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The polarity-sensitive intensifier mouth gestures in Japanese Sign Language*

Kazumi Matsuoka and Jon Gajewski
Keio University, University of Connecticut

As we consider the unique linguistic properties of Japanese Sign Language (*Nihon Shuwa*, JSL), it is important to note that cultural gestures of hearing Japanese were adopted into JSL and "grammaticized" to become a part of the language. Polarity-sensitive mouth gestures are discussed as an interesting example of grammaticized gestures in JSL. Matsuoka et al. (2012) reported that "polarity-sensitive" mouth gestures appear in antonym pairs in emphatic contexts. The choice of mouth gestures is determined by the positive/negative polarity of the signed adjectives. We investigated those polarity-sensitive mouth gestures with absolute and relative adjectives (specifically Kennedy and McNally's 2005 "totally closed/totally open adjectives") and argue that those mouth gestures themselves are intensifiers and the choice of the mouth gesture reflects the semantic properties of the adjective it accompanies. In addition, the data of eyebrow raise/furrow are provided to demonstrate that lexical and attitudinal polarity is expressed by different non-manuals.

Areas of interest: Japanese Sign Language, Sign language linguistics, Formal semantics, Polarity, Mouth gestures, Non-manual intensifiers

1. Introduction: What are the mouth gestures?

Japanese Sign Language (JSL, *Nihon Shuwa*) refers to the sign language that deaf children in Japan acquire as their first language, typically in a deaf household or through early exposure to the language. As in many other sign languages in the world, non-manuals, typically expressed by movements of eyes, eyebrows, cheek, mouth, tongue, heads, shoulders, etc., play an important role in the grammar. It has been reported that mouth gestures, a type of non-manual expressions, carry various grammatical or functional roles (Sakata et al. 2008, Matsuoka et al. 2010, 2011, 2012, Kimura 2011, Oka and Akahori 2011). In particular, we provide descriptions and a semantic analysis of the 'polarity-sensitive' mouth gestures, which can be considered as an interesting example of grammaticized gestures in JSL. Before we discuss the polarity-sensitive mouth gestures, which were never formally reported in previous studies, we will introduce other mouth gestures, which were treated as typical examples of mouth gestures with grammatical functions.

The Aspect, Mood, Affect Mouth Gestures, produced with the verb AU 'meet' in (1) below, influence the meaning (or nuance) of the entire sentence, as indicated in the possible translations. (The line indicates a mouth gesture, glossed after the line, overlapped with the manual sign.)[1]

(1) a. pro TOMODACHI AU
—pa
pro friend meet
'(I) met/meet a friend.'

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[1] JSL is a discourse-governed pro-drop language. The grammatical subject or object is frequently dropped in the surface form (as indicated by "pro"), as long as it can be recovered from the discourse. JSL does not have an overt tense marker.

b. pro TOMODACHI AU$^{\text{pi}}$
friend meet
'(I) met a friend (which ended up with an unhappy outcome).'

c. pro TOMODACHI AU$^{\text{mm}}$
friend meet
'(I) met a friend (as scheduled).' (Matsuoka, et al. 2012)

Figure 1. Aspect/mood/affect mouth gestures *pa*, *pi*, and *mm*

The functions of those mouth gestures belong to different linguistic categories and hence need to be analyzed separately. For instance, *pa* (perfective) is a type of Aspect marker, *po* (interrogative) is a Mood marker, and the mouth gestures *pi*, *pu*, *pe*, and *m* provide information about the attitude of the signer (Affect).

It is important to note that the mouth gestures introduced so far are not required. Aspectual/affective effects of those mouth gestures can also be achieved by using manual signs or other non-manuals. For example, the sign OWARU 'finish', when attached to the predicate, functions as the perfective aspect marker.

(2) pro PAN TABERU OWARU
bread eat finish
'(I) have eaten the bread.'

However, the mouth gestures to be reported in the following section demonstrate a very different nature. We classified those mouth gestures as "Polarity-sensitive".

The goal of this paper is to correctly characterize the basic properties of the Polarity-sensitive mouth gestures. Contrary to the analysis in Matsuoka et al. (2012), we argue that the Polarity-sensitive mouth gestures themselves are intensifiers. In Section 2, we will discuss previous analysis of polarity-sensitive mouth gestures. Our analysis with additional data will be presented in Section 3, with a brief presentation of the semantic background relevant to the discussion. We will demonstrate, in Section 4, that the speaker's evaluation of the quality (cheap is good vs. cheap is bad) does not affect the mouth gestures used, by showing that the attitudinal polarity is expressed with different non-manual expressions (i.e. eyebrow raise and furrow). Section 5 is the conclusion.

