# The Annotation of Antonym Information in the 'Word List by Semantic Principles'

**Sachi Kato**
Mejiro University

**Masayuki Asahara**
NINJAL, Japan
masayu-a@ninjal.ac.jp

**Nanami Moriyama**
NINJAL, Japan

**Asami Ogiwara**
NINJAL, Japan

**Makoto Yamazaki**
NINJAL, Japan

## Abstract

This article presents an antonym database construction based on the Word List by Semantic Principles. Antonym word pair candidates were extracted, after which we performed a cognitive experiment to rate the antonyms according to crowdsourcing. We then annotated the types of antonyms. The statistics based on the rates and types of antonyms indicated that closed antonyms tend to be considered 'antonyms' rather than open antonyms.

## 1 Introduction

This article presents an antonym database construction based on the 'Word List by Semantic Principles' (WLSP) (Kokuritsu‿ Kokugo‿ Kenkyusho, 2004). The National Institute for Japanese Language and Linguistics (NINJAL) has been developing language resources based on the WLSP, which comprises a collection of words that are classified and arranged by their meanings. The first version of the WLSP was published in 1964, and the revised and enhanced version was published in 2004. The database version of the WLSP was constructed by incorporating the contents of the revised and enlarged edition of the WLSP book. It was created in the CSV file format, and the total number of records was 101,070. The data can be accessed via the Internet[1].

Table 1 outlines the structure of the WLSP, and the words in the WLSP are assigned five digits that compose the article number. Further, the entries in the 'Paragraph number etc.' column include three hyphenated numbers: paragraph numbers, small paragraph number, and word number. These numbers indicate the hierarchical clusters of words.

The article numbers indicate the syntactic category of 'class' and the several hierarchical semantic levels of 'division', 'section' and 'article'. The categories are indicated with a one-integer digit to the left of a radix point and four fractional digits to the right of the radix point. An example is the word ホステス ('hostess'), which is assigned a value of 1.2220. Here, the first digit '1' designates the syntactic part, which is termed the 'Nominal Word', while '2220' designates the hierarchical semantic parts. The first digit '.2' denotes the top-level semantic category of 'Subject'; the two digits '.22' denote the second-level semantic category of 'Companion'; and the four digits '.2220' denote the finest-grained semantic category of 'Host and Guest'. These five digits are thus referred to as the 'WLSP number'. The syntactic categories include the following: 1. Nominal Word, 2. Verbal Word, 3. Modifier Word and 4. Other (e.g., Conjunction, Interjection, Greeting).

The WLSP semantic-label hierarchy assigns the same label to antonyms and opposites. For example, paragraph 1.2220-2 in Table 1 includes the antonym pairs ホステス 'hostess' ⇔ ホスト 'host' by the type of 相補 (complementation). However, ゲスト 'guest' is also included in paragraph 1.5300-3, and it can be considered an antonym of ホステス and ホスト by the type of 視点 (viewpoint). Therefore, it is difficult to determine whether some word pairs are antonyms.

Table 1: Structure of the 'Word List by Semantic Principles'

| Class | Division | Section | Article | Article number etc. | Paragraph number | Record ID | Lemma |
|---|---|---|---|---|---|---|---|
| 体 Noun | 主体 Subject | 仲間 Companion | 主客 Host and Guest | 1.2220 | 2-5-1 | 17125 | ホステス hostess |
| 体 Noun | 主体 Subject | 仲間 Companion | 主客 Host and Guest | 1.2220 | 2-5-2 | 17126 | ホスト host |
| 体 Noun | 主体 Subject | 仲間 Companion | 主客 Host and Guest | 1.2220 | 3-1-4 | 17131 | ゲスト guest |

Although the WLSP categorises words into hierarchical semantic categories, the WLSP does not have any relationship among the words. As a first step, we annotated the antonyms and opposite relations between words. These relations can be used for sentiment analysis in natural language processing, and are also of interest in cognitive semantics.

This study involved constructing a system for annotating large-scale antonym information for the WLSP. First, the antonym word pair candidates were manually extracted. Second, rating information was added to the antonym word pair candidates using crowdsourcing to discern how many people regarded the target word pair as an antonym. Third, we categorised the antonym word pairs into types of antonyms.

