

(28) Mod
    /    /
   Mod  Mod
  /    /
 D  N Mod  Asp
 /    /
 Mod  V  D  Asp
   /    /
 D  N Asp  ∅
    /    /
   Asp  V

Ultimately, a structure is derived in (29), which connects (27) and (28). We arrive at a phrase structure that is not much different from standard structures; however, many structural properties are directly accounted for if it is assumed that phrase structures are actually constructed from the more abstract Merge-markers, where the core syntactic relations are established, and where many structural computations are actually applied.  

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8 Note that the P-marker is a Calder-like structure (29). That is, it provides a blueprint for linearization at PF. This suggests that (29) can be mapped to more than one linear order. For a discussion of (a)symmetric rules in a parametric theory of merge and linearization, see Fukui and Takano (1998, 2000) and Saito and Fukui (1998).
Prinzhorn and Vergnaud (2004) further assume that global ordering of the primitive syntactic relations may be responsible for the macro-parameters of linguistic variation (Baker 1996, Huang 2005). For example, suppose a language adopts a different order from English: (N, V) >> (Subt, Func) >> (k, k’). The resulting phrase structures that are mapped from the Merge-markers can be illustrated as follows (using the Mod-Asp domain as an example):

(30) Applying the ordering (N, V) >> (Subt, Func) >> (k, k’) to Mod-Asp domain

Such phrase structures seem compatible with languages with syntactic N-V incorporation, such as Mohawk:

(31)  \textit{Wa´-ke-[nákt-a-hnínu]-’}  
\textit{Fact-IsS-bed-Ø-buy-PUNCTUAL}  
‘I bought the/a bed.’  

Wiltschko (2002) argues that in Mohawk, not only do V and N form a constituent, but D is also incorporated into a higher functional projection (e.g., an Agreement head). This analysis is expected by the theory proposed here. The differences between English and Mohawk, then, are only apparent in the sequences of applying ordering to the relational pairs. English would have an order of the (Subt, Func) relation first, which results in head selection (N and D) applied in prior to the theta selection, while Mohawk would fix the order of the (N,V) theta
relation first instead, which gives rise to the alternative pattern in (30). We can expect that other patterns of phrase structures be generated with respect to different orderings among the primitive syntactic relations. This is an interesting empirical task that we are not able to pursue in this article. We shall leave it for future research.\(^9\)

From a symmetry point of view, the transition from a highly symmetric Merge-marker to an asymmetric Phrase-marker is compared to the symmetry breaking process. That is, each type of phrase structure represents a unique pattern generated by breaking the inherent symmetry in order to satisfy the interfaces, and although they may appear different in their surface forms, the phrase markers are globally related to one another by the invariant set of primitive syntactic relations. In this sense, each type of phrase marker is regarded as a broken piece from the intrinsic symmetry of the abstract Merge-marker.

3.2 The Paradox of Nominal Syntax and Merge-Markers

We have argued that, conceptually, the Y-model can be viewed as a symmetry-breaking process. The next step is to look for empirical consequences of the symmetry-breaking view. Due to the limitations of space, we focus on a revealing case in the nominal syntax of classifier languages, especially East Asian languages. We show that the standard phrase structural analyses result in a paradox, and the paradox can be resolved if the syntactic computation is actually performed at a more abstract level (i.e., Merge-markers).

With respect to the nominal syntax of noun and classifier, there have been two major competing proposals. On the one hand, it has been proposed that classifiers and nouns form two independent constituents (Fukui & Takano 2000, Huang 1982, among others). On the other, classifiers are thought to be extended projections of nouns (Borer 2005, Li 1999, Simpson 2005, among others), and they belong to single constituents. The contrast is illustrated in (32):

\[
\begin{align*}
(32) & \hspace{1cm} \text{a. Dual-constituency analysis} \hspace{1cm} \text{b. Single-constituency analysis} \\
& \text{CLP/NP} \downarrow \hspace{1cm} \text{DP} \\
& \hspace{1cm} (\text{DP}) \downarrow \text{NP} \hspace{1cm} \text{D(\text{em})} \downarrow \text{NumP/CLP} \\
& \hspace{2cm} (\text{D}) \downarrow \text{CLP} \hspace{3cm} \text{Num} \downarrow \text{CLP} \hspace{3cm} \text{CL} \downarrow \text{NP} \\
& \hspace{3cm} \text{NumP} \hspace{3cm} \text{CL} \hspace{3cm} \text{NP}
\end{align*}
\]

