

Research paper

Usage and efficacy of electronic dictionaries for a language without word boundaries

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Abstract

There is cumulative evidence suggesting that hyper-glossing facilitates lower-level processing and enhances reading comprehension. There are plentiful studies on electronic dictionaries for English. However, research on e-dictionaries for languages with no boundaries between words is still scarce. The main aim for the current study is to investigate the usage and efficacy of e-dictionaries for Japanese language learners. This article reports the results of two studies concerning e-dictionaries: a survey study investigating the use of e-dictionaries (with a particular focus on *e-glossaries* that change a digital text into a hypertext) by L2 learners of Japanese, and a comparative study examining existing e-glossaries to evaluate whether they provide the optimal level of support for reading Japanese e-texts. The results of the survey showed that learners have their preferred e-dictionaries (in most cases, *e-word dictionaries* in which the user can look up individual words), and that few learners are aware of the existence of e-glossaries. The results of further study revealed that existing e-glossaries have various functions, but lack some requisite information crucial to the target language. This study suggests that technical issues revolving around the lack of spaces between words may be a reason for the lag in usage and efficacy of e-glossaries for languages without word boundaries.

Keywords: Electronic dictionary, Japanese, reading, vocabulary, function word, multiword unit.

1. Introduction

Fast-evolving technology has, in recent years, seen the emergence of abundant electronic dictionaries, and consequently, electronic dictionary users (Steel & Levy, 2013). Diverse types of computerised learning tools are available. Broadly speaking, computerised learning tools can be divided into lesson type (having a syllabus to follow) and dictionary type. The latter is usually referred to as electronic dictionary, or e-dictionary. While the use of the term 'electronic dictionary' is sometimes restricted to a portable battery-powered digital dictionary, in this article, the term is used to refer to a wide range of non-print form dictionaries. E-dictionaries come in several forms: online dictionary, portable battery-powered dictionary, dictionary app, and add-on/plugin dictionary. E-dictionaries can be divided into three forms (Pasfield-Neofitou, 2009), *word dictionaries*, in which users input a word and get a list of possible meanings (and other word-related information), *glossaries*, in which users paste a text and get glosses for individual words/phrases, and *translators*, in which users paste a text and get a translation of the whole text. In this article, they are called *e-word-dictionary*, *e-glossary*, and *e-translator* respectively. E-glossaries are more commonly known as reading support systems.

E-dictionaries are becoming an essential part of learning a foreign language. An electronic dictionary does not guarantee reading comprehension, as reading requires higher-level processing (e.g., syntactic and discourse analyses) as well as lower-level

processing (e.g., word identification and lexical meaning access) (e.g., Alderson, 2000; Koda, 1994). However, there is cumulative evidence suggesting that e-glossing facilitates lower-level processing and enhances vocabulary learning and authentic text reading (e.g., AbuSeileek, 2011; Lomicka, 1998). There are plentiful studies on electronic dictionaries for learning English, but those for learning Japanese are still scarce. There is a need for learning about the usage and efficacy of e-dictionaries for L2 learners of Japanese. The aims of the current study are (1) to investigate the use of e-dictionaries (particularly e-glossaries) by L2 learners of Japanese, and (2) to evaluate existing e-glossaries and identify areas for improvement.

2. Study 1: Use of e-dictionaries in L2 learners of Japanese

2.1. Background

There is a large number of studies on English learners' e-dictionary use, and the results suggest that paper dictionaries are losing popularity and that e-dictionaries are gaining importance among English learners (e.g. Sevik, 2014). The survey reported by Jin and Deifell (2013) showed that 87.5% of learners of foreign languages used e-dictionaries, and the percentage of e-dictionary users is expected to increase, given the rate of dictionary technology advancement. The use of e-dictionaries in L2 readers of Japanese is, however, under-investigated despite a growing number of Japanese-English bilingual e-dictionaries. According to Suzuki's survey (2012), which was conducted on 117 L2 Japanese learners from 42 different countries, showed that 71% of them used, frequently or relatively frequently, a portable electronic dictionary, 45% used an online dictionary, and 28%, a PC dictionary app (multiple choices were permitted). Not many learners were users of smartphone apps.

