

The Minimal Chain Principle and Parsing Korean*

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De Vincenzi's (1991, 2000) Minimal Chain Principle (MCP) is a good example of economy in parsing. It combines Superstrategy and the Active Filler Hypothesis (AFH). In this paper, the Korean data involving topicalized phrases and (scrambled) dative noun phrases are tested to examine the validity of the MCP. The processing difficulty observed from topicalized complements suggests that the parser considers syntactic movement as a last resort. The preferred readings in the sentences containing scrambled dative phrases also suggest that the parser prefers a singleton chain. Meanwhile, if there is evidence for the existence of a chain, the parser completes chain computation as soon as possible. Altogether, the core data from Korean can be well explained by the MCP.

Key words: parsing, economy. Minimal Chain Principle, Superstrategy, Active Filler Hypothesis, topicalization, scrambling

1. Introduction

One of the interesting issues raised in the field of psycholinguistics is how directly the human parser reflects properties of competence grammar. From Pritchett (1992), it has often been proposed that natural language processing can be characterized (completely) in terms of competence grammar. Although such a proposal is not uncontroversial, it seems undeniable that there is some transparency between the grammar and the parser.

If we assume that there are universal parsing principles as well as lan-

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guage-specific parsing strategies, the following question arises naturally: What is the fundamental idea or concept behind those universal parsing principles? As some linguists have suggested, one of the concepts governing those parsing principles seems to be economy.

From Frazier's (1978) Minimal Attachment, the notion of economy has been employed in many psycholinguistic proposals. Recently, De Vincenzi (1991, 2000) proposed the Minimal Chain Principle (MCP), which can also be considered as realization of economy. The MCP is based on the idea that chains are costly structures to maintain in short term memory and hence the following should be done: (i) Avoid postulating an unnecessary chain at surface structure, (ii) but do not delay postulating a chain once an element is identified as moved from somewhere.

In this paper, we consider the validity of the MCP by applying it to Korean, a typical head-final language. In particular, we concentrate on the sentences involving topic-marked phrases and dative NPs. Since scrambling is allowed rather freely in Korean, chain formation can easily be observed and hence we should be able to test the validity of the MCP.²⁾

This paper is organized as follows. In section 2, we overview the MCP in De Vincenzi (1991, 2000). In section 3, we observe how the MCP has been applied to head-initial languages such as Italian and English. Section 4 discusses topicalization and scrambling phenomena in Korean. It will be shown how the MCP can account for the distributions and interpretations of scrambled dative NPs and topic phrases in Korean. Section 5 summarizes our discussion.

2. The Minimal Chain Principle

The Minimal Chain Principle (MCP) is based on the idea that syntactic chains are costly for short-term memory and hence the parser tries to complete chain computation as soon as possible if there is evidence for the existence of a chain.

1) In this paper, if a sentence is judged to produce conscious processing difficulty, it is marked with '#' or '#?', depending on the degree of difficulty, and the judgements for the Korean data are mostly based on the results of survey from the graduate students in the English Department, the Catholic University of Korea. I am grateful to them. The results of survey from Suh (1994) are also cited when they are relevant.

As De Vincenzi (2000) points out, the MCP combines two previous processing principles, the Active Filler Hypothesis (AFH) in Frazier (1987) and Superstrategy in Fodor (1979). The former states that once the parser identifies an element as being moved from its argument position, it posits a corresponding empty category as soon as the grammar of the language allows it. The latter states that a string is analyzed as a well-formed deep structure, postulating movement as a last resort.

In the MCP, the AFH and Superstrategy are combined in the following way: An element is basically analyzed as a singleton chain, as predicted by Superstrategy. However, if the parser finds evidence for syntactic movement, it completes chain computation as soon as possible, as predicted by the AFH.

De Vincenzi (2000) claims that the MCP is a universal parsing principle and hence applies regardless of the types of languages. She demonstrates that the MCP can deal with a wide range of data from many European languages. In the following section, we examine how the MCP handles the core data from English and Italian.

3. MCP in Head-initial Languages

3.1. Italian

De Vincenzi (1991) demonstrated the validity of the MCP in parsing Italian by testing sentences involving a postverbal subject and a predicate allowing more than one argument structure. Consider the following.

- (1) Ha richiamato il venditore per chiedere uno sconto.
 called the seller to ask for a discount
 ‘He/ She called the seller to ask for a discount.’

