

Categorical Ambiguity of Possessives and Adjectives*

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This paper examines categorical, structural and semantic ambiguities of prenominal possessives and adjectives. The first part of this paper discusses the following ambiguities of adjectives and possessives, and present context-free grammars: when two adjectives modify a noun, the second adjective can be categorically ambiguous between an adjective and a noun. Double prenominal possessive (genitive) phrases can be also parsed in two ways: the first genitive phrase may either modify the noun in the following possessive phrase or modify the noun that two possessives modify. The second part of this paper addresses meaning disambiguation of Japanese genitive marker. Since relations denoted by Japanese possessive marker are highly ambiguous, I propose type-raising of not only a possessee noun (Partee 1997) but also of a possessor noun according to its argument structure.

1 Underspecified Meaning

Natural language can be interpreted ambiguously. For example, an English word *bank* is polysemous so that *I am going to a bank* can be understood either that the speaker is going to Bank of America or to a riverside. In addition to such *lexical ambiguity*, natural language contains *scopal ambiguity*. The semantic scope between *everyone* and *someone* is ambiguous: when *everyone* takes higher scope over *someone*, there would be different lovers for everyone, while when *someone* scopes over *everyone*, there is a unique lover that everyone loves. Moreover, pronouns are referentially ambiguous.

In view of such ambiguities, an intermediate ambiguous representation of a natural language has been suggested in the literature (van Deemter 1991, Poesio 1991, 1996). Poesio (1996) presents grammars that generate lexically, scopally and referentially underspecified languages.

Section 2 of this paper discusses *categorical* and *syntactic* ambiguities which Poesio (1996) does not discuss much. Double prenominal possessives and adjectives are categorically and structurally ambiguous. Section 3 analyzes *semantic* ambiguities of possessive relations and proposes type coercion based on the argument structure of the possessor noun. While Vikner and Jensen (2002) adopts qualia structure (Pustejovsky 1995) of a possessee noun, the possessive relation disambiguation in Japanese calls for type raising of a possessor noun into a one or two place predicate.

2 Categorical and Structural Ambiguities of Double Prenominal Possessives and Adjectives

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2.1 Categorical Ambiguity between Noun and Adjective and Rewrite Rules

When two adjectives modify a noun, the second adjective can be categorically ambiguous between an adjective and a noun. In (1), *yellow* may modify: (b) a noun *gold*, and the NP *yellow gold* becomes an adjectival phrase that modifies *ring*, so *yellow gold ring* is a ring made of yellow gold; or, (c) the noun phrase *gold ring* in which *gold* is an adjective, and the entire noun phrase refers to a gold ring painted in yellow. *Gold* is categorically ambiguous between a noun and an adjective.

- (1) a. yellow gold ring
 b. [NP [NP→AP [Adj yellow][NP gold]] [NP ring]]
 c. [NP [Adj yellow][NP [NP→Adj gold][NP ring]]]

Similarly in (2), when *royal* modifies a noun phrase *purple gown*, *royal* is an adjective as in (2b). The gown is the kind that royal families would wear even though the color itself does not have any significance. On the other hand, *purple gown* can form a complex noun phrase as in (2c), where *purple* is a noun modified by *royal*. The gown is a regular night gown but with royally looking purple color.

- (2) a. royal purple gown
 b. [NP [NP→AP [Adj royal][NP purple]] [NP gown]]
 c. [NP [Adj royal] [NP [NP→Adj purple] [NP gown]]]

Color terms and materials tend to be ambiguous even without preceding another adjective (3), and it is known that national names are categorically ambiguous (4).¹

- (3) [NP [NP→Adj brick] [NP wall]]²
 (4) a. conservative American newspaper
 b. [NP [NP→AP [Adj conservative] [NP American]] [NP newspaper]]
 `a newspaper of conservative Americans'
 c. [NP [Adj conservative] [NP [NP→Adj British] [NP newspaper]]]
 `an American newspaper which is conservative'

Context Free Grammar In view of categorical ambiguities between a noun phrase and an adjective (phrase), we need a context-free grammar presented in (5) which includes rewriting rules from an adjective (phrase) into NP. For example, AP *yellow gold* which modifies *ring* in (1b) is overwritten into NP, and then, into the adjective *yellow* and NP which is substituted by *gold*. Therefore, even though *gold* is a noun in its lexical entry, the rule in (5g) substitutes the higher node NP into AP.

