Qualia-Based Lexical Knowledge for the Disambiguation of the Japanese Postposition *No*

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1 Introduction

This paper proposes the elaboration of the qualia structure of the Generative Lexicon in [5] and the Extended Generative Lexicon theory [3]. My proposal is based on the Japanese genitive postposition *no*. The Japanese "NP_1-no NP_2" construction expresses a wider range of relations between two entities than does the English possessive "NP_1 *'s* NP_2," such that the Pustejovskian qualia roles encoded in NP_2 do not supply the necessary relations between two entities, which [7] succeeded to certain degree. Possessive relation disambiguation requires enriching lexical entries by incorporating the HAVE relation into the CONSTITUTIVE role and listing other qualia such as the ACTIVITY and the SPATIO-TEMPORAL role with the subcategories of LOCATION and TIME.

2 Various Relations and Argument Reversal

The Japanese genitive marker is semantically very ambiguous. 'NP1-GEN NP2' expresses not only possession as in *John's pen* and a part-whole relation as in *John's leg*, but also location, accompaniment, property, quantity, etc., as shown in Table 1.

Relation	Japanese Possessive	English Possessive	English Compound	English PP
I possession	Tanaka-no kaban	Tanaka's bag	*Tanaka bag	a bag of Tanaka
II part-whole	Tanaka-no kao	Tanaka's face	*Tanaka face	the face of Tanaka
III location	Tokyo-no shinseki	*Tokyo's relative	Tokyo relatives	relatives in Tokyo
IV time	3-ji-no koen	*3 o'clock's park	*3 o'clock park	park at 3 o'clock

V accompaniment	kaban-no hito	*bag's man	the bag man	the man with a bag
	boshi-no fujin	*hat's lady	hat lady	the lady with a hat
VI trade	Kaban-no Sanpei	*bags' Sanpei	Bags Sanpei	Sanpei of Bags
VII activity	maaruboro-no kuni	*Marlboro's country	Marlboro country	the country of Marlboro
	biiru-no machi	*the beer's city	*the beer city	the city of beer
VIII property	chisee-no hito	*intelligence's man	*intelligence man	a man of intelligence
	osu-no tora	*male's tiger	a male tiger	a tiger of male kind
	aoi-me-no ningyo	*blue eyes' doll	blue eyes doll	the doll with blue eyes
IX weight	1-kiro-no pasokon	*1 kg's computer	1 kg computer	the computer with 1kg
X quantity	3-bon-no pen	*three's pen	three pens	
XI intensional property	nise-no fukahire	*fake's shark fin	fake shark fin	
	nise-no keisatsukan	*fake's police officer	fake police officer	

Table 1:

Note the reversal of the possessor argument between (I) and (V–VI). The possessor argument is NP_1 in (I), as in English *Tanaka's bag* whose possessor argument is *Tanaka*. On the contrary in (V), the possessor of the bag is NP_2 *hito* "man" and there is no English equivalent *big bag's person*. In (VI) *Kaban-no Sanpei* "Bags Sanpei," *Sanpei* is a bag store, and therefore the possessor of a bag. The controller-controllee relation is also reversed, for example, in *Tanaka-no kuruma* "Tanaka's car" (type I), *Tanaka* is the controller of the car, i.e., NP_2 the car is at *Tanaka*'s disposal as in English *the girl's car* [7]. On the contrary, in *boshi-no fujin* "the lady with a hat," NP_1 *boshi* is at the person's disposal. *Aoi-me-no ningyo* "the doll with blue eyes," literally, "blue eyes' doll" in (VIII) even expresses the part-whole relation in the reverse direction, compared with *ningyo-no me* "the doll's eyes." Such non-canonical relations, i.e., other than those expressing possession or a part-whole relation, are more likely expressed in noun compounds such as *magic land* or prepositional phrases using *of*, *in*, or *with* in English.

3 Problems with Deriving Various Possessive Relations from NP_2

Possessive relations are ambiguous in both English and Japanese. For example, there is more than one interpretation for *Tanaka-no hon* "Tanaka's book." *Tanaka's book* may refer to the book that *Tanaka* owns or the book

that *Tanaka* wrote [1,87]. In view of such ambiguity, [4] assumes two syntactic types for *John's* depending on whether or not the following noun is inherently relational. If the following noun is a non-relational common noun (CN) such as *car*, *John's* composes with *car* which is regular (et) type, and the relation between *John* and *car* is contextually supplied (1a). On the contrary, when *John* is followed by inherently relational nouns such as *brother*, *employee* and *enemy*, which are (e,et) type with an extra argument slot, the relation between *John* and his brother in *John's brother* inherits kinship from the two-place predicate *brother* (1b). (2) exemplifies the computation related to another relational noun, *friend*.