- (2) Ha richiamato il venditore per offrire uno sconto.
 called the seller to offer a discount
 ‘The seller called to offer a discount.’

- (3) Ha insistito il venditore per offrire uno sconto.
 insisted the seller to offer a discount
 ‘The seller insisted to offer a discount.’

Since Italian is a null subject language, (1) is interpreted as having *he* or *she* as its subject. The verb *richiamato* (called) takes a noun complement optionally. As a result, (1) and (2) have different argument structures: *venditore* (seller) turns out to be the object in (1), but not in (2). (3) is a control sentence: The verb *insistito* (insisted) does not take a noun complement, and hence the postverbal NP can only be an inverted subject. The MCP predicts that since singleton chain is the preferred analysis, *venditore* in (1)/(2) will be initially taken as the object of *richiamato* and a null subject is posited. When subsequent input signals that *venditore* must be the subject in (2), reanalysis becomes inevitable. Provided that reanalysis results in longer reading times, it is predicted that the reading time for (2) will be longer than that for (1) or (3), which involves no reanalysis. De Vincenzi's experimental results confirm such a prediction, and hence she concludes that the Italian language obeys the MCP.

3.2. English

Frazier & Clifton (1989) found an effect of wh-assignment to a gap following intransitive verbs as well as transitive verbs. Consider the following.

- (4a) What did the silly young man whisper < > to his fiancée during the movie?
 (4b) What did the silly young man whisper < > to his fiancée about < > during the movie?

According to the experimental results in Frazier & Clifton (1989), the reading time for (4b) is longer than that for (4a). In particular, the reading time on the phrase *to his fiancée about* in (4b) was significantly longer than that on the phrase *to his fiancée* in (4a). Frazier & Clifton interpreted such a result as supporting evidence for the AFH, which proposes that once the parser identifies a moved element, it posits a corresponding empty category as soon as possible. The AFH predicts that the parser will immediately postulate an empty category after *whisper*, since that spot is the earliest possible gap position. When it turns out that *whisper* was used as an intransitive as in (4b), reanalysis is inevitable, and that is why the reading time for (4b) is significantly longer than

that for (4a), in which *whisper* was used as a transitive and hence reanalysis is not necessary.³⁾

The observations thus far suggest that the MCP applies rather strictly in languages such as English and Italian.⁴⁾ Below we will examine whether

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- 3) There are some experimental results inconsistent with the AFH. The results from a grammaticality judgement task and self-paced reading in Stowe, Tanenhaus, and Carlson (1991) provide evidence in favor of lexical effects. Consider the following.
- (i) Transitive preference verbs
 - (ia) The district attorney found out which (witness/church) the reporter ASKED < > about the meeting. (Early Gap)
 - (ib) The district attorney found out which (witness/church) the reporter ASKED anxiously about < >. (Late Gap)
 - (ii) Intransitive preference verbs
 - (iia) The sheriff wasn't sure which (horse, rock) the cowboy RACED < > down the hill. (Early Gap)
 - (iib) The sheriff wasn't sure which (horse, rock) the cowboy RACED desperately past < >. (Late Gap)

The *wh*-phrases in the above are either the object of the verb (Early Gap condition) or the object of the preposition following the verb (Late Gap condition). The *wh*-phrases are either plausible or implausible as the object of the verb for the Early Gap sentences. Meanwhile, both plausible and implausible *wh*-phrases are equally plausible for the Late Gap sentences. Hence, if plausibility effects are observed with the Late Gap sentences, we can conclude that the parser initially filled the false Early Gap. According to the experimental results from Stowe, Tanenhaus and Carlson (1991), for the preferred transitive verbs there is an effect of plausibility with both Early Gap and Late Gap (=ia, ib), whereas with the preferred intransitive verbs there was an effect of plausibility only with Early Gap sentences (=iia). This suggests that the parser posits a gap after a preferred transitive verb, but not after a preferred intransitive verb. Such a contrast between preferred transitive verbs and preferred intransitive verbs seems to contradict the AFH and support the claim that *wh*-filler-gap assignment is a process of thematic assignment rather than a syntactically driven process.