## 2 Related Work

We used the term 'antonym' in a broader sense that includes a word and its opposite as closed and open pairs. We classified them into five closed types and eight open types. Below, we review the antonym and opposite classifications.

Muraki (1987) defined Japanese antonym types. His antonym types can be categorised into 'closed' and 'open' types. The closed types include 相補 (complementation), 両極 (bipolar), 程度 (degree), 視点 (viewpoint), and 変化 (change). The open types include 典型（２値）(representative), 部分全体 (whole-part), ２側面 (two-sided), 慣用 (idiom), and その他開 (others).

Cruse (2011) defined the degree of antonymy to be based on intrinsic binarity, the 'purity' of the opposition, symmetry, and matched non-propositional features. Antonyms should have a two-way relationship. However, sometimes antonyms are assigned a three-way relationship. Cruse classified antonyms into the following subtypes: polar (heavy:light, fast:slow, high:low), overlapping (good:bad, pretty:plain) and equipollent (nice:nasty, sweet:sour, happy:sad).

Löbner (2003) defined the following subtypes: antonyms (程度 (degree) by Muraki), directional opposites (両極 (bipolar), 変化 (change) by Muraki), complementary (相補 (complementation)), heteronymy (open types by Muraki), and converse (視点 (viewpoint) by Muraki).

We used the most fine-grained categorisation by Muraki to classify Japanese antonyms, and add three new open types to Muraki's types.

Next, we apply a questionaire to evaluate how people judges word pairs as antonyms through Yahoo! crowdsourcing. Below, we present the earlier work on antonym judgement tasks.

Ogino and Noguchi (1996) evaluated 165 pairs of Japanese antonyms using a questionnaire to discern how closely the words in the pair seemed to be antonyms. Their results suggested that antonyms tend to be judged according to the relationships of objects in the real world. Word pairs with a binomial opposition tend to be considered antonyms.

Matsumoto (2007) also evaluated 138 pairs of Japanese antonyms with a questionnaire method. He analysed the degree to which the pairs were considered antonyms according to their direction and polarity.

In this context, the present study can be considered an enhanced version of the Japanese antonym evaluation which is conducted using crowdsourcing and a thesaurus.

## 3 Methodology

### 3.1 Extraction of antonym word pair candidates

Four annotators were employed to extract the antonym word pair candidates in two layers. First, the annotators extracted 162,990 pairs of antonym candidates from within the small paragraphs of WLSP, and then extracted 842,459 pairs of antonym candidates from within the paragraphs of WLSP. The annotators referred to the 三省堂反対語対立語辞典 (Sanseido Hantaigo Tairitugo Jiten) throughout the annotation work. The annotators began the extraction work in June 2017 and completed it in November 2018.

They extracted 7,658 antonym word pair candidates. Of these, 3,405 word pairs were from the small paragraphs and 4,253 word pairs were from the paragraphs.
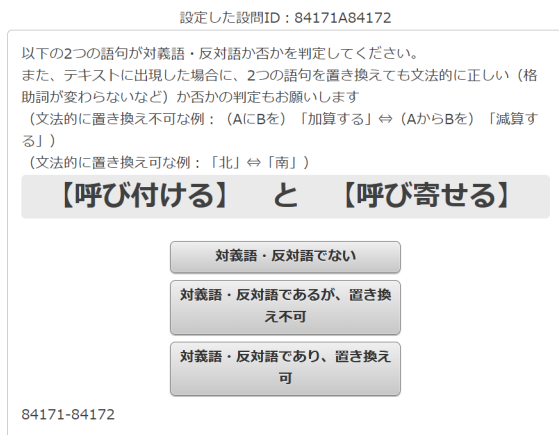
### 3.2 Rates in the crowdsourcing experiment