2. Polarity-sensitive mouth gestures: Previous analysis

In addition to the mouth gestures introduced above, Matsuoka et al. (2012) reported another type of mouth gesture, *(h)o* and *(h)ee/ii*, commonly used among native signers of JSL. Predominantly in an

emphatic context, the mouth gesture *(h)o* appears with adjectives with positive polarity, while *(h)ee/ii* is chosen for those with negative polarity. Typical examples are shown in (3) and (4) below (more example photos are provided in the Appendix 2):

(3) FUKU TAKAI
__(h)o/*(h)ee/*ii
clothes expensive
'(The) clothes are awfully expensive.'

(4) FUKU YASUI
__*(h)o/(h)ee/ii
clothes inexpensive
'(The) clothes are awfully inexpensive.'

Figure 2. Polarity-sensitive mouth gestures *ho* and *hee*[2]

A list of antonym pairs which co-occur with the polarity mouth gestures is presented in the following table.[3]

Table 1. Relative standard adjective (totally open adjectives) antonym pairs

MG *(h)o* **Positive polarity**		**MG *(h)ee/ii*** **Negative polarity**	
TAKAI	'expensive'	YASUI	'inexpensive'
OOKII	'large'	CHIISAI	'small'
JOZUNA	'be good at'	HETANA	'be bad at'
SEGATAKAI	'tall'	SEGAHIKUI	'short'
URESHII	'happy'	KANASHII	'sad'
NONKINA	'easygoing'	KIMAJIMENA	'serious'

[2] We will discuss eyebrow movements in Section 4.

[3] This list is a subset of the list of the antonym pairs provided in Matsuoka et al. (2012). We included the pairs for which the polarity-sensitive alternations were confirmed with at least three informants of ours recruited for this study.

It was of particular interest of Matsuoka, et al. (2012) that those polarity-sensitive mouth gestures occur only in emphatic contexts. Focusing on the interaction of the polarity and emphasis, they pointed out the possibility that the verum focus operator (Höhle 1992, Romero and Han 2004, etc.) is associated with the instantiation of the mouth gestures. In (5), because of the presence of the emphatic stress (which the verum operator is associated with) on the verb *study*, the implicature arises that the speaker B believed or expected that Tom had not studied for the class.

(5) A: Tom got an A in Ling106.
B: Did he STUDY for that class? (Romero and Han 2004)

The example (5) exemplifies a close connection between the emphasis and polarity: the emphatic stress in B's utterance activates the negative proposition ('Tom did not study for Ling 106') even though no negative expression is included in the sentence. As reported in the previous study, the emphatic context and the polarity-sensitive pattern of alternation seem to be closely linked in the data of the JSL mouth gestures.

As Matsuoka et al. (2012) noted, however, the verum focus operator is considered to be relating a pair of propositions with the positive and negative polarity. Even though the possible association between polarity and emphasis at the lexical, in addition to the propositional-level might be a possible extension of the analysis, it is not an empirically well-motivated option. For example, it is not clear the mouth gestures which co-occur with lexical antonyms such as EXPENSIVE-INEXPENSIVE are comparable to the phenomenon caused by the interaction of polarity question and the verum operator, such as 'Tom studies for the exam' vs. 'Tom did not study for the exam'.[4] In fact, negating the English adjective *expensive* does not necessarily imply that the item in question is 'inexpensive', i.e., it could be moderately priced. Thus, the meanings of gradable antonyms are the extremes of a continuum and negating one end (expensive) does not necessarily mean that the other end (inexpensive) holds.

In the following section, we will present an additional set of data (non-gradable antonym pairs) of JSL. We argue that mouth gestures themselves are intensifiers and the choice of the mouth gesture reflects the semantic properties of the adjective it accompanies.

3. Gradability and intensifier mouth gestures

We interviewed five native/early signers of JSL, in their 30's-40's, born and raised in various regions of the country, with 94 sets of adjectival antonyms (47 pairs, bare and combined with negation). The adjectival antonym pair list was created based on English examples in Kennedy and McNally (2005). See Appendix 1 for the complete list, with the discussion of comparing seemingly related words from different languages. Our informants consist of six native signers (deaf children of deaf parents) and one early signer (exposed to JSL at a deaf preschool). Five out of the seven informants confirmed the basic patterns reported by Matsuoka et al.