Due to increasing internet access, mobile device ownership and e-dictionary availability, the e-dictionary usage situation is ever-changing. In 2015, in order to investigate the change over the three years, a survey study was conducted to investigate the use of e-dictionaries among L2 learners of Japanese at the same university as Suzuki's study (2012).

2.2. Participants

Participants were students who were enrolled in intermediate and advanced Japanese courses for international and exchange students at the Japanese Language Center for International Students, Tokyo University of Foreign Studies, in the first semester in 2015. The students received survey forms in their reading comprehension classes, and were asked to complete them immediately following the class sessions. Participation was voluntary. 88 of 114 enrolled students submitted the survey forms.

After eliminating those with missing background information, the subject of analysis became the data of 82 students from 29 different countries (14 from China, 8 from Russia, 6 each from Italy and Korea, 4 each from US, Australia and Brazil, 3 each from England, Taiwan and Hong Kong, and 27 students from other countries). The levels of Japanese proficiencies (determined by class levels) were: 27 intermediate (two intermediate classes combined), 19 intermediate-advanced, 28 advanced (two advanced classes combined), and 8 near-native levels. Students in beginner classes were not invited to participate because the instructors in charge judged that the students rarely, if ever, used dictionaries for reading inside and/or outside classrooms as they were given difficulty-adjusted reading passages with full glossaries.

2.3. Procedure

A paper questionnaire regarding the use of e-dictionaries was circulated in 6 classes of reading comprehension modules in Japanese language courses. Students were asked to fill out the questionnaire during the class time. The first half of the survey concerns general use of dictionaries for studying Japanese, and students were asked to write down the names of up to three dictionaries that they use. The second half of the survey concerns the use of e-glossaries. An e-glossary type is an e-dictionary specifically designed for assisting learners by providing the information necessary for reading a text, such as segmentation of a text into meaningful units, and providing pronunciations, meanings, collocations, synonyms, and example sentences with the target items.

2.4. Results - Use of e-dictionaries

Out of the 82 students, 16 students did not name any dictionaries, and two students wrote the names of paper dictionaries, from which we can deduce that at least 64 students (78%) are e-dictionary users. There was a tendency for students from a particular country to favour particular dictionaries. There are no identifiable differences in the use of dictionaries between the students at the different proficiency levels, except the near-native level students, who use much fewer dictionaries than those from the other levels.

As 24 of the 64 students are users of multiple dictionaries, there are 88 counts of reporting of the use of an e-dictionary. 38 counts (i.e., 59% of the e-dictionary users) for online dictionaries (e.g., Jisho.org, Google translate, and Weblio), 38 (59%) for Smartphone apps (e.g., Imiwa, Naver, and JED), eight (13%) for battery-powered portable dictionaries, and four (6%) PC apps (including plugin apps). Apparently, online dictionaries and smartphone apps became the most used e-dictionaries in 2015, whereas portable dictionaries were popular in 2012 (See Table 1).

Type	2012 (Suzuki)	2015
Online	45%	59%
PC Apps	28%	6%
Smartphone Apps	20%	59%
Portable	71%	13%

Table 1. E-dictionary use.

Note: The percentages do not total 100% due to a number of multiple e-dictionary users.

The most used e-dictionary is *Imiwa* (Japanese multilingual dictionary for i-phone and i-pad) scoring 16 counts, followed by *Jisho.org* (online Japanese-English bilingual dictionary) scoring 13 counts. *Google Translate* (online translator), *Naver* (multilingual dictionary for Android), *Weblio* (online dictionary) scored eight, five and five respectively. There are 22 more e-dictionaries (including online dictionaries, plugin dictionaries and smartphone apps) mentioned. Some online dictionaries are used on more than one platform (e.g., desktop, laptop, tablet, phone).

Students use their dictionary/ies for various reasons. The most mentioned are 'convenient (easy) to use' and 'many and/or good examples', followed by 'can use anytime anywhere', 'fast' and 'extensive lexicons'. In addition, 'handwriting recognition', 'shows how to write *kanji* (adopted Chinese characters used in Japanese)', 'camera recognition', 'explanation in my language', 'including discipline-specific words', 'display in multiple languages', and 'works offline' are sometimes the reasons for using the particular e-dictionary. Other reasons include: 'free', 'can make a vocabulary list', 'good layout', 'shows word difficulty level', 'can learn both Japanese and English', 'can use on any site', 'no need to type in words', 'explanation in Japanese', 'reliable', 'has a word completion function', 'has intonation information', 'comprehensive', 'has a translation function', 'can input Japanese using alphabet', 'has collocation information', 'can use both on a computer and on a phone', and 'no advertisements'.