The debate between the two types of analyses is strengthened by the fact that each analysis has its own advantage. The dual-constituency analysis successfully captures the parallelism between N and CL. One of the same properties shared by both N and CL is the ability to take a case marker.
Second, both N and CL may be assigned a theta-role, as observed in Riemsdijk (1998). The examples are from Chinese, where both the noun ‘water’ and classifier ‘bottle’ may receive a theta-role, depending on the choice of verb:

(34) a. John he-le [san ping shui]. (theme = water)
    John drank three bottle water
    ‘John drank three bottles of water.’

b. John da-po [san ping shui]. (theme = bottle)
    John break three bottle water
    ‘John broke three bottles of water.’

Despite being conceptually appealing, the dual-constituency analysis has great difficulties capturing the strong selection relation between CL and N because it predicts that the classifier and noun belong to two separate constituents. Given the common assumption that heads engaged in selection are subject to strict locality, the dual-constituency analysis fails to represent the strict locality. The local selection between CL and N, then, provides strong support instead for the single-constituency analysis. Since CL is the immediate extended projection of N, the selection can be easily accounted for within the latter analysis. The classifier constructions hence lead us to a conceptual paradox in the standard theories.

This paradox is reminiscent of the sub-extraction problem noted in Kayne (2005), shown in (36). The sub-extraction problem involves the same paradox of single and dual constituency:

(35) Money, John has lots of [money].

*Lots of money* in English looks like a single DP/NP constituency, and the extraction of an inner element should be blocked. However, no such blocking effects are observed, and Kayne therefore points out that *lots* and *money* actually belong to two separate constituents as a result of a series of remnant movements, as illustrated in (36) (the capital OF stands for an unpronounced counterpart of *of*):

(36) a. have [SC [money] [lots]]
    b. OFCase [VP have[SC [money] [lots]]] (Merging OF)
    c. [money [OFCase [VP have [SC t-money [lots]]]]] (NP movement to Spec, OFP)
    d. of [money [OFCase [VP have [SC t-money [lots]]]]] (Merging of)
    e. [VP have [SC t-money [lots]]] [of [money] [OFCase tVP]] (remnant movement to Spec, ofP)

Two crucial aspects of Kayne’s analysis are as follows: (i) The local selection between *lots* and *money* (and between CL and N) is established in a small clause in the underlying structure, and (ii) the movements resulting in dual constituency are triggered by a pair of connective (of, OF). It might be possible to solve the tension between the single and dual constituency analyses of CL and N if we assume a similar analysis in Chinese, where (k, k’) in Chinese is realized by the pair of connectives (de, DE). This is shown in (37):
(37) a. he san ping (de) jiu
drink three bottle CL DE wine
‘drink three bottles of wine’
b. drink [SC [wine] [three-bottle CL]]
c. DECase [VP drink [SC [wine] [three-bottle CL]]] (Merging DE)
d. [wine [DECase [VP drink [SC twater [three-bottle]]]]] (NP movement to Spec, DEP)
e. (de) [wine [DECase [VP drink [SC twater [three-bottle]]]]] (Merging de)
f. [VP drink [SC twater [three-bottle]]] [(de) [wine] [DECase tVP]]
   (remnant movement to Spec, deP)

However, Kayne’s analysis still cannot explain why both CL and N may receive theta roles from the verb. In fact, Chinese has verb-copying constructions, which indicates that each of the dual constituents may contain a verb of its own:10

(38) Zhangsan [[he jiu] DEi [he san ping] de]
Zhangsan drink wine drink three bottle
‘Zhangsan drank three bottles of wine.’