Figure 1: Screenshot of the cognitive experiment

We performed a cognitive experiment using Yahoo! crowdsourcing. They evaluated the degree of antonymy by investigating whether the target word pairs were 'not antonyms', 'unreplaceable antonyms' or 'replaceable antonyms'. 'Not antonyms' signified that there was no antonymic relation in the target word pair. 'Unreplaceable antonyms' signified that the target word pair contains antonyms, but that they were not replaceable in some contexts (e.g., case alternation). 'Replaceable antonym' signified that the target word pair

contained antonyms and that they were replaceable in any context. (AにBを) 加算する 'add B to A' ⇔ (AからBを) 減算する 'subtract B from A' is presented here as an example of an 'unreplaceable antonyms' word pair. As an example of 'replaceable antonyms', we presented the pairs 北 'north' ⇔ 南 'south' and 暑い 'hot' ⇔ 寒い 'cold'. The target word pairs mentioned in Section 2.1 included 7,658 pairs that were extracted and 4,253 word pairs that were randomly extracted within small paragraphs as filler word pair samples. There were 12,000 word pairs in total. Each word pair was evaluated by 40 participants, with 20 participants evaluating the word pairs in the forward order and 20 participants in the reverse order. We performed two crowdsourcing experiments, which cost 400,000 yen. The first experiment for forward-ordered pairs began at 08:03 on 17 December 2018 and ended at 21:25 on the same day. The experiment took 18 hours and 21 minutes and involved 1,597 participants. The second crowdsourcing experiment for reverse-ordered pairs began at 08:03 on 22 November 2019 and ended at 07:40 on 24 November 2019. This experiment took 47 hours 37 minutes and involved by 1,753 participants.

### 3.3 Labelling antonym types

We annotated the antonym types of the 5,594 word pairs that received an antonym rate greater than 0.5 ('unreplaceable antonyms' + 'replaceable antonyms').

First, three annotators independently annotated the antonym type labels for the 5,594 word pairs. The antonym type labels were based on (Muraki, 1987) and were divided into 'closed' and 'open' types. The closed antonym types were expressed as follows:

- 相補 (complementation): The two words divided a conceptual domain into two subdomains. An intermediate state was not allowed. The negation of one word meant the other word. e.g. 男 'man' ⇔ 女 'woman', 上 'up' ⇔ 下 'down'.

- 両極 (bipolar): The two words were located at opposite poles in a conceptual domain. An intermediate state was allowed, and the domain can either be continuous or discrete. (e.g. 最

大値 'maximum' ⇔ 最小値 'minimum', 開会 'opening' ⇔ 閉会 'closing').

- 程度 (degree): The two words expressed an attribute or property of an object or event, and they can co-occur with a degree adverb such as とても 'very' and 少し 'little'. This type was mainly assigned to adjectives. The conceptual domain was not strictly divided into two subdomains. Although there was no intermediate state (they are not 両極 [bipolar]), the negation of one word does not mean the other word. (e.g. 大きい 'large' ⇔ 小さい 'small', 高い 'high' ⇔ 低い 'low').

- 視点 (viewpoint): The two words did not belong to the physical world, and the pairs were defined by the perspectives of people.

  – one object or process was named from two different perspectives (e.g. 入口 'entrance' ⇔ 出口 'exit', 売る 'sell' ⇔ 買う 'buy')

  – one presupposed the other and vice versa (e.g. 親 'parent' ⇔ 子 'child' ⇔ 医者 'doctor' ⇔ 患者 'patient').

- 変化 (change):

  – movement occurred in opposite directions in space (e.g. あがる 'go up' ⇔ さがる 'go down', 到着 'arrival' ⇔ 出発 'departure')

  – transition occurred from one state to the other, and reversibly (e.g. 現れる 'appear' ⇔ 消える 'disappear', 暖める 'warm up' ⇔ 冷やす 'cool down').

It was found that open antonyms contrasted two perspectives and tended to be recognised as antonyms. Although context was a decisive factor, we could generally recognise the binary conditions or bipolar states that were involved. The open antonym types were exemplified as follows:

- 典型（2 値）(representative): The two words were representatives in one domain (e.g. 和室 'Japanese style room' ⇔ 洋室 'Western style room', 都会 'urban' ⇔ 田舎 'rural').

- 部分全体 (whole-part): One word denoted a subpart of the other word (e.g. 往復 'round trip' ⇔ 片道 'one way', 両手 'both hands' ⇔ 片手 'one hand').

- 2 側面 (two-sided): The two words expressed two-sided attributes of one domain (e.g. たて 'vertical' ⇔ よこ 'horizontal', 一般 'general' ⇔ 特殊 'particular').