2.5. Results. Use of e-glossaries

To the question 'Have you used any system/application to assist reading Japanese e-texts?', only 17 (out of 82 students) responded 'Yes'. Eight students have used Rikai, five students, WWWJDIC, and four, Reading Tutor (No other e-glossary was mentioned). 49 out of 65 students who do not use an e-glossary provided a reason for not using; the main reason is that they do not know of such a system (26 students). 18 students think that such a system is not necessary (not doing out-of-class reading, being happy with their e-dictionaries or already having high level of reading ability).

Other reasons for not using include: not convenient, e-dictionaries are better, do not like reading, do not know what an e-glossary does, and no particular reason.

2.6. Discussion

Sevik's survey (2014) on English learners revealed that using e-dictionaries on mobile devices was the most favoured method of looking up unknowns. The current study indicated the same tendency in L2 readers of Japanese. In contrast to Suzuki's (2012) results, which showed the majority of learners using portable e-dictionaries, the current survey revealed that many students use online dictionaries and smartphone apps, although portable e-dictionaries have not disappeared.

Except for the clear strong preferences towards *Imiwa* and *jisho.org*, and the moderate preference towards *Google Translate*, students seem to be using a variety of e-dictionaries, most of which are e-word dictionaries. The reasons for using their dictionary/ies vary as well; user friendly (easy to use, fast, in learner's language) ubiquitous (anywhere anytime, can be used offline), and functions (extensive lexicons, good examples, facilities to recognise *kanji*).

The second half of the survey concerned the use of e-glossaries. An e-glossary can provide what an e-word dictionary can (i.e., provide information about individual words) and what it cannot (e.g., segment a text into meaningful units, and gloss a whole text). Despite this superior usability, the majority of students do not use an e-glossary due to a lack of information about this system. It is vital that learners and educators have a sound knowledge about e-glossaries, and make an informed decision on whether or not to use one. To this end, this study examines e-glossaries in terms of user-friendliness, ubiquity and functions, which are the main reasons mentioned for using the e-dictionaries.

3. Study 2: Evaluation of e-glossaries

3.1. Background

Before we examine what an e-glossary *can do*, we review the literature to see what it *should do* to support L2 readers.

3.1.1. User-friendliness

An e-glossary differs from an e-word dictionary in that it assists users to comprehend an e-text. Therefore, being able to capture a whole text and hyper-gloss individual words/phrases are essential. The format of the glossing can be in-text (embedded within a text) or pop-up (become visible only when clicked or a mouse hovered over). Chen and Yen (2013) compared three ways of display, in-text, pop-up and a separate list, and found that the pop-up format produced the best performance in L2 readers. On the other hand, the study conducted by AbuSeileek (2011) revealed that in-text glossing in the left or right margin had the best impact. In either case, however, a separate list (at the bottom) format did not produce a desirable effect. An e-glossary should give L2 readers glossing of words/phrases in the language that requires minimum cognitive load. Research findings suggest that, L2 learners prefer bilingual dictionaries (Sevik, 2014), and even when different types of glosses are made available for consultation, L2 learners tend to utilize primarily L1 definitions only (Lomicka, 1998), with an exception for highly advanced readers' preference to L2 definitions (Sevik, 2014).

3.1.2. Ubiquity

With the improvement of internet connectivity and mobile devices, not having an offline option may be a diminishing issue. What is an issue is that some online dictionaries only work on a large screen. Jin and Deifell (2013) reported that 93.4% of e-dictionary users used a laptop computer as the primary device, and 31.4% of them used other mobile devices (multiple choices were permitted). As smartphone and tablet owners increase, there will be an ever-increasing demand for e-glossaries that work on any platform (e.g., desktop, laptop, tablet, phone) whether offline or online, and however connected (e.g., cable, wifi or phone network).

