Mapping Word Knowledge in Japanese:

Coding Japanese Word Associations

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Abstract

This project is investigating lexical knowledge by mapping out the associative structures that exist for Japanese words. Specifically, the project is (1) constructing a large-scale database of Japanese word associations, (2) utilizing the association database to create lexical association network maps as a means of capturing association patterns, and (3) exploring applications of the database and the maps. This paper focuses on describing the coding of word association responses collected so far in preparation for the release of Version 1 of the Japanese Word Association Database. The paper also introduces a study conducted to explore the application of lexical maps to Japanese language instruction.
Index Terms: lexical knowledge, Japanese word association database, lexical association network maps, bilingual lexical maps

1. Introduction

Reflecting the fact that association is a basic mechanism of human cognition [1][2], there has been considerable interest within various areas of cognitive science, such as psychology, artificial intelligence and natural language processing, in identifying and understanding the structured relations that exist between concepts by mapping out how concepts are represented in the rich networks of associations that exist between words [3][4][5][6][7][8][9].

In a similar vein, this project is seeking to investigate the nature of lexical knowledge in Japanese by mapping out the complex networks of associations that exist for basic Japanese vocabulary as captured through large-scale free word association surveys [10][11][12][13][14]. This paper reports on the on-going construction of a large-scale database of Japanese word associations, based on responses collected from two conducted questionnaire surveys and from a web-based survey. More specifically, Section 2 focuses on describing the coding of collected word association responses for a random sample of 2,100 vocabulary items from the present database corpus of 5,000 items, which will made publicly available as Version 1 of the Japanese Word Association Database. Section 2 also touches on the development of a web-based version of the word association survey launched as an effective way of collecting the large-scale quantities of responses required for the database. Section 3 presents an example of the lexical association network maps and an example of how analyzing the types of association relationships elicited from related words can provide insights into their conceptual structures. Finally, Section 4 introduces a study conducted to explore the application of lexical maps to Japanese language instruction.

2. Constructing the database

This project is constructing a Japanese word association database that is large-scale in terms of both the number of words surveyed and the number of association responses collected.

2.1. Survey corpus of basic Japanese vocabulary

A survey corpus of 5,000 basic Japanese kanji and words was compiled [10][12], by identifying common items in three references sources of basic vocabulary for Japanese language education.

2.2. Questionnaire surveys

The majority of the word association responses collected to date have come from two large questionnaire surveys. The first survey collected up to 50 word association responses for a random sample of 2,000 items, while the second survey collected at least ten responses for the remaining 3,000 items in the survey corpus.

2.2.1. Method

Participants: Native Japanese university students (N = 1,481; 929 males and 552 females; average age 19.03, SD = 0.97) participated in the two surveys on a volunteer basis.
Questionnaire sheets: For both surveys, target items were divided into lists of 100 items. A survey questionnaire consisted of 10 pages with 10 items printed per page, as a centered column of words with underlined blank spaces for association responses (e.g., _____). The instructions asked the participants to look at each printed item and to write down in the blank space the first semantically-related Japanese word that comes to mind.

2.2.2. Results

From two traditional paper questionnaire surveys, approximately 148,100 word association responses were collected for a corpus of 5,000 basic Japanese kanji and words.

2.3. Version 1 of Japanese Word Association Database

Through two questionnaire surveys, 2,100 items drawn at random from the survey corpus were presented to up to 50 respondents for word association responses (a list of these is available at http://www.valdes.titech.ac.jp/~terry/jwad.html). The word association responses to these items are being processed and coded in order to make them publicly available as Version 1 of the Japanese Word Association Database.