- (5) A grammar describing a fragment of English LE:
 a. DP → DP D'
 b. D' → D NP

¹ See the examples of ambiguous national names in Aronoff (2004).

² *Brick wall* is not a noun compound as the stress pattern suggests: *bríck wàll, √bríck wáll.

- c. NP → AP NP
- d. NP → A NP
- e. NP → A N
- f. NP → N
- g. AP → NP
- h. A → NP
- i. A → {yellow, royal, conservative}
- j. N → {gold, ring, purple, gown, brick, wall, British, newspaper}

2.2 Structural Ambiguity

Structural ambiguity of propositional phrase attachment has been studied by a number of researchers. Hindle and Rooth (1993) presents corpus-based analysis of PP disambiguation for a sentence as in (6):

- (6) I saw the man [*PP* with the telescope].

The PP *with the telescope* may either modify the DP *the man* or the VP *saw the man*. The possessor of the telescope is the man in the former and the speaker in the latter.

Likewise, double PP attachment to a noun phrase creates structural ambiguities as well.

- (7) a. a picture of Chomsky in Boston
 b. [*DP* a picture [*PP* of [*DP* Chomsky [*PP* in Boston]]]]
 `a picture of Noam Chomsky who is in Boston (the picture is in the Semantics Lab at Stony Brook University)'
 c. [*DP* [*DP* a picture [*PP* of Chomsky] [*PP* in Boston]]]
 `Chomsky's picture exhibited in Boston (Chomsky himself is elsewhere)'

Similarly to PP attachment, double prenominal possessives are structurally ambiguous. I would like to analyze the following two patterns: prenominal double possessives and prenominal adjective and possessive combination.

Prenominal Double Possessives Double prenominal possessive (genitive) phrases demonstrate structural ambiguities. The first possessive phrase may either modify the noun in the following possessive phrase or the noun that two possessive phrases modify. The possessor of a scarf is *a dog* in (8b) and *Mary* in (8c).

- (8) a. Mary's dog's scarf
 b. [*DP* [*DP* Mary's dog][*D'* [*D* 's][*NP* scarf]]]
 `A scarf of Mary's dog'
 c. [*DP* [*DP* Mary][*D'* [*D* 's][*DP* [*DP* dog] [*D'* [*D* 's][*NP* scarf]]]]]
 `Mary's scarf which is the kind that dogs usually wear'

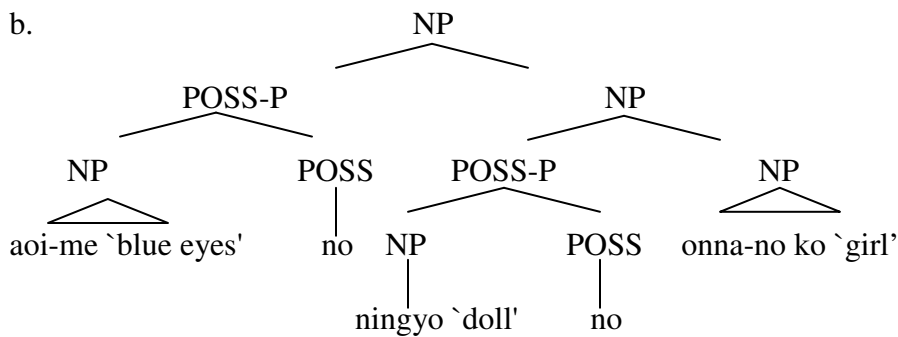
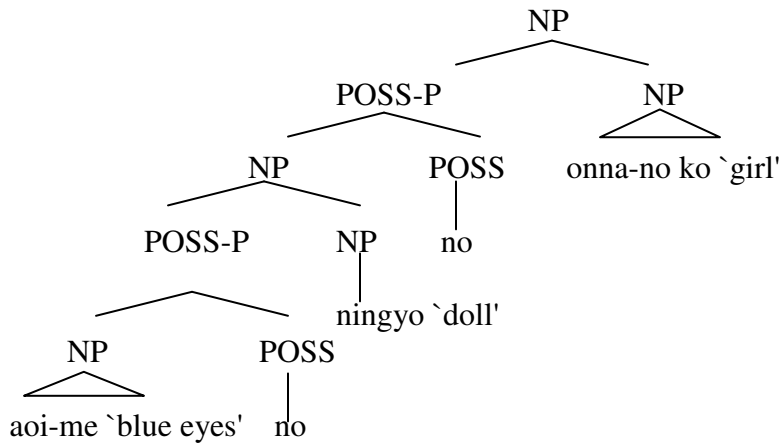
In the Japanese example (9a), the possessor of the blue eyes is a doll in (9b) and a girl in (9c) because *aoi-me-no* `blue eyes' modifies a doll in the former and a girl in the

latter. The second genitive phrase *ningyo-no* 'doll's' is adjectival in (9c), while it is parsed as a possessive phrase in (9b) where the preceding *aoi-me-no* 'blue eyes' modifies only the NP *ningyo* 'doll.'