- 慣用 (idiom): This denoted idiomatic phrases that people regard as antonyms (e.g. (気が) はれる 'feel cheerful' ⇔ (気が) ふさぐ 'feel depressed', 骨をおる 'take trouble' ⇔ 骨をおしむ 'spare oneself').

- その他開 (others): This included other types than those mentioned above.

After this stage was completed, one supervisor determined the final label based on the labels of the three annotators. In the next phase, we introduced new open types of antonyms (その他開 'others') as follows:

- 終了 (finished): One telic word denoted the finished aspect of the other word (e.g. 進捗（しんちょく）'progress' ⇔ 停滞 'stagnation', 授乳 'lactation' ⇔ 離乳 'delactation').

- 主副（別）(main-sub): This denoted cases in which one is the main word while the other is subordinate (e.g. 本社 'headquarters' ⇔ 支社 'branch office', 直行する 'direct' ⇔ 迂回する 'indirect').

- 因果 (cause-effect): This denoted cases in which one word is the cause of the other, or the effect word (e.g. 起因する 'cause' ⇔ 結果する 'effect', 突き当たる 'come to the end' ⇔ 通り抜ける 'go through').

## 4 Statistics

### 4.1 Analysis by antonym types

We analysed the rates according to the antonym type (see Table 2 for the statistics according to the antonym type). The statistics are listed in ascending order of the rate 'not antonyms'. The most frequent antonym type was 相補 (complementation). 変化 (change), 程度 (degree), and 両極 (bipolar)

Table 2: Statistics for antonym types

| Type of antonym | Closed or open | Not antonyms | Antonyms unreplaceable | Antonyms replaceable | No. of word pairs |
|---|---|---|---|---|---|
| 程度 (degree) | closed | 18.4% | 29.0% | 52.6% | 803 |
| 相補 (complementation) | closed | 19.9% | 28.0% | 52.0% | 1686 |
| 変化 (change) | closed | 20.0% | 35.2% | 44.8% | 991 |
| 両極 (bipolar) | closed | 20.1% | 28.8% | 51.1% | 756 |
| 慣用 (idiom) | open | 20.4% | 36.8% | 42.8% | 44 |
| 視点 (viewpoint) | closed | 22.1% | 30.6% | 47.2% | 434 |
| 2 側面 (two-sided) | open | 22.9% | 25.5% | 51.7% | 72 |
| 典型 (representative) | open | 32.5% | 23.2% | 44.3% | 452 |
| 部分全体 (whole-part) | open | 35.8% | 26.5% | 37.7% | 75 |
| 終了 (finished) | open | 37.1% | 33.6% | 29.3% | 44 |
| 主副 (main-sub) | open | 41.0% | 25.3% | 33.6% | 29 |
| その他開 (others) | open | 44.6% | 25.2% | 30.2% | 124 |
| 因果 (cause-effect) | open | 47.6% | 26.9% | 25.5% | 28 |

Table 3: Type and unigram frequency

| Type of Antonym | Closed or open | Log frequency ratio | Difference in presentation |
|---|---|---|---|
| 相補 (complementation) | closed | 0.641 | 0.090 |
| 両極 (bipolar) | closed | 0.625 | 0.086 |
| 程度 (degree) | closed | 0.615 | 0.086 |
| 視点 (viewpoint) | closed | 0.516 | 0.093 |
| 変化 (change) | closed | 0.708 | 0.092 |
| 典型 (representative) | open | 0.500 | 0.116 |
| 部分全体 (whole-part) | open | 0.778 | 0.120 |
| 2 側面 (two-sided) | open | 0.353 | 0.098 |
| 慣用 (idiom) | open | 0.398 | 0.103 |
| 終了 (finished) | open | 0.376 | 0.124 |
| 主副 (main-sub) | open | 0.741 | 0.166 |
| 因果 (cause-effect) | open | 0.980 | 0.141 |
| その他開 (others) | open | 0.806 | 0.148 |

were also frequent antonym types. The closed types of antonyms tended to be more strongly regarded as antonyms, because the closed feature is considered the most important feature in the strict antonym definition. The closed types tended to be more replaceable than the open types. In the closed types, 変化 (change) and 視点 (viewpoint) tended to be considered unreplaceable, as these terms included case alternation phenomena. The open types of antonyms tended to be marginal, which was not defined in the strict antonym definition. However, some nonlinguists regarded 部分全体 (whole-part), 終了 (finished), and 主副 (main-sub) as 'antonyms'.