Table 1. Examples of database codes

Level 1		
Semantic association (SA)		
(plow, cultivate)	(field)	
(cool)	(breeze, wind)	
Phonological association (PA)		
/iru/ (exist; need)	/iruka/ (dolphin)	
/shimau/	/shimauma/ (zebra)	
Orthographic association (OA)		
(red)	/akakawa/ /akagawa/ (proper noun)	
(condition, state)	((feudal) lord)	
Transcription response (TR)		
/naku/	/naku/ (cry, weep)	
/jimi/ (plain)	/jimi/	
Blank (B)		
Level 2		
Foreign word (FW)		
(apologize)	sorry	
Verb conversion (VC)		
(consideration)	(consider)	
Proper noun (PN)		
(consciousness)	(Freud)	

The database codes, with examples, are presented in Table 1. There are two levels of codes. The level 1 codes classify responses at a general level in terms of their appropriateness. The main type is of semantic association, such as when the target word of meaning plow or cultivate elicits the semantically associated word of meaning field. While semantic association responses naturally represent the ideal type of data, responses are sometimes motivated by phonological and orthographic similarities. An example of a phonological association is the response of /shimauma/ which means zebra (morphologically, a combination of (stripe) and (horse)) for the word /shimau/, a verb meaning to put away or finish. An orthographic association example is the response of ((feudal) lord) for meaning condition or state, based on the shared second kanji. Although these two types of association are undoubtedly of interest in highlighting the richness of association as a mechanism of human cognition, they are not central to this project's objectives of investigating lexical knowledge in Japanese, and are being coded so they can be excluded from analyses when desired. Another level 1 code is transcription response, where the response word is essentially the target word represented in a different script, such as when the ambiguous word of in hiragana is written with the kanji specifying the meaning of weep or cry. The last code at this level is for blanks. Although blanks on the questionnaire sheets that were clearly due to a respondent skipping a page or failing to complete a questionnaire are treated as non-presented items, isolated blank responses are recorded as an index of words that do not easily elicit association responses. Level 2 codes include foreign word (e.g., (apologize) eliciting sorry), verb conversion, where a noun is changed to a verb by adding (e.g., (consideration) eliciting (consider)), and proper nouns (e.g., (consciousness) eliciting (Freud)).

Once this coding work is completed, the word association response data will be made publicly available as Version 1 of the Japanese Word Association Database at the project website (http://www.valdes.titech.ac.jp/~terry/jwad.html).

2.4. Web-based survey

The data from the two questionnaire surveys makes a considerable contribution to the construction of the large-scale database, but the traditional paper format involves burdens in terms of preparation and data inputting. Accordingly, the project has developed a web-based version of the word association survey in order to collect large-scale quantities of association responses for the database (http://nerva.dp.hum.titech.ac.jp/terry/index.jsp).

When someone participates in the online survey, a unique individual survey list of 100 items is automatically generated from the survey corpus of 5,000 items. In generating a new list, the system executes a series of checks to eliminate intra-list associations based on information for the survey corpus, including presentation counts, pronunciations, orthographic form, component kanji codes, semantic category codes, and feedback ID codes. As the participant makes association responses to the items displayed on the computer screen one at a time, the system writes the participant ID number, the item ID number, the presented item, and the association response to an output file.

Since the launch of web-based survey at the end of July 2006, about 146 native Japanese speakers have participated providing approximately 13,260 word association responses. An initial block of 10,000 web-based responses has been checked for new feedback data, which has already been added to the survey corpus.

2.5. Future development of the database

The project plans to release Version 2 of the Japanese Word Association Database once at least 50 association responses have been collected and coded for all of the items in the present survey corpus of 5,000 basic Japanese kanji and words. The coding work is already underway for the responses collected from the second questionnaire survey for 3,000 items together with the first block of web-based responses.

The project also plans in the near future a major expansion of the survey corpus by adding between 3,000 to 5,000 new items. These items will be words that are frequent associates elicited for a core set of 1,000 survey items but are not already part of the survey corpus. These items will be extremely important in investigating the asymmetrical nature of word associations for the core set of 1,000 items. The core set of items has already been selected, based on Japanese language proficiency test levels, and the work of identifying the new items is presently underway.