(1) a. Free R type:

Syntax: $[\text{John's}]_{NP/CN}$

Semantics: $\lambda Q \lambda P[NP'(\lambda z[\exists x[\forall y[[Q(y) \wedge R(y)(z)] \leftrightarrow y = x] \wedge P(x)]])]$

b. Inherent relation type:

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

Semantics: $\lambda R \lambda P[NP'(\lambda z[\exists x[\forall y[R(z)(y) \leftrightarrow y = x] \wedge P(x)]])]$

(2) Syntax: $[[\text{John's}]_{NP/TCN}[\text{friend}]_{TCN}]_{NP}$

Semantics: $\lambda R \lambda P[John'(\lambda z.\exists x[\forall y[R(z)(y) \leftrightarrow y = x] \wedge P(x)]](friend-of') = \lambda P[John's(\lambda z.\exists x[\forall y[friend-of'(z)(y) \leftrightarrow y = x] \wedge P(x)]]$

If we apply Partee's theory to Japanese examples, most of the possessive relations are unpredictable, and the contextually supplied relation R remains largely ambiguous. Possession relation (I) is prototypical, and part-whole relation (II) can be derived lexically from a possessive *te* "hand" [1]. However, other possessee nominals are not necessarily relational. In order to reduce the cost of pragmatics, [7] apply the Qualia Structure [5] of the possessee noun and type-shift even non-inherently relational NP_2 into a relational noun. For example, even though *poem* is not a relational noun, *John's poem* can be interpreted as the *poem* that John composed because the internal semantic structure of *poem* contains an author-of relation as AGENTIVE role. The meaning shifting operator Q_A raises a one-place holder *poem* in (3a) into a two-place holder in (3b). The type-shifted NP_2 can now combine with the possessive NP, which has a uniformly type ((e,et),(et,t)) so that the authorship relation is inherited from NP_2 *poem*, and R is no longer a free variable.

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

However, even [7]'s method is not sufficient to systematically compute the meaning of the Japanese 'NP$_1$-no NP$_2$' construction. For example, in terms of location (III), *tomodachi* "friend" and *shinseki* "relative" in *Tokyo-no tomodachi* "a friend in Tokyo" and *Kyoto-no shinseki* "Kyoto relative" are relational nouns, i.e., *friend-of x/relative-of x*, but the relation between NP$_1$ and NP$_2$ is not *friend-of* or *relative of* but of location, namely, NP$_2$ is in NP$_1$. We also encounter a problem with *boshi-no fujin* "the lady with a hat." Since wearing a hat is not part of the qualia roles, that are AGENTIVE (origin), TELIC (purpose), CONSTITUTIVE (part-whole) and FORMAL (isa) roles, of the non-inherently relational noun *fujin* "lady," even Vikner and Jensen's system is unable to supply the binder for R.

4   Enriching the Qualia Structure

In order to reduce the weight of pragmatics, I propose encoding more information into the lexicon elaborating the qualia structure. Specifically, I suggest adding two qualia into the already existing four qualia roles:
    - CONSTITUTIVE = SIZE, WEIGHT, HAVE, COLOR
    - TELIC = TRADE
    - SPATIO-TEMPO = IN, AT
    - ACTIVITY = MAKE_ACT, DRINK_ACT
HAVE, which is a two-place predicate with possessor and possessee arguments, is added to subcategories of the extended CONST quole. LOCATION and TIME are subcategories of the new SPATIO-TEMPO role. These are added to the qualia roles of nominals because all physical objects usually occupy some space and time [6]. In addition to WEIGHT, which is included into the CONST quale in [5], we add SIZE, which is related to dimensionality, and COLOR. TRADE is incorporated into the TELIC role.

SIZE and COLOR are part of the CONST role of clothing artifacts such as *boshi* "hat"; therefore, *aka-no boshi* "the red hat" can be computed compositionally. The TIME, the LOCATION and the HAVE roles of location terms such as *koen* "park" are used to interpret *haru-no koen* meaning "the park in spring," *chicaku-no koen* meaning "a nearby park," and *tsutsuji-no koen* meaning "a park with azaleas," respectively. TRADE role in the TELIC of proper nouns is observed in *Supa-no Maruetsu* "Maruetsu Supermarket" and *Kaban-no Sanpei* "Sanpei for bags." Such expanded qualia roles can substitute R through type-shifting NP$_2$.

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The ϵ operator and the ι operator lower the types of CN into (e). The use of the ϵ operator follows its use for Japanese nouns in [2].