In the course of this data collection, an additional discovery was made. The systematic use of mouth gestures to mark adjective polarity is not consistent across antonym pairs. One class of antonyms permits the use of these mouth gestures and the other does not. A precise description of the two classes will be given in the next section, once we have introduced a few notions from the formal semantics of adjectives that will aid the discussion. These formal notions will also enable us to formulate an explicit analysis of the conditions that select for the insertion of *(h)o* vs. *(h)ee/ii*. Thus, in the next subsection, the formal semantic background necessary for these tasks will be given, including discussion of gradability, the positive form of adjectives and antonymy (i.e., polar opposition in adjective pairs).

[4] We appreciate a JJL reviewer for clarifying the issue here.

3.1. Semantic background

In our study, following the work of Kennedy and McNally (2005), we investigated the use of polarity-sensitive mouth gesture with adjectives that differ from each other in the structure of their scales. The defining characteristic of a gradable adjective is that it is associated with a scale that is used to rank the individuals in the domain of adjectives along a given dimension. Formally, a scale is a set of abstract ordered points. The semantic function of an adjective is to relate individuals to points on these scales. The scales of different adjectives have different ordering properties. These ordering differences have consequences for the semantic properties of adjectives.

Kennedy and McNally specifically argue for the linguistic significance of scales having endpoints. Endpoints to scales can be detected with degree modifiers such as *completely, totally,* and *100%.* Only adjectives with scalar endpoints are compatible with such modifiers. The English equivalents of the adjectives given in Table 1, which combine productively with *(h)*o and *(h)ee/ii*, do not easily accept these kinds of modifiers.

(6) *totally large/small, *completely tall/short, *100% good/bad at

There are many other adjectives, however, that are compatible with such modifiers. Consider the list given below.

(7) 100% full/empty, completely awake/asleep, totally visible/invisible

Kennedy and McNally argue that the two adjectives of an antonym pair make use of the same scale. This assumption is necessary to explain the tautological nature of sentences such as (8).

(8) Bill is taller than Sue if and only if Sue is shorter than Bill.

So, they reason that if both members of an antonym pair accept modification by *completely, totally* or *100%,* as in (7) above, then the scale associated with that pair of antonyms is closed on both ends, or "totally closed". Similarly, if neither of a pair of antonyms is compatible with *completely, totally* or *100%,* as in (6) above, the then scale associated with that antonym pair is open on both ends, or "totally open". In our investigations, we discovered that the polarity-sensitive patterns of the mouth gestures of *(h)o/(h)ee/ii* occur systematically only with adjective that have a totally open scale and disappear with non-gradable antonyms and antonyms that share a totally closed scale.[5,6]

[5] Recently the notion of gradability has undergone some revision. One common diagnostic for gradability is the ability to combine with expressions like *very, quite* and *much,* cf. Klein (1980). None of the adjectives in Table 2 allow such modification. It has been observed, however, that these adjectives combine with other proportional degree modifiers like *half, 100%* and *completely*: *half dead, completely empty, 100% visible.* This has suggested the reanalysis of some stereotypically non-gradable adjectives such as *dead* as gradable adjectives with totally closed scales.

[6] We also investigated adjectives with scales closed on one end (see Appendix 1 for the complete list of the adjectives). The results were unclear and we will not make any particular claims about these cases.

Table 2. Absolute standard adjective (totally closed adjectives) antonym pairs

(h)o/(h)ee/ii/pa/aa/po/no		**MG**	
Positive polarity		**Negative polarity**	
IPPAINO	'full'	KARANO	'empty'
IKITEIRU	'alive'	SHINDEIRU	'dead'
OKITEIRU	'awake'	NETEIRU	'asleep'
UGOITEIRU	'working'	KOWARETEIRU	'broken'
MIERU	'visible'	MIENAI	'invisible'

Based on the observations above, we will propose that the mouth gestures *(h)o/(h)ee/ii* are intensifying degree adverbials, similar in meaning to *very* or *so* in English. Since they are intensifiers, it is natural that they show up in an emphatic (high-degree) context. This intensifier analysis accounts for the incompatibility of these mouth gestures with adjectives that do not have totally open scales. Intensifiers like *very* can only be combined with relative adjectives, those whose scales are totally open. Observe the oddness of combining *very* with totally closed adjectives, as in *#very dead* and *#very asleep*.

Furthermore, we suggest that the form of the mouth gesture *(h)o/(h)ee/ii* is sensitive to the lexical polarity of the adjective that it combines with. Heim (2006) and Büring (2007) present a variety of arguments in favor of the explicit representation of some form of negation within the marked, negative member of an antonym pair. Heim (2006) dubs this antonym internal negation LITTLE. Let's see how this works in detail. We follow Heim (2006) and others in assuming that gradable adjectives denote relations between degrees (points on a scale) and individuals. For example, *tall* would receive the interpretation below.