## 4.2 Analysis by unigram frequencies

We then explored the differences of word frequencies in the antonym pairs. They evaluated the unigram frequencies in the Balanced Corpus of Contemporary Written Japanese (BCCWJ), which is a 100 million–word Japanese corpus compiled from newspapers, books, magazines, and other registers. The BCCWJ has two word–delimitation standards: short unit words (SUW) and long unit words (LUW). We only evaluated 2,747 word pairs, in

which both words appeared at least once in the corpus, and in which the antonym pair was defined as SUW in the BCCWJ. It should be noted that we also conducted an LUW-based analysis, whose the results were nearly the same as the SUW-based results.

They used a log frequency ratio with the following formula: `log frequency ratio`:

$$= \frac{log(\texttt{frequency of the source word})}{log(\texttt{frequency of the target word})}$$

A larger difference implies a larger log frequency ratio, and the log frequency ratio is zero if the frequencies of the two words are identical. We investigated whether the differences in frequencies were correlated with the rate based on the difference between forward and reverse presentations. We evaluated the Spearman correlation between the log frequency ratios and the rates by the difference of presentation. A significant correlation was not confirmed with a correlation coefficient of 0.051 ($p <$ 0.01). No correlation signifies that the preferences of the presentation order in the crowdsourcing experiment were not caused by the frequency in the corpus. Even though a difference in frequency was observed, a difference by presentation order was not observed (and vice versa).

Table 3 outlines the log frequency ratios and the differences of the rates according to the differences of presentation. It is shown that although 視点 (viewpoint), 典型 (representative) and 2 側面 (two-sided) tended to have small log frequency ratio, 変化 (change), 部分全体(whole-part), 主副(main-sub) and 因果 (cause-effect) tended to have large log frequency ratios.

### 4.3 Correspondence relations of antonym pairs

It was found that the antonym pairs were not always in one-to-one correspondence relations; rather, they were in one-to-many correspondence relations. Table 4 displays the frequencies of corresponding antonyms, which more than 50% of the subjects regarded as antonyms in forward or reverse orders. While 8,184 words (88% of 9,286 words) were in one-to-one correspondence relations, 1,102 words (12% of 9,286 words) were in one-to-many correspondence relations.

Table 4: Frequencies of frequencies of corresponding antonym

| Frequency of corresponding antonym | Frequency of frequencies of corresponding antonym |
|---|---|
| 1 | 8,184 |
| 2 | 761 |
| 3 | 191 |
| 4 | 86 |
| 5 | 33 |
| 6 | 16 |
| 7 | 2 |
| 8 | 7 |
| 9 | 4 |
| 10 | 1 |
| 12 | 1 |

Cruse (1986) investigated congruence variants with congruence relations (i.e. those that share antonyms). Cruse defined the 'hypo-super' and 'semi-' types of congruence variants, of which the former is frequently observed in lexicons. Cruse presented the Japanese example of 脱ぐ (take off) with the antonyms of 着る (wear), かぶる (put a hat on) and はく/履く/穿く (put shoes/trousers on). These examples appear in the database of this study (see Table 5). Other examples included complementation by gender and viewpoint. For example, as Table 5 outlines, ホステス (hostess), ホスト (host), and ゲスト (guest) were in antonym relations.

### 4.4 Polysemy in the antonym database

Next, we explored the polysemy in the antonym pairs, as some one-to-many correspondence relations appeared due to their multiple senses. We used the table of WLSP2UniDic [2](Kondo et al., 2018), which defines the correspondence relations between entries in a morpheme-based lexicon UniDic and entries in a sense-based lexicon WLSP. Table 6 outlines the 'numbers of senses' and frequency of 'numbers of senses' based on UniDic lemma. The 'numbers of senses' denote how many word senses in the WLSP are assigned for the target UniDic lemma in WLSP2UniDic. The 3,050 entries