De Vincenzi claims that there is a way to reconcile the contradiction between the AFH and the claim by Stowe, Tanenhaus and Carlson (1991). She points out that the experimental materials in the former include only *WHO/WHAT* type questions, whereas the latter uses only *WHICH (+noun)* type questions. She further claims that *WHICH (+noun)* dependencies are more sensitive to lexical properties since they involve structure coindexing operations occurring after the building of the syntactic structure, whereas bare *wh*-phrases (= *WHO/WHAT* type) enter a stricter grammatical relation and hence exhibit filler-gap effects regardless of lexical effects. Interestingly, De Vincenzi also found the same kind of contrast between *WHO/WHAT* type and *WHICH* type questions from Italian in terms of obeying the MCP. Meanwhile, the discussions in this paper concentrate on bare *wh*-phrases.

- 4) An anonymous reviewer inquired, given AFH, how multiple *wh*-questions can be parsed in languages such as Bulgarian, where every *wh*-phrase can be fronted. To my knowledge, there has been no experimental study on multiple *wh*-fronting from the viewpoint of AFH. Given that two or more *wh*-phrases and gaps are involved in parsing a single sentence, it may be too risky to apply AFH blindly in that case. Presumably, each *wh*-phrase in that language will be distinguished as much as possible based on its syntactic/semantic feature, and the parser will try to fill each gap considering relevant features. I leave this for future research.

the MCP also applies in head-final languages such as Korean.

4. MCP and Parsing Korean

In this section, the validity of the MCP is examined by considering core Korean data. We will concentrate on the sentences involving topic-marked NPs and dative NPs. Both topic and dative NPs are often affected by the process of scrambling, and hence syntactic chains can be observed.

4.1. Topicalization and Scrambling

As Suh (1994) points out, topics in Korean can be classified into two categories: One is base-generated, and the other involves syntactic movement. The former typically occurs in the subject position of a depictive statement.⁵⁾ Meanwhile, topics involving syntactic movement function as a complement or an adjunct and seem to obey the movement constraint, as pointed out by Saito (1985) and Lasnik & Saito (1992), among others.⁶⁾

In the following sentences, compare base-generated topics with topicalized phrases, i.e., topics involving syntactic movement.

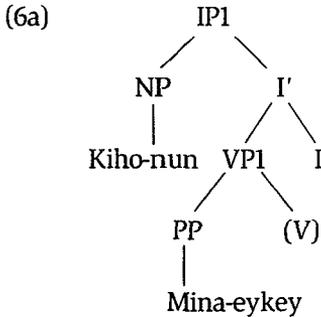
- (5) Kiho-nun Mina-eykey Yumi-ka ecey swuswul-ul
 -Top -Dat -Nom yesterday operation-Acc
 hayssta-ko malhayssta
 did-Comp said
 'Kiho told Mina that Yumi underwent an operation yesterday.'

5) Subject NPs in Korean can be topic-marked as well as nominative-marked, and the choice of subject markers is tied to whether the sentence is depictive or presentational. See Suh (2003) and references cited there for the details.

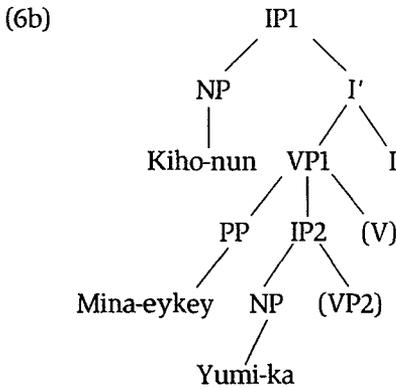
6) Strictly speaking, besides topic-marked subject NPs and topicalized objects/adjuncts, there is a third type of topics such as the following.

- (i) sayngsen-un yene-ka ceyil matissita
 fish-Top salmon-Nom best is delicious
 'Speaking of fish, salmon is the most delicious.'

The topic-marked noun in (i) does not involve any syntactic movement, and yet it does not seem to function as a subject noun. Hence it may be considered to belong to neither the first nor the second category of topics discussed above.



The next input, *Yumi-ka*, is attached under IP2, which is a complement of VP1, as in the following.