3. Lexical association network maps

A central objective of the mapping lexical knowledge project is to utilize the Japanese word association database in developing lexical association network maps that capture and highlight the association patterns that exist between Japanese words [11][12][13]. After describing the basic concept of lexical association network maps and an example linking together a small set of related words, this section briefly discusses the future work of classifying association responses in order to elucidate the association structures of words and the complex nature of lexical knowledge.
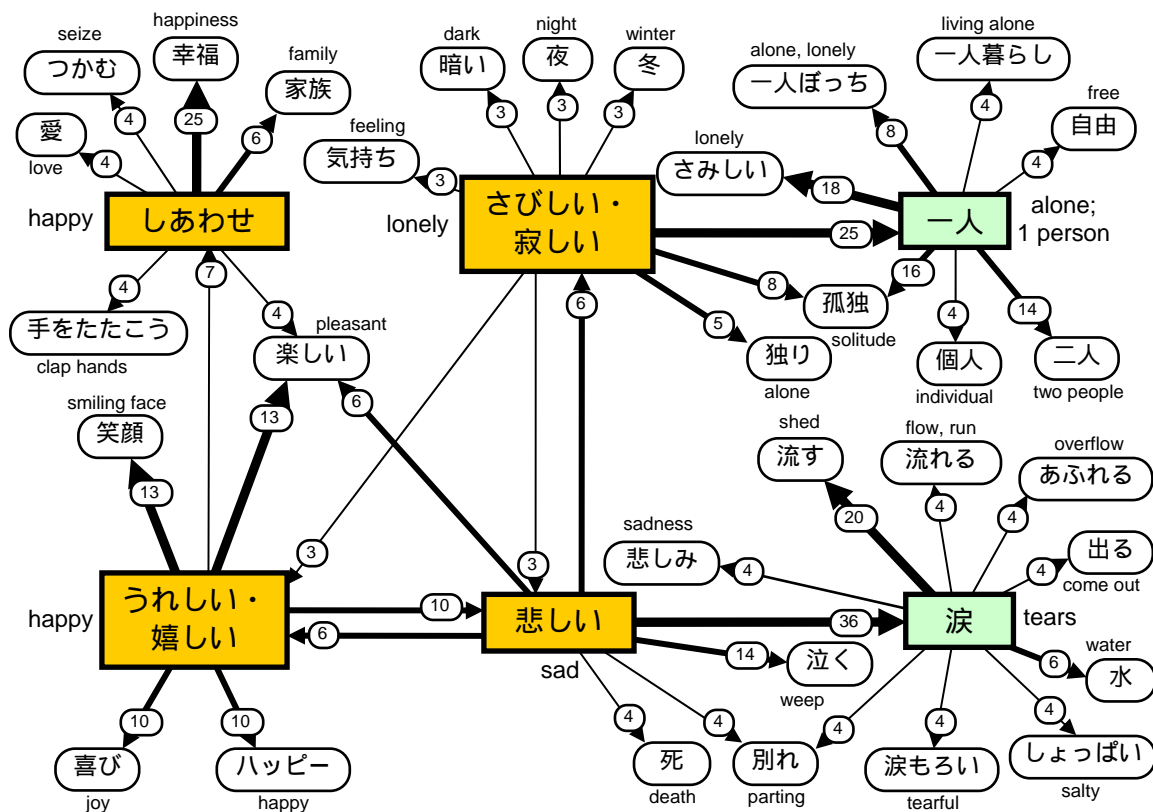
Figure 1. Example of lexical association network map building from and contrasting a small set of emotion words

Note: The numbers on the arrows indicate response frequency as percentages for a particular association set.

3.1. Basic concept of lexical association network maps

The basic component of the maps is the set of associates given in response to a given target word and association strengths in terms of response frequency. Although the basic associate set is defined by the forward association relationship between a target word and its associates, the maps also feature backward associations both in terms of numbers and strengths, as well as representing association density in terms of the associations between all the words within a particular association set. Comparisons of lexical association network maps for words from different word classes can provide interesting insights into the syntactic aspects of lexical knowledge [11][12][14].