[2]`https://github.com/masayu-a/WLSP2UniDic/`

Table 5: Antonyms with one-to-many correspondence relations

| Target | Type | Correspondent antonym |
|---|---|---|
| 脱ぐ (take off) | 変化 (change) | 着る (wear)<br>かぶる (put a hat on)<br>はく，穿く (put shoes on)<br>はく，履く (put trousers on) |
| ホスト (host) | 相補 (complementation)<br>視点 (viewpoint) | ホステス (hostess)<br>ゲスト (guest) |
| ホステス (hostess) | 相補 (complementation)<br>視点 (viewpoint) | ホスト (host)<br>ゲスト (guest) |
| ゲスト (guest) | 視点 (viewpoint) | ホステス (hostess)，ホスト (host) |

Table 6: Polysemy in the antonym database

| Numbers of senses | Frequency of the number of senses | Examples |
|---|---|---|
| - | 3,050 | 悪条件 (bad condition), オンライン (on-line) |
| 1 | 3,651 | 類似 (similar), メリット (merit) |
| 2 | 1,743 | 実 (real), 偶然 (accidental; chance) |
| 3 | 477 | プラス (plus), 全部 (all; whole) |
| 4 | 207 | イレギュラー (irregular), 不純 (impure; mixed) |
| 5 | 70 | ダウン (down; wool), ショート (short) |
| 6 | 41 | 純粋 (pure; genuine; real) |
| 7 | 22 | 先 (point, tip; ahead; future; previous; destination) |
| 8 | 14 | 整う (be ready; be in order; be adjusted; be settled) |
| 9 | 4 | 上がる (go up; go in; get out; call; climb; rise; jump) |
| 10 | 4 | 内 (in; inside; within; while; during; between; among; amid; my) |
| 11 | 2 | 下ろす (put down; discharge; set down; drop; unload; launch) |
| 12 | 1 | 掛ける (hang; suspend; hook; sprinkle; pour; spend; wear; multiply; begin to do) |

for '-' in the column 'numbers of senses' indicate that the antonym phrases are not defined in the Uni-Dic lexicon because of word/phrase unit discrepancies. In the other 6,232 entries, 3,951 entries (59%) were monosemeous words, and 2,281 entries (41%) were polysemous words. The maximally polysemous word 掛ける (hang; suspend; hook; sprinkle; pour; spend; wear; multiply; begin to do) had 12 senses. Table 7 outlines the antonym example of 甘い (soft; sweet). 甘い has three sorts of antonym senses: difficult, treatment and taste.

### 4.5 Analysis by crowdsourcing experiment

This section presents the statistics for the rates determined in the crowdsourcing experiment. Table 8 displays the results for the overall rates. In the table, 'candidate (small para)' indicates the pairs that were extracted from small paragraph, and 'candidate (para)' indicates the pairs that were extracted from paragraph. Approximately 35 % (34.32% and 35.39%) of the antonym word pair candidates were deemed as 'not antonyms'. The difference in the 'not antonym' rate between the small paragraph and paragraph was relatively small (1.07 %). The difference in the 'antonym replaceable' rate between the small paragraph and paragraph was relatively large, at 5.58 % (43.47% – 37.89%). Approximately 16 % (8.37% + 7.86%) of the 'not candidate' (filler) word pair samples were deemed to be 'antonyms'.

We evaluated the rate of antonyms in both forward and reverse order presentations, and each presentation was evaluated by 20 participants. Table 9 out-

Table 7: Antonyms of the polysemous word 甘い (soft; sweet)

| Target | Type | Antonym | WLSP article number | Article |
|---|---|---|---|---|
| 甘い (soft) | 程度 (degree) | 厳しい (hard) | 3.1346 (difficulty) | 相-関係-様相-難易・安危 |
| 甘い (soft) | 程度 (degree) | 厳しい (strict) | 3.3680 (treatment) | 相-活動-待遇-待遇・礼など |
| 甘い (soft) | 程度 (degree) | 辛（から）い ［点が―］ (strict) | 3.3680 (treatment) | 相-活動-待遇-待遇・礼など |
| 甘い (sweet) | 程度 (degree) | 辛（から）い (spicy; salty) | 3.5050 (taste) | 相-自然-自然-味 |