Again, the VP parallelism poses problems for both the standard analysis and Kayne’s analysis, as neither is able to give a satisfactory account for “chaining” of the two verbs and maintaining the local selection of CL and N. In view of the VP-parallelism in (38), we shall reinterpret Kayne’s analysis by assuming that (k, k’) is a pair of connectives that connects two parallel structures, as assumed in the Merge-markers. We shall call it the CL-N domain (see (39); F[unit] stands for the functional item responsible for mass/count distinction; see Liao & Vergnaud to appear for a discussion):11

(39) The CL-N domain

Like other domains discussed in section 3.1, the CL-N domain is constructed by the Cartesian products of the primitive syntactic relations. The correspondence between the feature matrices and the lexical realizations are displayed in (40) (where (k, k’) = (of, OF)):

10 Verb-copying constructions are different from VP-conjunction constructions in that the two VPs in verb-copying constructions share a single aspectual marking (only marked in the second verb), as in (ia) (which is not the case in VP-conjunction constructions, where both verbs can have their own aspectual marking), and the two VPs also share a single manner adverb (modifying either VP) in verb-copying constructions, as in (ib):
   (i) a. Zhangsan he(*-le) jiu he-le san ping.
       Zhangsan drink-ASP wine drink-ASP three bottle
       ‘Zhangsan drank three bottles of wine.’
   b. Lisi (zixi-de) kan shu (zixi-de) kan san ben.
       Lisi carefully read book carefully read three CL
       ‘Lisi read three books carefully.’

11 The specific contents of F1 and F2 of the verbal domain are dependent on other domains, like Aspect-Modal and C-T when the CL-N domain is extended and combined with other domains. We shall not discuss the specific mechanisms here, leaving it instead as a topic for future research.
After lexical instantiations, (41b) illustrates the Merge-marker of the classifier constructions in (41a), and due to the asymmetric ordering requirements of phrase structures, the Merge-marker can be translated to the Phrase marker in (41c), subject to the ordering (Sb, Fn) $>>$ (N, V) $>>$ (k, k') (with the same technique introduced in the last section):

(41) a. [he san ping] (de) [he jiu] DE drink three bottle drink wine
b. c. $\{k, k'\} = \{de, DE\}$

The verb-copying construction, then, can be viewed as resulting from a reversed pattern of spelling out the order of (de, DE), and with a different pronunciation rule for the corresponding verbs, as illustrated in (42):

(42) [k'P $[VP2 he jiu]$ DEi [kP $[VP1 he san ping]$ de ]]

The proposed analysis allows us to capture Kayne’s “small clause plus remnant movement” analysis in a more precise way. Under our analysis, the local selectional relations between N and CL and between the two verbs are actually performed in the underlying Merge-markers, and the difference in surface structures is only apparent, resulting from a symmetry-breaking process from the Merge-markers to the phrase markers. The tension between the single- and dual-constituency analyses is therefore neutralized.

4. Conclusion
We have shown that many linguistic principles and theories are governed by an underlying symmetry principle that is widely assumed in other sciences of natural objects. The phenomenon of symmetry breaking, derived from the symmetry principle, is also argued to be responsible for the emergence of different linguistic patterns and orderings. Applying the principle of symmetry, we argue that the standard Y-model of linguistic computation can be understood as a symmetry-breaking process, and Narrow Syntax is highly symmetric. We
construct a symmetric syntax by viewing syntax as a Cartesian product generated by the primitive syntactic relations, called Merge-markers. The breaking of the symmetric Merge-marker to the asymmetric Phrase-marker, triggered by the asymmetric requirements of the interfaces, gives rise to various syntactic patterns, yet the syntactic relations among them remain invariant. Empirically, the abstract level of Merge-marker also proves to be useful in that it provides a solution to the single- vs. dual-constituency paradox in the classifier constructions.
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