3.2. Small domain example

Beyond the single-word level, lexical association network maps can also be combined to create various kinds of global semantic networks as another promising approach to investigating lexical knowledge. For example, in discussing their analyses of semantic networks based on word association norms, WordNet [15], and Roget's thesaurus, Steyvers and Tenenbaum speculate that the observed similarities between their networks reflect pervasive and deep features of semantic knowledge [5].

Figure 1 presents a lexical association network map based on a small set of emotion words. Interestingly, while the positive synonymous words of   and   meaning happy have rather strong associations to a small set of close synonyms, such as   (happiness),   (happy),   (joy), and   (pleasant), the negative emotion words of   (lonely) and   (sad) primarily elicit word association responses that can be regarded as having a causal or resultant relationship. For example, the prime associate for (lonely) is   (alone; 1 person), followed by the related words of   (solitude) and   (alone), as well as (dark),   (night) and   (winter), while   (sad) has a particularly strong prime association of   (tears) (given by 36% of the respondents), followed by   (weep) (given by 14% of the respondents). However, looking at the word associations from   , although the prime associate is   (lonely), there are a number of other associations, while the prime associate for   is   (to shed).

3.3. Classifying word association responses

Implicit awareness for the association structures that exist between words is a fundamental aspect of human lexical knowledge. When we hear or read a given word, conceptual schema are activated according to the word's association structures. Accordingly, a particularly important task for the mapping Japanese lexical knowledge project will be to classify the collected word association responses. Because the classification work offers an interesting opportunity to investigate the appropriateness and validity of classification systems and taxonomies from a cognitive perspective, it will undoubtedly have implications for approaches to both human-readable and machine-readable thesauri and for ontology research which has been extremely active in recent years [9].

Table 2. Comparison of the association structures for (calm down, relax) and (be flustered; be in a hurry) based on tentative classifications of their word association responses

(calm down, relax)
Synonyms and antonyms, etc. (13 word types)
(feeling)(4), (relief)(3), (heart, spirit)(2), (feeling)(2), (quiet)(2), (relax)(2), (sit down)(2), (breath; pause)(2), (calm down; soften)(1), (calm; composure)(1), (calm; comfortable)(1), (throb; beat (fast))(1), (children)(1)
Location (13 word types)
(home)(6), (room)(3), (corner of a room)(1), (the bath)(1), (sofa)(1), (parental home)(1), (toilet)(1), (whereabouts)(1), (home)(1), (place)(1), (destination)(1), (tomboy)(1), my room (1)
Means (instrumental) (4 word types)
(tea)(2), (coffee)(1), (cigarettes)(1), (marriage)(1)
(be flustered; be in a hurry)
Synonyms and antonyms, etc. (15 word types)
(hurry)(9), (in a hurry; be impatient)(3), (in a hurry; hastily)(2), (confusion)(2), (calm down)(2), (panic; be flustered)(2), (be surprised)(1), (hurry; impatient)(1), (about to blow one's fuse)(1), (be distracted)(1), (bewilderment)(1), (panic)(1), (calm; composure)(1), (calm down)(1), (unrest; shaking)(1)
Cause relationship (11 word types)
(lateness)(2), (time)(1), (morning)(1), (oversleep)(1), (test)(1), (before test)(1), (job)(1), (fire)(1), (earthquake)(1), (dust cloud)(1), (panic; consternation)(1)
Resultant relationship (9 word types)
(sweat)(1), (cold sweat)(1), (tumble)(1), (fall down)(1), (fly out)(1), (forget)(1), (suspicious behavior)(1), (dangerous; critical)(1), (flapping)(1)