Table 8: Rate antonym judgement

| | Not antonyms | Antonyms unreplaceable | Antonyms replaceable | Number of answers | Number of word pairs |
|---|---|---|---|---|---|
| candidate (small para) | 34.32% | 22.19% | 43.47% | 68,100 | 3,405 |
| candidate (para) | 35.39% | 26.71% | 37.89% | 85,060 | 4,253 |
| not candidate (filler) | 83.76% | 8.37% | 7.86% | 86,840 | 4,342 |
| all | 52.59% | 18.79% | 28.61% | 240,000 | 12,000 |

lines the antonym pairs and presents the rate differences between forward and reverse-order presentations. For example, while the pair ぷりぷりする and にこにこする was deemed as 'not antonyms' by 70% of the participants in forward order, it was also deemed as 'not antonyms' by 10% of the participants in reverse order. We analysed these phenomena by gender and magnitude relations.

We also identified 'antonyms' that received more than 50% antonym judgements in the crowdsourcing experiment in forward or reverse-order presentation. In total, 2,465 pairs were obtained from the small paragraph section, 3,008 pairs from the paragraph section and 65 pairs from the 'not candidates' section.

### 4.6 Analysis by word embeddings

Finally, we investigated the word vectors of antonym pairs in word embeddings (Mikolov et al., 2013). It is known that the relation of $\vec{king} - \vec{man} + \vec{woman} = \vec{queen}$ in word embeddings can be observed among the antonym pairs. We used NWJC2vec (Asahara, 2018), which is trained using a 25-billion–word corpus known as the NIN-JAL Web Japanese Corpus (NWJC) (Asahara et al., 2014). NWJC2vec is trained using a skip-gram set-

ting of fastText (Bojanowski et al., 2017) with 300 dimension vectors.

We investigated the cosine similarities between the word vectors of antonym pairs. They evaluated the Spearman correlation between the cosine similarities and the rate of 'replaceable'. The correlation efficient was found to be 0.286 ($p < 0.05$). This result indicates that a moderate correlation was observed between the replaceability of human subjects and the similarities in word embeddings.

Table 10 outlines the cosine similarities and the 'replaceable' rates according to antonym types. 2 側面 (two-sided), 慣用 (idiom) and 典型 (representative) displayed higher cosine similarities than others. These open types are not considered 'antonyms' as per the definition. However, their contextual similarities might lead people to recognise the types as 'antonyms'. 視点 (viewpoint) displayed the highest rate of similarities in the closed types. Even though 視点 (viewpoint) included case alternation phenomena, the word embedding techniques might capture a term's contextual similarities beyond its 'unreplaceability'.

Table 9: Differences between rates of 'not antonym' between forward and reverse orders

| Source | Target | Forward order | Reverse order | Difference |
|---|---|---|---|---|
| ぷりぷりする (get ratty) | にこにこする (smile) | 70% | 10% | 60% |
| 官立 (governmental) | 私立 (private) | 20% | 75% | 55% |
| 水勢 (force of water) | 火勢 (force of fire) | 25% | 80% | 55% |
| 粗放農業 (extensive agriculture) | 集約農業 (intensive agriculture) | 25% | 80% | 55% |
| 治癒 (care) | 回復 (recovery) | 35% | 90% | 55% |
| 手を施す (give treatment) | 手をつかねる (stand and watch) | 100% | 45% | 55% |
| にぎわしい (busy) | 寂しい (desolate) | 0% | 50% | 50% |
| 従兄 (elder cousin) | 従弟 (younger cousin) | 85% | 35% | 50% |
| 稚拙 (childish) | 老巧 (veteran) | 25% | 75% | 50% |
| 晴れ上がる (clear up) | ぐずつく (be unsettled) | 30% | 80% | 50% |