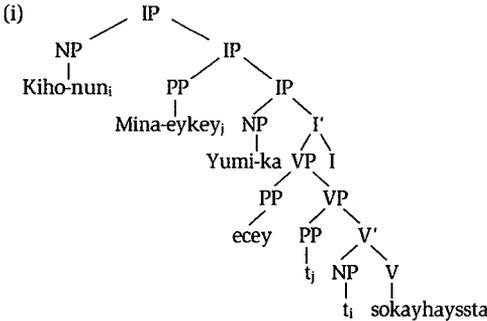


Notice that in order to derive a complete grammatical structure from (6b), it is necessary to have two verbs: VP1 needs a verb as its head, and upcoming VP2, which is the complement of IP2, also needs a verb. Meanwhile, the subsequent string in (6) is not compatible with the structure (6b) since it has only one verb, *sokayhayssta*. Therefore, reanalyzing (6b) is inevitable. The reanalysis cannot but involve deleting VP1 node⁸⁾, and thus it causes conscious processing difficulty, as predicted by the theories adopting determinism.⁹⁾

8) In the ultimate structure of (6), *Kiho-nun* and *Mina-eykey* are adjoined to IP, and *Yumi-ka* is in predication relation to the VP headed by *sokayhayssta*, as shown below. Therefore, what should be deleted from (6b) in order to derive the correct structure is VP1 (and I/ I).

The MCP also correctly predicts the contrast between (6) and (7) below.

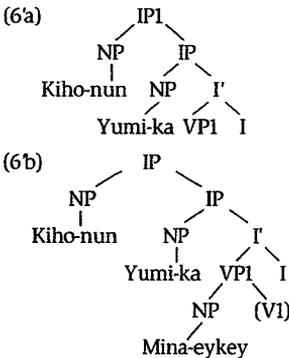
- (6) #Kiho-nun Mina-eykey Yumi-ka ecey sokayhayssta
 -Top -Dat -Nom yesterday introduced
 'As for Kiho, Yumi introduced him to Mina yesterday.'



9) An anonymous reviewer pointed out that if there is a contrast of acceptability between (6) and the following sentence, that supports our claim that the reanalysis characterized as structure deletion in (6) is costly.

- (6') #?Kiho-nun Yumi-ka Mina-eykey ecey sokayhayssta
 -Top -Nom -Dat yesterday introduced
 'As for Kiho, Yumi introduced him to Mina yesterday.'

Most of my informants seem to share the reviewer's intuition that (6') is easier to process than (6). Even though some of them do not see considerable difference between (6) and (6'), none of them judged (6') to be more difficult than (6). Provided that (6) is more difficult to parse than (6'), the contrast between them can be explained in the following way, as the reviewer pointed out: (6) is disadvantageous in the respect that not only the topic NP but also the dative NP have been scrambled. Moreover, at the final stage of parsing, deleting VP1 node is inevitable. Meanwhile, such a deletion process is not necessary in parsing (6'), given that the parser builds the following parse tree.



In (6'a) and (6'b), there is only one VP node postulated and hence it is not necessary to delete any substantial part of the parse tree. Therefore, the processing difficulty observed in (6) is not created in (6').

- (7) Kiho-lul Mina-eykey Yumi-ka ecey sokayhayssta
 -Acc -Dat -Nom yesterday introduced
 'Yumi introduced Kiho to Mina yesterday.'

Whereas the reanalysis of the sentence-initial topic is inevitable in (6), processing the initial noun phrase in (7) does not involve any reanalysis since the case marking on the initial noun phrase indicates that it is preposed, i.e., it involves syntactic movement. As the second part of the MCP states, the human parser immediately postulates a syntactic chain when there is clear evidence for syntactic movement. Hence (7) is parsed without any reanalysis and no garden path results.¹⁰⁾

4.2. Evidence from Sentence Completion Task

There are also interesting data from a sentence completion task reflecting the idea of the MCP. Consider the following.

- (8) Yumi-nun Kiho-ka

- (8a) Yumi-nun Kiho-ka mikwuk-ey kassta-ko malhayssta
 -Top -Nom America-to went-Comp said

'Yumi said that Kiho went to America.'

- (8b) Yumi-nun_i Kiho-ka t_i silehanta
 -Top -Nom hates

'As for Yumi, Kiho hates her.'

Given a sentence fragment such as (8), nine subjects completed it with degree 1 embedding sentences such as (8a), and only one subject provided a sentence involving topicalization, such as (8b). Such a result is consistent with what the MCP predicts: A sentence initial topic is analyzed as a base-generated subject NP rather than a topicalized NP since the former, a singleton chain, is computationally less complex. Consequently, a construction in which the topic NP as well as the nominative NP functions as a subject of its own clause is produced.