Note: The numbers in parenthesis indicate number of responses

While the classification examples shown in Table 2 should be regarded as early tentative attempts requiring further refinement, with some classifications admittedly open to alternative interpretations, a comparison of the two association sets may still serve to illustrate how awareness of the association structures of words is an integral part of our lexical knowledge. Table 2 compares the association structures for the antonyms of (calm down, relax) and (be flustered; be in a hurry). For both words, a considerable proportion of the word association responses may reasonably be classified as either synonym or antonym associations: in the case of , 13 types and 24 tokens (representing 43% and 49% of the responses respectively); in the case of , 15 types and 29 tokens (43% and 58% of the responses respectively). However, although the two verbs elicit fairly similar levels of synonym and antonym responses, they contrast sharply in terms of their overall association patterns. The verb also elicits a considerable number of responses (13 types (43%) and 20 tokens (41%)) that may be classified as representing a location for the activity, such as (home), (room), and (sofa). The third group of responses for can be regarded as means or instrumental referents, such as (tea), (coffee), and (cigarettes) (4 types (13%) and 5 tokens (10%)). In contrast, the remaining association responses for the verb of may be classified under one of two related groups reflecting either causal or resultant relationships. For instance, the causal relationship group (11 types (31%) and 12 tokens (24%)) includes responses like (lateness), (test), and (job), while the resultant relationship group (9 types (26%) and 9 tokens (9%)) includes responses like (cold sweat), (fly out), and (forget). This simple comparison clearly shows that while the two verbs of and are fairly close antonyms, they differ markedly in terms of their characteristic patterns of association, and consequently activate very different sets of cognitive schema.

4. Applications of the database and maps

The mapping Japanese lexical knowledge project is also committed to exploring a number of promising applications of the Japanese Word Association Database and the lexical association network maps.

4.1. Mental lexicon research

One area is the visual word recognition and mental lexicon research that the author has also been conducting [16][17][18][19]. Within that research, the word association database will be extremely useful in designing new psychological experiments to investigate the influence of morphological information in the lexical representation and retrieval of two-compound words, while the lexical association maps will enhance the Japanese lemma-unit model as a connectionist model of the Japanese mental lexicon [16][17].

4.2. Japanese lexicography

There are also direct applications of the database and the maps to Japanese lexicography. Firstly, the incorporation into Japanese learner dictionaries of word association data in the form of core associates, together with phrase patterns where appropriate, would enrich the variety of information provided and be especially useful for Japanese language learners.
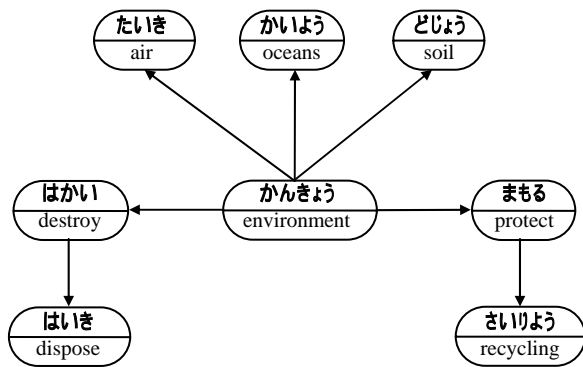
Figure 2. Section of the "environment" bilingual lexical map

Secondly, the database and the maps could be used to enhance electronic dictionaries in supporting user-friendly look-up functions [20]. The basic notion is that, if the lexical association network maps were incorporated within the dictionary, a user could search along association connections to locate a target word; something that would be especially helpful in the fairly common situation of the tip-of-the-tongue phenomenon where conventional form-based entry searching is useless.

4.3. Japanese language instruction: A bilingual lexical map study

The project has also being exploring the application of lexical association network maps to Japanese language instruction, and has conducted a study to investigate the use of bilingual lexical maps as an instruction strategy for specialist vocabulary [21], which is outlined in this section.