(9) $[\![\text{tall}]\!] = \lambda d.\lambda x.\ \text{HEIGHT}(x) \geq d$

This is a relation that holds between a degree d and an individual x just in case x's height is greater than or equal to d. Hence, this relation relates an individual x to his/her height and every degree below it on the scale. For example, if Yoshi is 195cm tall, then $[\![\text{tall}]\!]$(195 cm)(Yoshi)=1,[7] but $[\![\text{tall}]\!]$(n cm)(Yoshi) is also 1 for all *n* below 195. The attentive reader will have noticed that such a relational meaning predicts that *tall* cannot combine directly with an individual-denoting expression. How then to analyze simple predicative sentences like the following?

(10) Yoshi is tall.

The usual response to this problem (cf. von Stechow 1984) is to assume a covert positive morpheme that combines with the adjective before it combines with the subject. We model our version of the positive morpheme POS on von Stechow's (2005).

(11) $[\![\text{POS}_{N,S}]\!] = \lambda F_{<d,<e,t>>}.\lambda x.\ N(S) \subseteq \{d: F(d)(x)=1\}$

According to von Stechow, the positive morpheme is interpreted relative to two contextual parameters, N and S. S is the contextually relevant portion of the scale associated with the adjective POS applies to and N(S) is the neutral zone of S – also known as the zone of indifference. This function denoted by POS then

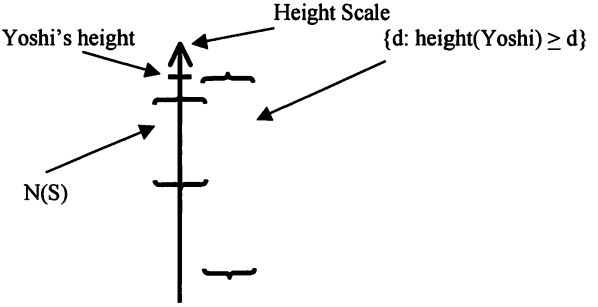
[7] Within the semantics that we are assuming, an output of 1 stands in for truth.

takes a gradable adjective F as an argument and gives back a predicate of individuals that is true of an individual x if and only if the set of x's degrees of F-ness is a superset of the contextually determined neutral zone of the scale associated with F. Typically, N(S) denotes the zone of the scale in between the ranges at the poles carved out by the antonyms. Hence, the logical from for the sentence above is:

(12) Yoshi [$\text{POS}_{\text{N,S}}$ tall]
$\text{N(S)} \subseteq \{\text{d: HEIGHT(Yoshi)} \geq \text{d}\}$

The figure below represents a situation in which it is true that Yoshi is tall.

(13)



Now we turn to the logical form of sentences involving the negative member of an antonym pair. Building on Heim (2006), Büring (2007) proposes that the antonym-internal negation LITTLE has the meaning given below.[8]

(14) $[\![\text{LITTLE}]\!] = \lambda F_{<d,<e,t>>}.\lambda d.\lambda x.F(d)(x) = 0$

This function takes a set of degrees as input and returns its complement set. For example, LITTLE would apply to the set of degrees at or below Yoshi's height and return the set of degrees above Yoshi's height. Büring assumes that this morpheme combines directly with the adjective below degree modifiers like POS. We make the inference that LITTLE sits in a Polarity head within the extended projection of A.

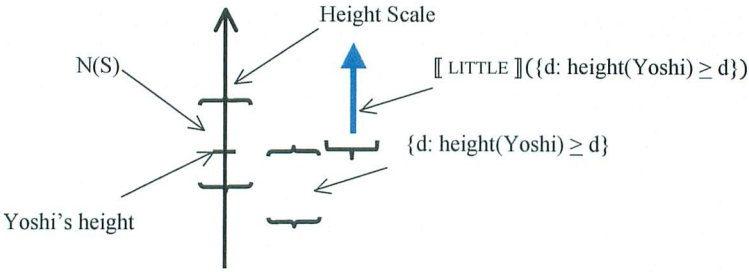
(15) Yoshi is short
Yoshi [$\text{POS}_{\text{N,S}}$ [LITTLE [tall]]]
$\text{N(S)} \subseteq \{\text{d: HEIGHT(Yoshi)} < \text{d}\}$

As we argued above, it is necessary to assume that *tall* and *short* make use of the same scale in order to account for the inference in (8). Since antonyms share scales, they will also share the neutral zone. This means that an individual cannot be considered both tall and short without a shift in context.