The observations thus far suggest that the complexity resulting from

10) According to the results of the rating task in Suh (1994), only 12.9% of the sentences patterning with (7) were judged to be difficult.

chain formation is more serious than the complexity associated with embedding. Examples (5) and (8a) might be considered more complex than (6) and (8b) in the sense that the former involves more degree of embedding. Yet, the complexity associated with embedding doesn't seem to lead to actual processing difficulty, and that is why (5) and (8a) are not problematic at all. On the other hand, the complexity resulting from chain computation can result in a real processing problem, especially when a reanalysis is involved.

Notice that (5) and (8a) involve so-called center-embedding, which can create a serious processing problem in English when the degree of embedding is more than two. Given that center-embedded sentences are used much more frequently in Korean than in English, it is possible that the Korean parser has a specific strategy to deal with center-embedding.¹¹⁾

4.3. Dative NP Ambiguity

4.3.1. Dative NP Preference

The MCP can account for the preference of interpretation observed in the following ambiguous sentence.

(9) Inho-ka chinkwu-tul-eykey Yumi-ka kecitmalhayssta-ko
 -Nom friend-Pl-Dat -Nom lied-Comp
 cwucanghayssta
 claimed

(9a) 'Inho told his friends that Yumi told a lie.'

(9b) 'Inho said that Yumi told her friends a lie.'

(9) is associated with two interpretations due to the possibility of scram-

11) As seen below, degree 2 center-embedding in English leads to parsing break-down, whereas that in Korean doesn't seem to be problematic.

(i) #The young man [the nurse [the police officer suspected] had met] threatened the senator.

(ii) Inho-nun [apeci-kkeyse [Mina-ka cikcang-ul olmkiki-lul] wenhasinta-ko]
 -Top father-Nom -Nom job-Acc changing-Acc want-Comp
 malhayssta
 said

'Inho said that his father wants Mina to find another job.'

See Suh (2000) for the possible parsing strategies dealing with center-embedding in Korean.

bling; *chinkwu-tul eykey* (to the friends) is the goal argument of the matrix verb *cuwucanghayssta* (claimed) in the first reading and the goal argument of the embedded verb *kecitmalhayssta* (lied) in the second reading. In the latter case, *chinkwu-tul eykey* is scrambled to the clause initial position. Since both the matrix verb and the embedded verb can optionally take a goal NP, both (9a) and (9b) reading would be equally accessible if scrambling were done without any cost. However, native speakers' judgements suggest that (9a) is strongly preferred.¹²⁾ Such a preference implies that scrambling is indeed a costly process.

4.3.2. Koh (1997)

The processing of dative NPs in Korean was also discussed in Koh (1997). In his eye-movement study, the following constructions were compared.

- (10) emeni-ka yeyppun maknayttal-eykey samchon-i
 mother-Nom pretty youngest daughter-Dat uncle-Nom
 sacwu-n cha-lul mwulleycwuessta
 buy&give-Rel car-Acc handed down
 'Mother handed down to the pretty youngest daughter the car
 which her uncle bought (for her).'

- (11) emeni-ka yeyppun maknayttal-eykey samchon-i
 mother-Nom pretty youngest daughter-Dat uncle-Nom
 sacwu-n cha-lul coahayssta
 buy&give-Rel car-Acc liked
 'Mother liked the car which her uncle bought for the pretty
 youngest daughter.'

Both (10) and (11) contain a relative clause, in which a dative verb *sacwu-ta* (to buy and give) is included. While (10) has a dative verb *mwulleycwuta* (to hand down) as its matrix verb, (11) has a simple transitive verb *coaha-ta* (to like) as its matrix verb. Comparing these two types of constructions can give us a clue for finding out the basic parsing strategies in head-final languages, as Koh (1997) points out. He was partic-

12) 8 subjects out of 10 had a preference for (9a), and 2 subjects said (9a) and (9b) were equally accessible.