(4) *boshi* "hat": $\epsilon x.hat'(x)$: some x satisfying hat'(x), if there is one

hito "person": $\iota y.person'(y)$: the unique x satisfying person'(x), if there is such a thing

no: $\lambda X.\lambda Y.\iota y.[Y(y) \wedge R - Y(\epsilon x.X(x))(y)]$

boshi-no hito "the hat person": $\iota y.[person'(y) \wedge HAVE(\epsilon x.hat'(x))(y)]$

$$
\begin{bmatrix}
\textbf{hito} \text{ "person"} \\
\text{TYPESTR} = \quad \text{ARG1} = \boxed{x}\text{ human} \\[4pt]
\text{ARGSTR} = \begin{bmatrix} \text{D-ARG1} = \boxed{w}\text{CLOTHING\_ARTIFACT} \\ \text{D-ARG2} = \boxed{z}\text{ACCESSARY} \\ \text{D-ARG3} = \boxed{l}\text{LOCATION} \\ \text{D-E1} = \boxed{e1}\text{STATE} \\ \text{D-E2} = \boxed{e2}\text{STATE} \\ \text{D-E3} = \boxed{e3}\text{STATE} \end{bmatrix} \\[4pt]
\text{QUALIA} = \begin{bmatrix} \text{FORMAL} = \boxed{x} \\ \text{CONSTITUTIVE} = \text{HAVE}(\boxed{e1}, \boxed{x}, \boxed{z}) \\ \text{SPATIO-TEMPO} = \text{AT}(\boxed{e3}, \boxed{x}, \boxed{l}) \end{bmatrix}
\end{bmatrix}
$$

The SPATIO-TEMPO role of nouns enables the interpretations for *Tokyo-no shinseki* "Tokyo relative" and *3-ji no koen* "the park at three o'clock," by supplying location and temporal relations.

$$
\begin{bmatrix}
\textbf{koen "park"} \\
\text{TYPESTR} = \quad \text{ARG1} = \boxed{x}\text{ outdoor's\_location} \\[4pt]
\text{QUALIA} = \begin{bmatrix} \text{CONSTITUTIVE} = \{\text{LAWN, BENCH, FOUNTAIN,...}\}, \text{HAVE}(\boxed{e2}, \boxed{x}, \boxed{y}) \\ \text{TELIC} = \text{RECREATIONAL\_ACTIVITY}(\boxed{e3}, \boxed{w}, \boxed{x}) \\ \text{AGENTIVE} = \text{MAKE\_ACT}(\boxed{e1}, \boxed{z}, \boxed{x}) \\ \text{SPATIO-TEMPO} = \text{IN}(\boxed{e2}, \boxed{x}, \boxed{l}), \text{AT}(\boxed{e2}, \boxed{x}, \boxed{t}) \end{bmatrix}
\end{bmatrix}
$$

The ACTIVITY roles in *Maarumoro-no kuni* "the Marlboro Country," and *biiru-no machi*, or "the city of beer" account for the interpretations.

$$
\begin{bmatrix}
\textbf{machi "town"} \\
\text{TYPESTR} = \quad \begin{bmatrix} \text{ARG1} = \boxed{x}\text{LOCATION} \end{bmatrix} \\[4pt]
\text{ARGSTR} = \begin{bmatrix} \text{D-ARG1} = \boxed{y}\text{HUMAN} \\ \text{D-ARG2} = \boxed{z}\text{OBJECT} \end{bmatrix} \\[4pt]
\text{QUALIA} = \begin{bmatrix} \text{FORMAL} = \text{LIVE}(\boxed{e1}, \boxed{y}, \boxed{x}) \\ \text{SPATIO-TEMPO} = \text{IN}(\boxed{e2}, \boxed{x}, \boxed{l}) \\ \text{ACTIVITY} = \text{DRINK\_ACT}(\boxed{e3}, \boxed{y}, \boxed{z}) \end{bmatrix}
\end{bmatrix}
$$

5   Conclusion

Japanese genitive postpositions cannot be disambiguated in terms of the existing qualia of the possessee nominals. We need to enrich the lexical input by expanding the subcategories of FORMAL and CONSTITUTIVE roles, and by supplementing them with new roles – SPATIO-TEMPO and ACTIVITY. As [7] did not propose any method for restricting the quale to be used for type-shifting, the present analysis does not provide any suggestions for identifying the quale to be used for the interpretation of the possessive noun phrases. However, it provides the enriched lexical entry which enables access to the sense of NP_2 and determines the semantic relation expressed by Japanese genitive postpositions.

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