The figure in (16) below represents a situation in which it is true that Yoshi is short.

[8] In fact, for reasons that are irrelevant to present concerns, Büring's lexical entry for LITTLE is of type <<d,t>,<d,t>>. We have chosen this modified type to simplify the composition for expository purposes.

(16)



As is standard, we claim that *very* occupies the same position as POS does within the extended projection of A. Indeed, it serves much the same function as POS. The main difference is that the interval contributed by *very* is larger than that contributed by POS, see (17), for a similar analysis see Heim (2006). In particular, we claim that *very* is interpreted relative to a contextually determined zone of a scale E(S), where E stands for extremities. We assume that the relationship between the neutral zone and the extreme zone in (18) holds across all contexts.[9]

(17) $[\![\text{very}_{E,S}]\!] = \lambda F.\lambda x.\ E(S) \subseteq \{d: F(d)(x)=1\}$

(18) In any context, for any scale S: $N(S) \subset E(S)$

Given this, we propose that the structure of simple intensified antonym pairs are as given below.

(19) a. Yoshi is very tall. Yoshi [very tall]
b. Yoshi is very short. Yoshi [very [LITTLE [TALL]]]

3.2. Our analysis

With this semantic background in mind, we can now precisely state our hypotheses about the distribution and interpretation of the polarity-sensitive mouth gestures *(h)o/(h)ee/ii* in JSL. First, we propose that *(h)o* and *(h)ee/ii* both have the semantics of *very*. This restricts their distribution to modifying adjectives with the correct scale structure, 'totally open' as discussed in the last section. Below we use 'VERY' to indicate a morpheme of JSL that is sometimes realized as *(h)o* and sometimes as *(h)ee/ii*.

(3) FUKU TAKAI
clothes expensive
'(The) clothes are awfully expensive.'
(3') Logical form: [(the) clothes [VERY [expensive]]]

(4) FUKU *(h)o/(h)ee/ii YASUI
clothes inexpensive
'(The) clothes are awfully inexpensive.'
(4') Logical form: [(the) clothes [VERY [LITTLE [expensive]]]

[9] In fact, to guarantee that E(S) yields extreme values for both antonyms, we might want a stronger statement:
glb(E(S)) < glb(N(S)) and lub(E(S)) > lub(N(S)) [glb = greatest lower bound; lub = least upper bound]

Within this class of adjectives, *(h)ee/ii* is used if and only if the antonym negation LITTLE appears in the polarity head of the adjective phrase that VERY is modifying. So, the morpheme LITTLE has two morphological effects. First, it conditions root suppletion of the adjective to its antonym form, for example, changing the sign TAKAI 'expensive' to YASUI 'inexpensive', or OOKII 'large' to CHIISAI 'small'. Second, it licenses the occurrence of the negative intensifier *(h)ee/ii* and blocks the occurrence of the positive intensifier *(h)o*. There are two possible analyses that could account for this distribution. The first is that LITTLE triggers root suppletion for the intensifier just as it does for the verb root.

(20) ____ LITTLE / VERY → *(h)ee/ii*

If the grammar contained such a rule, only *(h)o* would occur with positive antonyms and only *(h)ee/ii* would occur with negative antonyms, as observed.

The second possible analysis is that *(h)o/(h)ee/ii* are both polarity-sensitive: *(h)o* requiring positive polarity and *(h)ee/ii* requiring negative polarity. Notice that it is not unusual for degree adverbials to show sensitivity to polarity. In English, *all that* is a degree adverb that requires the presence of negation, while *a little* requires a positive environment, as shown in below:

(21)a. It is not all that expensive.
b. #It is all that expensive.
(22)a. It is a little expensive.
b. #It is not a little expensive.

One important difference between these examples and the JSL examples is that in English the negation takes wide scope with respect to the sensitive degree adverbs. In JSL, the negation LITTLE takes narrow scope with respect to VERY. Interestingly, it has recently been argued that some languages, including Japanese and Korean, have NPIs that must take wide scope with respect to negation, cf. Sells (2006) and Shimoyama (2011). At this point, we will not attempt to decide between these two hypotheses.

4. Lexical and attitudinal polarities

As described in Section 3, the Polarity-sensitive mouth gesture is sensitive to the lexical polarity of the adjective it overlaps with. In the example (3), repeated below, the mouth gesture *(h)ee/ii* appears with the adjective of negative polarity (YASUI 'inexpensive'):

(3) FUKU TAKAI
___(h)o/*(h)ee/*ii
clothes expensive
'(The) clothes are awfully expensive.'