Memory research has long demonstrated that the categorization and semantic organization of stimulus materials dramatically influences retrieval performance [22]. However, in the case of foreign vocabulary learning, Tinkham has argued that thematic associations may be more effective than semantic relationships, because interference effects can occur when simultaneously studying sets of semantically-related L1-L2 word pairs [23]. Morin and Goebel have demonstrated the effects of semantic clustering based on themes and associations in learning Spanish as a second language [24], while Tokuhiro has reported effects of using 'conceptual maps' for Japanese [25]. Comparing the effects of presenting English and German word pairs in either a bilingual knowledge map format or a list format, Bahr and Dansereau have reported significantly better memory performance for the map condition [26].

4.3.1. Method

Participants: 47 foreign students attending a Japanese language course in preparation to enter Japanese technical high schools. The participants were beginner-level learners of Japanese (approximately one month of study) from various Asian and African countries (accordingly there were no native English speaker participants in this study). Counterbalancing for nationality and for Japanese language proficiency, the participants were randomly assigned to two groups: a bilingual lexical map presentation group and a list presentation (control) group.
Material: Three lists of general academic specialist vocabulary (trees, academic reports, and environment) were prepared, consisting of 14 English and Japanese word pairs.

Table 3. Average recall scores as a function of task, session and presentation condition

| | Task | | |
	FR		CR-R		CR-F	
Session 1						
List format	28.1		17.9		19.9	
Map format	37.8	*	21.6	ns	28.0	*
Session 2						
List format	12.0		11.2		14.4	
Map format	24.8	**	13.0	ns	22.8	**

Note: FR = free recall; CR-R = random cued recall; CR-F = study format cued recall.
The scores are higher in the free recall condition which required recall of both English and Japanese words.
* $p < .05$. ** $p < .01$.

In the list presentation condition, the word pairs were simply arranged as a vertical column on an A4-page. In the map presentation condition, the word pairs were spatially arranged to emphasize semantic and thematic relationships, as the section of the 'environment' bilingual lexical map shown in Figure 2 illustrates.
Procedure: Session 1 consisted of a study stage and an immediate test stage. In the study stage, the participants had 30 minutes to learn the three sets of vocabulary. There were three memory tasks in the immediate test stage: (1) a free recall task (FR: 15 minutes); (2) a random arrangement cued recall task (CR-R: 7 minutes); and (3) a study-format cued recall task (CR-F: 7 minutes). In the cued recall tasks, the Japanese words were presented as cues. Session 2, conducted one week later, consisted of a test stage with the same three tasks (FR: 10 minutes, CR-R: 5 mins., CR-F: 5 mins) and a short language test.

4.3.2. Results and discussion

Table 3 presents the average recall scores as a function of task, session and presentation condition. The results of a 3-factor ANOVA (2 presentation formats x 2 sessions x 3 tasks) indicated significant main effects for presentation format ($F(1, 45) = 198.01$, $p < .01$), for session ($F(1, 45) = 148.89$, $p < .01$), and for task ($F(2, 90) = 69.37$, $p < .01$), as well as a significant interaction ($F(2, 90) = 3.64$, $p < .05$). The results of planned comparisons revealed that recall scores were significantly higher for the map presentation condition than the list presentation condition for both the free recall and study-format cued recall tasks for both sessions.

These results indicate that studying specialist vocabulary presented within bilingual lexical maps can aid learning by emphasizing the semantic and thematic relationships within the target L2 vocabulary through the spatial organization of concepts and by activating existing L1 conceptual knowledge. These findings suggest that bilingual lexical maps based on the lexical association network maps for basic Japanese vocabulary being developed within this project can be very helpful in creating effective vocabulary learning strategies for Japanese language instruction.

5. Summary

This paper has reported on recent progress within the mapping Japanese lexical knowledge project. Specifically, the paper has described the coding of word association responses for 2,100 vocabulary items, which will made publicly available as Version 1 of the Japanese Word Association Database, as well as mentioning the on-going

construction of the database through a web-based survey. After presenting an example of the lexical association network maps and noting the insights that can be gained from classifying word association responses, the paper has introduced a study conducted to explore the application of lexical maps to Japanese language instruction.

6. Acknowledgements

7. References

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