ularly interested in whether the parser builds phrase structure in the absence of the head of the phrase. Head-driven parsing theories predict that processing difficulty occurs only in (10) for the following reason¹³: Clausal structure can be computed only when its head, i.e., the inflected verb, is encountered, and this means that the appearance of the dative verb *sacwu-n* will force the dative NP *yeyppun maknayttal-eykey* to be attached as the complement of *sacwu-n*, given that parsing is not delayed, i.e., the parser computes clausal structure as soon as the head of the clause is encountered. Ultimately, the dative NP should be reanalyzed as the complement of the matrix verb *mwulleycwuessta*, and that will create comprehension difficulty.¹⁴ Meanwhile, parsing theories based on the idea of incrementality predict that processing difficulty is observed only in (11) for the following reason: Provided that parsing is done incrementally and head-final and head-initial languages are parsed equally efficiently, some information other than from the head should guide first-pass processing in head-final languages.¹⁵ Hence, the dative NP as well as the first nominative NP will be attached as a constituent of the matrix clause before the verb is encountered. This means that in (11) the dative NP must be reanalyzed as a constituent of the relative

13) The basic architecture of a head-driven parsing model can be seen well in Pritchett (1992). He proposes that attachment to constituent structure representation is motivated by principles such as the Case filter and Theta theory. He also claims that when the parser receives structurally ambiguous input, it pursues a single analysis in which principles of syntax are maximally satisfied. In his system, for instance, argument attachment is preferred over adjunct attachment since the former facilitates Theta-role assignment. Given such a framework, in the processing of verb-final languages, clausal structures are not computed until the verb is encountered, since Theta-role or Case assignment is possible only when the verb is received. In other words, Pritchett's theory assumes a delay-until-the-verb strategy in parsing verb-final languages. However, such a delay strategy often makes incorrect predictions on the garden path status of Korean sentences. For instance, the fact that some degree-0 embedding sentences such as (6) in section 4.1 create severe garden path cannot be accounted for by Pritchett's theory for the following reason: Given a delay-until-the-verb strategy, the parser does not make attachment decisions on the three NPs in (6) until the verb is encountered. When the verb is received, it becomes evident how the three NPs are related to the verb *sokayhayssta*, a three-place predicate. But it is then mysterious why (6) leads to severe garden path. As is pointed out below, the Korean parser in fact makes structural decisions prior to the appearance of the verb, running the risk of misanalysis.

14) It is logically possible that the dative NP ultimately belongs to the relative clause and the matrix verb takes an empty pronominal as its dative argument, but such a possibility doesn't seem to be pursued, as is clear from the native speakers' intuition.

15) As Inoue (1991) and Suh (1994) pointed out, case marking on each NP can be the major source guiding first-pass processing in Japanese and Korean.

clause at the last moment, since the matrix verb *coahayssta* (to like) is not compatible with a dative complement. Hence comprehension difficulty occurs.

The experimental results from Koh (1997) suggest that the prediction made by head-driven parsing theories is not correct: the total reading time was faster in (10) than in (11), and regarding the eye movement measurement, regression occurred in (11) more often than in (10). Given this, we can conclude that the parser starts attaching a phrase to a projection available at the moment even in the absence of its head, rather than delaying attachment until the head is encountered.

Meanwhile, the above data can be considered to support the claim made by the MCP in the following respect: Since both the matrix verb and the relativized verb can take a dative argument in (10), there are two logical possibilities and hence two possible interpretations, as in the following.

- (10a) 'Mother handed down to the pretty youngest daughter the car which her uncle bought (for her).'
- (10b) 'Mother handed down (to somebody) the car which her uncle bought for the pretty youngest daughter.'

Native speakers' intuition favors (10a) over (10b), and such a preference can be accounted for by the first part of the MCP; the shortest chain, i.e., a singleton chain, should be pursued unless there is clear evidence for movement, and thus the dative NP is postulated as a complement of the upcoming matrix verb rather than a scrambled complement for the relativized verb.

5. Concluding Remarks

The core data from Korean strongly suggest that the MCP can be effective in head final languages as well as in head initial languages. In particular, from the processing difficulty created by topicalized objects, we can observe the validity of Superstrategy, the first part of the MCP, which considers syntactic movement as a last resort. In addition, the preferred readings in the sentences containing dative arguments and the experimental results from sentence completion tasks suggest that syntac-

tic chains are costly and hence the parser prefers a singleton chain. Meanwhile, as we have seen from the contrast between topicalized objects and scrambled ones, if there is evidence for the existence of a chain, the parser completes chain computation as soon as possible. The fact that the MCP can account for the core data from very different types of languages such as Italian and Korean suggests that the MCP can be a universal parsing principle.

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