The term "polarity" can be associated with different dimension; it could be propositional (i.e. affirmative/negative), lexical (i.e., positive/negative), or more affective (i.e., positive/negative feelings of the speaker). Interestingly, JSL data can provide insight into different domains of polarity. As briefly reported in previous studies (Matsuoka et al. 2011, 2012), the polarity-sensitive mouth gestures can be combined with either raised eyebrows or furrowed eyebrows. The former combination yields the connotation that the signer has a positive attitude about the content s/he is communicating, while the later indicates the opposite (negative) attitude of the signer.

In examples (23) and (24), below, the different attitude of the signer is indicated in the parenthesized part of the English translation. (*ebr* refers to the eyebrow raise, and *ebf* refers to eyebrow furrow.)

(23)
_____ebr
_____(h)ee/ii
FUKU YASUI
clothes inexpensive
'(The) clothes were awfully inexpensive (and it was a good deal.)'

(24)
____ebf
____(h)ee/ii
FUKU *YASUI*
clothes inexpensive
'The clothes were inexpensive (and it was junk.)

Figure 3. Eyebrow raise and furrow, combined with the mouth gesture *hee*

The non-manual contrast discussed here is different from the polarity-sensitive pattern reported in the previous sections. The negative-polarity mouth gesture *(h)ee/ii* is observed in both examples above. Readers can compare the mouth gestures above to the lexically positive mouth gesture *(h)o*, repeated below.

Figure 4. the mouth gesture *ho*

In those examples, different non-manuals are responsible for different types of polarity: the mouth gesture reflects linguistic polarity (a part of the lexical information of the adjective), while the eyebrow movement conveys the positive or negative attitude of the signer.

Distinguishing those two types of polarity and their effect on linguistic expressions have been proposed in the analysis of morphemic choice in Swedish. Saury (1984) conducted a corpus analysis of spoken Swedish to find that two derivational morphemes of the same meaning systematically alternate according to the attitude of the speaker. Based on that observation, he argued that there are two different types/levels of polarity: cognitive and attitudinal.

For example, the noun *skuld* 'debt' can be followed by a derivational suffix *–fri* or *–lös*, which derives two words of the same meaning, 'without debt'. The choice of the two morphemes, though, is determined by the context, as shown in the following:

(25)a. skuld-fri
Typical context: You are free when you pay off the debt.

b. skuld-lös
Typical context: No one can live without debt in this society.

The morpheme *–fri* is selected when *skuld* is meant (by the speaker) to be something negative (i.e., a debt one does not want to have). On the other hand, the other morpheme *–lös* is used when *skuld* refers to something desirable (a debt, i.e., kindness or consideration that one receives from people around her/him). The positive/negative polarity discussed here is not a part of the lexical information of the noun *skuld*. Rather, the "polarity" is a reflection of the attitude of the speaker.

The JSL examples in (23) and (24) clearly show that the two types of polarity in Saury's analysis are expressed with different non-manuals. The linguistic/cognitive polarity appears in the form of the mouth gesture, and the attitudinal polarity is indicated by the form of eyebrow movements. Our data provide empirical support for the distinction of cognitive/attitudinal polarity discussed in Saury (1984). It is also interesting to consider how non-manual items in a sign language divide the labor of expressing different types of semantic/pragmatic information.

5. Conclusion

Non-manual expressions in sign languages have a dual nature and hence are a challenge for linguistic analysis: while they can be used as affective/emotional gestures (equivalents of the facial expressions used by hearing people), they sometimes appear as an instantiation of abstract grammatical properties that the sign language contains. In this paper, we presented evidence of the existence of the non-manual expressions that interact with the semantic properties of lexical items expressed manually. Our data show that the polarity-sensitive mouth gestures are directly associated with gradability and polarity of the adjective that they modify, and argue that they have grammatical functions as intensifiers.

It is possible that the mouth gestures reported in this study were originally adopted from cultural verbal gestures of hearing Japanese. There are commonly used interjections *hee* or *hoo*, which are typically used when the speaker feels very impressed or surprised. It is interesting to observe that the mouth gestures were grammaticalized after the adaptation to acquire the polarity-sensitive property (which is not observed in the usage of the interjections in spoken Japanese). This process of grammaticalization strongly indicates that JSL is a natural language with its own grammar, not just a manual translation from spoken Japanese.