- (9)a. aoi me-no ningyo-no onna-no ko
 blue eye-GEN doll-GEN female-GEN child
- b. [NP [POSS-P [NP [POSS-P [NP aoi me]-no] [NP ningyo]]-no] [NP onna-no ko]]
 'a girl who has a doll with blue eyes'
- c. [NP [POSS-P aoi me-no] [NP [POSS-P ningyo-no] [NP onna-no ko]]]
 'a girl with blue eyes who carries a doll'

(9a) can be parsed in the following two ways.

(10) a.



Another example (11a) is semantically ambiguous in two ways (11b-c).

- (11) a. Tokyo-no tomodachi-no fuku
 Tokyo-GEN tomodachi-GEN cloth
- b. A cloth of my friend which is kept in Tokyo (the friend is in Osaka and her cloth is in Tokyo)

Taylor 1996, Vikner and Jensen 2002). Japanese genitive marker expresses even wider range of relations between two entities than in English. `NP1-GEN NP2' expresses not only possession as in *John's pen* and part-whole relation as in *John's leg*, but also location, accompaniment, property and quantity. Since the possessive marker denotes more various relations in Japanese, the denotation of the relation R is underspecified.

$$(16) \parallel noll = \lambda x. \lambda y. R(y)(x)$$

(17)

a. possession: $R = \{ \langle x, y \rangle \mid x \text{ owns } y \}$	(18) Tanaka-no kaban Tanaka-GEN bag `Tanaka's bag'
b. part-whole: $R = \{ \langle x, y \rangle \mid y \text{ is part of } x \}$	(19) Tanaka-no te Tanaka-GEN hand `Tanaka's hand'
c. location: $R = \{ \langle x, y \rangle \mid y \text{ is in } x \}$	(20) Tokyo-no tomodachi Tokyo-GEN friend `a friend in Tokyo'
d. accompaniment: $R = \{ \langle x, y \rangle \mid y \text{ carries } x \}$	(21) akai kaban-no hito red bag-GEN person `a person who carries a red bag'
e. property: $R = \{ \langle x, y \rangle \mid x \text{ is dominant characteristic of } y \}$	(22) maho-no kuni magic-GEN country `a magic country' (23) kaban-no Tanaka bag-GEN Tanaka `Bags Tanaka' (a bag shop) (24) supa-no Muramatsu supermarket-GEN Muramatsu `Supermarket Muramatsu'
f. quantity: $R = \{ \langle x, y \rangle \mid \text{the quantity of } y \text{ is } x \}$	(25) 2-satsu-no hon-no nedan 2-cl-GEN book-GEN price `the price of two books' (26) Takusan-no Nihonjin-no tokei many-GEN Japanese-GEN watch `many Japanese watches / the watch that many Japanese wears'

Note the reversal of the possessor argument between (18) and (21)(23). The possessor argument is NP₁ in (18), as in English possessive *Tanaka's bag* whose possessor argument is *Tanaka*. On the contrary, in (21), the possessor of the bag is NP₂ *hito* `person.' In English, *red bag's person* would not mean someone who carries a bag. In (23) *Kaban-no Tanaka* `Bags Tanaka,' *Tanaka* is a shop which sells a bag, therefore, the possessor of a bag.

As shown in (27), some Japanese genitives correspond to English noun compounds such as *magic land* and *2kg computer* rather than to possessives. However,

accompaniment and property readings are unique to Japanese and cannot be expressed by either possessive or compounds in English.