Table 10: Cosine similarities in word embeddings

| Type of antonym | Closed or open | Number of word pairs | Cosine similarities (averaged) | Rate of 'replaceable' (averaged) |
|---|---|---|---|---|
| 相補 (complementation) | closed | 910 | 0.599 | 54.6 % |
| 両極 (bipolar) | closed | 425 | 0.563 | 55.4 % |
| 程度 (degree) | closed | 480 | 0.544 | 55.3 % |
| 視点 (viewpoint) | closed | 218 | 0.645 | 53.3 % |
| 変化 (change) | closed | 398 | 0.544 | 49.3 % |
| 典型 (representative) | open | 243 | 0.633 | 47.2 % |
| 部分全体 (whole-part) | open | 35 | 0.495 | 43.4 % |
| 2 側面 (two-sided) | open | 40 | 0.720 | 55.1 % |
| 慣用 (idiom) | open | 6 | 0.686 | 44.2 % |
| 終了 (finished) | open | 1 | 0.554 | 32.5 % |
| 主副 (main-sub) | open | 13 | 0.565 | 35.4 % |
| 因果 (cause-effect) | open | 5 | 0.443 | 33.5 % |
| その他開 (others) | open | 35 | 0.527 | 33.6 % |
| Total | | 2809 | 0.582 | 52.8 % |

## 5 Conclusions

This article presents an overview of the antonym information in the WLSP. First, we extracted antonym word-pair candidates from the hierarchical thesaurus categories. Second, a cognitive experiment was performed to evaluate the rate at which people judged

the antonym word pair candidates to be 'antonyms'. Third, we annotated the labels of antonym types for word pairs. We then analysed the basic statistics of word pairs, correlations with unigram frequencies, and correlations with word similarities in word embeddings. The data statistics revealed that judging antonyms is difficult to perform dichotomously. The participants tended to consider open-type word pairs such as 2 側面 (two-sided) and 典型 (representative) as antonyms due to contextual similarities. Sometimes, the participants also deemed 部分全体 (whole-part) and 主副 (main-sub) relations as 'antonyms'. The analysis of word embeddings supported the claim that the relation $\vec{king} - \vec{man} + \vec{woman} = \vec{queen}$ is feasible for antonym pairs.

The data are publicly available[3] under the Creative Commons BY-NC-SA 3.0.

## Acknowledgments

## References

Masayuki Asahara, Kikuo Maekawa, Mizuho Imada, Sachi Kato, and Hikari Konishi. 2014. Archiving and analysing techniques of the ultra-large-scale web-based corpus project of ninjal, japan. *Alexandria*, 1–2:129–148.

Masayuki Asahara. 2018. NWJC2Vec: Word embedding dataset from 'NINJAL Web Japanese Corpus'. *Terminology: International Journal of Theoretical and Applied Issues in Specialized Communication*, 24(2):7–25, Feb.

Piotr Bojanowski, Edouard Grave, Armand Joulin, and Tomas Mikolov. 2017. Enriching word vectors with subword information. *Transactions of the Association for Computational Linguistics*, 5:135–146.

Alan Cruse. 1986. *Lexical Semantics*. Cambridge University Press.

Alan Cruse. 2011. *Meaning in Language: An Introduction to Semantics and Pragmatics*. Cambridge University Press.

Kokuritsu_Kokugo_Kenkyusho. 2004. *Bunrui goihyo zouho kaitei-ban (Word List by Semantic Principles, Revised and Enlarged Edition)*. Dainippon Tosho, Tokyo.

Asuko Kondo, Makiro Tanaka, and Masayuki Asahara. 2018. Alignment table between unidic and 'word list by semantic principles'. In *Proceedings of The Eighth Conference of Japanese Association for Digital Humanities (JADH2018)*, pages 125–128.

Sebastian Löbner. 2003. *Understanding Semantics*. Routledge.

Yo Matsumoto. 2007. Hangisei-ni Kansuru Ninchi-imironnteki Kousatsu (in Japanese) [A Cognitive Semantic Study of Antonymity]. In *Nihon Gengo Gakkai Dai 135-kai Yokoushuu*.

Tomas Mikolov, Kai Chen, Greg Corrado, and Jeffrey Dean. 2013. Efficient estimation of word representations in vector space. In *International Conference on Learning Representations*.

Shinjiro Muraki. 1987. Taigigo-no Rinkaku-to Jouken (in Japanese) [Structure and Condition of antonyms]. *Nihongogaku*, 6(6):29–41.

Tsunao Ogino and Miwako Noguchi. 1996. Hantaigo Ishiki-no Kouzou (in Japanese) [Cognitive Structure for Antonymity]. *Nihongo Kenkyu*, 16:78–111.

---

[3]https://github.com/masayu-a/WLSP-antonym