Appendix 1: Antonym pairs used

The following lists of adjectival antonyms were created based on English examples in Kennedy and McNally (2005). Our informants' judgments indicate that not all the pairs in the "OPEN-OPEN" list are treated in the same way, in terms of the appearance of the polarity-sensitive mouth gestures. It is important, however, to note that the words were translated from English to written Japanese, and then to JSL; words that "seem to mean the same" are not necessarily the "equivalents", or precise translations of the same lexical items. For our analysis, we made short lists the pairs (presented in the main text) with the words to which the three informants provided us with the consistent alternating pattern in terms of the polarity-sensitive mouth gestures. All JSL signs are expressed as one unit ("monosyllabic"), even when their Japanese gloss seems to be multi-syllabic (e.g. YARUKI-GA-ARU 'eager'). The asterisk following some of the signed expression indicates the items included in Table 1 in the text (see footnote 3 for more information).

OPEN-OPEN

1	TAKAI*	expensive	YASUI*	inexpensive
2	OOKII*	large	CHIISAI*	small
3	YOI	good	WARUI	bad
4	FUKAI	deep	ASAI	shallow
5	JOZUNA*	be good at	HETANA*	be bad at
6	NAGAI	long	MIJIKAI	short
7	TOSHIOTOTTEIRU	old	WAKAI	young
8	AKARUI	blight	KURAI	dark
9	SEGATAKAI*	tall	SEGAHIKUI*	short
10	HAYAI	fast/early	OSOI	slow/late
11	OMOI	heavy	KARUI	light
12	OOI	in large quantity	SUKUNAI	in small quantity
13	REBERUGATAKAI	higher in quality	REBERUGAHIKUI	lower in quality
14	YARUKIGAARU	eager	YARUKIGANAI	uneager
15	KANTAN	easy	MUZUKASHII	tough
16	URESHII*	happy	KANASHII*	sad
17	TSUYOI	strong	YOWAI	weak
18	NONKINA*	easygoing	KIMAJIMENA*	serious
19	HAKKIRI	clear	BONYARI	unclear
20	GENKIGAARU	energetic	GENKIGANAI	lethargic
21	FUTOTTEIRU	fat	YASETEIRU	thin
22	TOOI	far	CHIKAI	near
23	KIBISHII	strict	YASASHII	kind
24	OOMAKANA	general	KOMAKAI	detailed

25	KAKUBATTA	cornered	MARUMIGAARU	round
26	SUZUSHII	cool	ATSUI	hot
27	ATATAKAI	warm	SAMUI	cold
28	ATSUI	hot	SAMUI	cold

OPEN-CLOSED

29	MAGATTA	bent	MASSUGU	straight
30	URUSAI	loud	SHIZUKANA	quiet
31	YUMEINA	famous	MUMEI-NO	unknown

CLOSED-OPEN

32	KAKUSHINGANAI	certain	KAKUSHINGANAI	uncertain
33	SUMIKITTA	pure	NIGOTTE-IRU	impure
34	ANZENNA	safe	KIKENNA	dangerous
35	KIREINA	clean	KITANAI	dirty
36	KAWAITE-IRU	dry	NURETE-IRU	wet
37	TOMEINA	transparent	NIGOTTA	opaque

CLOSED-CLOSED

38	IPPAINO	full	KARANO	empty
39	(MISE-GA) AITEIRU	open (store)	(MISE-GA) SHIMATTEIRU	closed (store)
40	IKITEIRU	alive	SHINDEIRU	dead
41	OKITEIRU	awake	NETEIRU	asleep
42	TADASHII	right	AYAMATTA	wrong
43	UGOITEIRU	working	KOWARETEIRU	broken
44	(MADO-GA) AITEIRU	open (window)	(MADO-GA) SHIMATTEIRU	closed (window)
45	MIERU	visible	MIENAI	invisible
46	KEKKONSHITEIRU	married	DOKUSHIN	single
47	KANZENNA	complete	FUKANZENNA	incomplete

OPEN-OPEN (Negation)

48	TAKAI/NAI	not expensive	YASUI/NAI	not inexpensive
49	OOKII/NAI	not large	CHIISAI/NAI	not small
50	YOI/NAI	not good	WARUI/NAI	not bad