(27)

	Japanese possessive	English possessive	English compound
a. possession	Tanaka-no pen	Tanaka's pen	*Tanaka pen
b. part-whole	Tanaka-no kao	Tanaka's face	*Tanaka face
c. location	Tokyo-no shinseki	*Tokyo's relative	Tokyo relatives
d. accompaniment	boshi-no fujin	*the hat's lady	*the hat lady
e. property	inu-no onna-no ko	*dog's girl	*dog girl (a girl dog)
f. quantity	2-kiro-no pasokon	*2kg's computer	2kg computer

3.2 Problems with Deriving Various Possessive Relations from Possessor Nouns

Possessive relations are ambiguous in both English and Japanese. For example, there are more than one interpretation available for *Tanaka-no hon* 'Tanaka's book.' *Tanaka's book* may refer to the book that Tanaka owns or the book that Tanaka wrote (Barker 1995,87).

Langacker (1993) considers ownership to be the prototypical meaning of the possessive construction, and other relations to be the instantiations.

Partee (1997) analyzes possessive relations in two kinds: a free relation R that is contextually supplied and inherent relations inherited from relational nouns, e.g., *brother*, *employee*, and *enemy*. For example, *brother* is inherently relational whose lexical entry would be: $\lambda x.\lambda y.[\text{father-of}(x)(y)]$. The possessive phrase *John's* in *John's brother* would have the following lexical entry:

(28) Syntax: [John's]_{NP/TCN} (TCN: transitive common noun)

Semantics: $\lambda R.\lambda P.[\exists x[\forall y[R(j)(y) \leftrightarrow y = x] \wedge P(x)]]$

(29) Syntax: [[John's]_{NP/TCN} [brother]_{TCN}]_{NP}

Semantics: $\lambda R.\lambda P.[\exists x[\forall y[R(j)(y) \leftrightarrow y = x] \wedge P(x)]](\lambda s.\lambda t.\text{brother-of}(s)(t))$
 $= \lambda P.[\exists x[\forall y[\text{brother-of}(j)(y) \leftrightarrow y = x] \wedge P(x)]]$

Possessive relation in (18) is prototypical and part-whole relation in (19) can be derived lexically from a possessive nominal *te* 'hand' (Barker 1995). However, other possessee nominals are not relational necessarily. *Tomodachi* 'friend' (20) and *shinseki* 'relative' (27c) are relational, i.e., *friend-of x / relative-of x*, but the relation between NP₁ and NP₂ is not *friend-of* ' or *relative of* ' but of location, namely, NP₂ is in NP₁. As far as we only consider NP₂ and apply (29), there is no way to derive location, accompaniment, property and quantity relations.

Vikner and Jensen (2002) suggests type-raising even non-inherent nouns by creating argument slot taken from the Qualia Structure in Pustejovsky (1995). This method systematically derives unambiguous relations which were considered to be contextually given in Partee (1997). It does predict the relation *x weighs y* in *2kg-no pasokon* '2kg computer' in (27f). Non-inherently relational noun *pasokon* 'personal computer' may type-shift into relational noun in consideration of its constitutive role, i.e.,

a computer has its own weight. Following Vikner and Jensen (2002), Q_C is a type-raising function from a word to a relational noun with an unsaturated argument slot.

- (30) a. $\left[\begin{array}{l} \mathbf{pasokon} \text{ `personal computer'} \\ \text{Argument Structure} = x: \text{electronic device} \\ \text{Qualia Structure} = \left[\begin{array}{l} \text{TELIC: } \lambda x.\lambda y. [\text{use-for-convenience}'(x)(y)] \\ \text{CONST: } \lambda z.\lambda x. [\text{weigh}'(z)(x)] \end{array} \right] \end{array} \right]$
- b. $Q_C(\text{pasokon}) = \lambda z.\lambda x. [\text{weigh}'(z)(x) \wedge \text{computer}'(x)]$

This item-weight relation substitutes free R between NP₁ and NP₂. Any `inherent' telic (purpose), argument, constitutive or formal roles are eligible to create their own argument slots in nouns. Thus, the meaning of *2kg computer* is computable.

However, accompaniment and property relations do not derive from the qualia structure of the possessor noun. *Fujin* `a lady' does not inherently carry a hat, so carrying or wearing is hard to be considered to be part of the qualia structure. The relation between *Tanaka* and its trade is hard to derive without *comparison* with the possessor noun. Therefore, I propose that Japanese possessives need to consider the argument structure of the possessor noun.

3.3 Relation Disambiguation by Possessor Noun: Type-Shifting Possessor into a Relational Noun

In (20)-(26) it is rather possessor nominals than the possessee nominals that carry more information about relations between two arguments. For example, *Tokyo* is a location, *a bag* is something to carry with, and *onna* `woman' and *2-kiro* `2kg' are properties. Even though these nouns are not lexically relational as *brother* is, our world knowledge that Tokyo is a location, a hat is a thing to wear, *female* is a property and *2kg* is weight assigns accompaniment, locative and property interpretations to the possessive construction.

Therefore, we need to consider the argument structures of non-relational possessor nouns and apply the type-shifting operators to the possessor noun in Japanese. As stated earlier, Vikner and Jensen (2002) applies the Qualia Structure (Pustejovsky 1995) of the possessee noun and type-shifts the possessee noun into a relational noun. For example, *John's poem* can receive the interpretation of the poem that John composed by means of the meaning shifting operator Q_A that raises *poem* into a two-place holder (31). Then, the type-shifted NP₂ combines with the possessive NP and the authorship relation is derived.

$$(31) Q_A(\text{poem}) = \lambda x.\lambda y. [\text{poem}'(x) \wedge \text{compose}'(x)(y)]$$

The possessive relations in Japanese are derived from either the Argument Structure or the Qualia Structure of possessor nouns.

$$(32) \left[\begin{array}{l} \mathbf{Tokyo} \\ \text{ARGSTR} = [\text{ARG}_1 = x: \text{location}] \\ \text{QUALIA} = [\text{FORMAL} = x] \end{array} \right]$$

$$(33) \left[\begin{array}{l} \mathbf{boshi} \text{ `hat'} \\ \text{ARGSTR} = [\text{ARG}_1 = \lambda x.\text{accessory}(x)] \\ \text{QUALIA} = \left[\begin{array}{l} \text{FORMAL} = x \\ \text{TELIC} = \text{wear}(x, y) \end{array} \right] \end{array} \right]$$

$$(34) \left[\begin{array}{l} \mathbf{2\ kiro} \text{ `2kg'} \\ \text{ARGSTR} = [\text{ARG}_1 = x: \text{weight}] \end{array} \right]$$

The function A_1 type-shifts Tokyo into a function from its resident into Tokyo (35c). *No* composes with $A_1(\text{Tokyo})$ and forms a determiner which carries a location relation between Tokyo and the relative. As for *boshi-no fujin* 'the lady with a hat (hat's lady),' the telic quale provides a wearer (36). *2kg* is a weight of something so that *2kg* is type-raised into a predicate. *2kg-no* then becomes a definite determiner which picks a unique wearer.

$$(35) \text{ Tokyo-no shinseki `The relative in Tokyo (lit. Tokyo's relative) '}$$

- a. Tokyo: t
- b. $A_1 = \lambda x.\lambda y.\text{in}(x, y)$
- c. $A_1(\text{Tokyo}) = \lambda y.\text{in}(t, y)$
- d. $\text{no}(A_1(\text{Tokyo})) = \lambda P.\lambda Q.\exists!x[[\lambda y.\text{in}(t, y)](x) \wedge P(x) \wedge Q(x)]$
- e. $\text{no}: \lambda R.\lambda P.\lambda Q.\exists!x[R(x) \wedge P(x) \wedge Q(x)]$

$$(36) \text{ a. boshi: } \lambda x.\text{hat}(x)$$

- b. $Q_T(\text{boshi}) = \lambda x.\lambda y.[\text{hat}(x) \wedge \text{wear}(x)(y)]$
- c. $\text{no}(Q_T(\text{boshi})) = \lambda P.\lambda Q.\exists!x,y[\text{hat}(x) \wedge \text{wear}(x)(y) \wedge P(y) \wedge Q(y)]$
- d. $\text{no} = \lambda R.\lambda P.\lambda Q.\exists!x,y[R(x)(y) \wedge P(y) \wedge Q(y)]$

$$(37) \text{ a. 2kg: } x$$

- b. $A_1(2\text{kg}) = \lambda x.[\text{weigh } 2\text{kg}'(x)]$
- c. $\text{no}(A_1(2\text{kg})) = \lambda P.\lambda Q.\exists!x[[\lambda y.\text{weigh } 2\text{kg}'(y)](x) \wedge P(x) \wedge Q(x)]$

Thus, the various relations are inherited from the lexical input of possessor nouns. The argument and qualia structure of possessor nouns makes possessor nouns one or two place predicates.

4. Conclusion

This paper analyzed categorical, structural and semantic ambiguities of prenominal possessives and adjectives. The context free grammar rewrites an adjective into a noun so that structural ambiguities come to exist. The sense disambiguation of Japanese possessives necessitates type raising of the possessor noun according to the argument structure.

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