51	FUKAI/NAI	not deep	ASAI/NAI	not shallow
52	JOZUNA/NAI	Be not good at	HETANA/NAI	Be not bad at
53	NAGAI/NAI	not long	MIJIKAI/NAI	not short
54	TOSHIOTOTTEIRU/NAI	not old	WAKAI/NAI	not young
55	AKARUI/NAI	not blight	KURAI/NAI	not dark
56	SE-GA-TAKAI/NAI	not tall	SE-GA-HIKUI/NAI	not short
57	HAYAI/NAI	not fast/early	OSOI/NAI	not slow/late
58	OMOI/NAI	not heavy	KARUI/NAI	not light
59	OOI/NAI	not in large quantity	SUKUNAI/NAI	not in small quantity
60	REBERUGATAKAI/NAI	not higher in quality	REBERUGAHIKUI/NAI	not lower in quality
61	YARUKIGAARU/NAI	not eager	YARUKIGANAI/NAI	not uneager
62	KANTAN/NAI	not easy	MUZUKASHII/NAI	not tough
63	URESHII/NAI	not happy	KANASHII/NAI	not sad
64	TSUYOI/NAI	not strong	YOWAI/NAI	not weak
65	NONKINA/NAI	not easygoing	KIMAJIMENA/NAI	not serious
66	HAKKIRI/NAI	not clear	BONYARI/NAI	not unclear
67	GENKIGAARU/NAI	not energetic	GENKIGANAI/NAI	not lethargic
68	FUTOTTEIRU/NAI	not fat	YASETEIRU/NAI	not thin
69	TOOI/NAI	not far	CHIKAI/NAI	not near
70	KIBISHII/NAI	not strict	YASASHII/NAI	not kind
71	OOMAKANA/NAI	not general	KIMAJIMENA/NAI	not detailed
72	KAKUBATTA/NAI	not cornered	MARUMIGAARU/NAI	not round
73	SUZUSHII/NAI	not cool	ATSUI/NAI	not hot
74	ATATAKAI/NAI	not warm	SAMUI/NAI	not cold
75	ATSUI/NAI	not hot	SAMUI/NAI	not cold

OPEN-CLOSED (Negation)

76	MAGATTA/NAI	not bent	MASSUGU/NAI	not straight
77	URUSAI/NAI	not loud	SHIZUKANA/NAI	not quiet
78	YUMEINA/NAI	not famous	MUMEI-NO/NAI	not unknown

CLOSED-OPEN (Negation)

79	KAKUSHINGANAI/NAI	not certain	KAKUSHINGANAI/NAI	not uncertain
80	SUMIKITTA/NAI	not pure	NIGOTTEIRU/NAI	not impure
81	ANZENNA/NAI	not safe	KIKENNA/NAI	not dangerous
82	KIREINA/NAI	not clean	KITANAI/NAI	not dirty
83	KAWAITEIRU/NAI	not dry	NURETEIRU/NAI	not wet
84	TOMEINA/NAI	not transparent	NIGOTTA/NAI	not opaque

CLOSED-CLOSED (Negation)

85	IPPAINO/NAI	not full	KARANO/NAI	not empty
86	(MISE-GA) AITEIRU/NAI	not open	(MISE-GA) SHIMATTEIRU/NAI	not closed
87	IKITEIRU/NAI	not alive	SHINDEIRU/NAI	not dead
88	OKITEIRU/NAI	not awake	NETEIRU/NAI	not asleep
89	TADASHII/NAI	not right	AYAMATTA/NAI	not wrong
90	UGOITEIRU/NAI	not working	KOWARETEIRU/NAI	not broken
91	(MADO-GA) AITEIRU/NAI	not open (door)	(MADO-GA) SHIMATTEIRU/NAI	not closed (door)
92	MIERU/NAI	not visible	MIENAI/NAI	not invisible
93	KEKKONSHITEIRU/NAI	not married	DOKUSHIN/NAI	not single
94	KANZENNA/NAI	not complete	FUKANZENNA/NAI	not incomplete

Appendix 2: Examples of Mouth Gestures

A. Relative adjective (totally open adjectives) antonym pairs (cf. Table 1)

OOKII 'Large' – CHIISAI 'small'

JOOZUNA 'be good at' – HETANA 'be bad at'

SEGATAKAI 'tall' – SEGAHIKUI 'short'

URESHII 'happy' – KANASHII 'sad'

NONKINA 'easygoing' – KIMAJIMENA 'serious'

B. **Absolute adjective (totally closed adjectives) antonym pairs (cf. Table 2)**

IPPAINO 'full' – KARANO 'empty'

IKITEIRU 'alive' – SHINDEIRU 'dead'

OKITEIRU 'awake' – NETEIRU 'asleep'

UGOITEIRU 'working' – KOWARETEIRU 'broken'

MIERU 'visible' – MIENAI 'invisible

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Kazumi Matsuoka
Keio University
Japan
matsuoka@z7.keio.jp

Jon Gajewski
University of Connecticut
U.S.A.
jon.gajewski@uconn.edu