3.1.3. Functions

The annotations should cover, ideally, all words/phrases in texts. Research suggests that, to successfully comprehend a text, L2 learners need to be able to recognise and decode 95-98% of the words in the text (Nation, 2001). An e-glossary assists in increasing intermediate and pre-advanced L2 learners' coverage of the text to the optimal level, and hence improving comprehension (Caleb & Matsumoto, 2011). Even if full comprehension may not be achieved by the use of an e-glossary in the case of beginner L2 learners, it will be helpful for vocabulary learning. An e-glossary therefore should have glossing for as many words/phrases as possible so that it will be ready for L2 readers.

As a Japanese sentence does not have a break between words (except some occasional commas), accurate and appropriate word segmentation on a system is critical in providing useful information about words/phrases. Chun (2001) reported that learners who used an e-word dictionary could not find many words in the dictionary due to their looking words up improperly, e.g., declined or conjugated forms rather than the base or root forms. An e-glossary is designed to solve this problem; it should identify any form and gloss it.

Not only *content* words (e.g., nouns, verbs, adjectives and adverbs), but *function* words (e.g., pronouns, particles, conjunctions, auxiliary verbs, components showing tense, aspect, voice and modality) need to be glossed. Knowledge of function words/phrases is a similar, if not identical, concept to that of grammar knowledge and syntactic knowledge. In the meta-analysis of components related to L2 reading comprehension, Jeon and Yamashita (2014) found that grammar and vocabulary are the two major contributors to comprehension. Grabe (2009) lists vocabulary and syntactic knowledge as the top two crucial components of L2 reading comprehension. Glossing function words is critical for syntactic comprehension, particularly in Japanese, in which tense, aspect, voice and modality are all shown in the form of bound (non-stand-alone) morphemes.

3.2. Evaluation of e-glossaries

3.2.1. Materials

In order to evaluate existing e-glossaries and identify areas for improvement, the three e-glossaries that have been named in the above e-dictionary survey are evaluated against the following criteria. The e-glossaries in question are: Rikai, WWWJDIC, and Reading Tutor.

3.2.2. Criteria

- User-friendliness – (a) Capture of a text, (b) Display of gloss, and (c) Languages of gloss
- Ubiquity – (a) Platforms and (b) Online/offline
- Functions – (a) Coverage, (b) Segmentation, (c) Content words, and (d) Function words

3.2.3 Procedure

Three unmodified Japanese text segments in different styles of writing (plain, polite, and colloquial styles), were chosen as test passages. These three passages were pasted into the three e-glossaries, and the results of processed passages were examined.

3.3. Results

3.3.1. User-friendliness

Rikai allows users to enter a web address or paste a text in the box provided. When the 'go' button is pressed, the results page is displayed. Glosses (definitions in English and pronunciations in Japanese) are shown in pop-up windows when the user moves the mouse over the text to see the definitions and pronunciations. WWWJIC is a multi-functional e-dictionary, one of the functions of which is an e-glossary. Users can enter a web address or paste a text into the provided box. The results (glosses) are shown below each sentence of the text. The default language is English, but users can change the system to display in other languages. Reading Tutor can be used as an e-word dictionary or an e-glossary (different pages). The e-glossary page lets users paste a text into the box, and when one of several languages is selected, it displays a scrollable

bar of glosses on the right hand side of the results page in the language (see Figures 1, 2 & 3, and Table 2).



Figure 1. The result pages of *Rikai*.



Figure 2. The results page of *WWWJDIC*.



Figure 3. The results page of *Reading Tutor*.

	<i>Rikai</i>	<i>WWWJDIC</i>	<i>Reading Tutor</i>
Capture of text	URL or paste	URL or paste	Paste
Display of glosses	Pop-up	Below sentences	Right margin
Language(s) of glosses	English (& 2 others in add-on/plugin versions)	English & Japanese & 9 others	English & Japanese & 4 others

Table 2. User-friendliness of e-glossaries.

3.3.2. Ubiquity

Rikai has add-on/plugin versions: Rikai-chan (for Firefox), Rikai-kun (for Chrome), Rikai-sam (modified version of Rikai-chan. Supports Windows, Ubuntu and newer versions of OSX). Rikai-sama has more features than the earlier versions. Strictly speaking, WWWJDIC does not have mobile device versions. However, there is WWWJDIC for Android created by another author, and the databases of WWWJDIC have been used in many other e-dictionaries, including Rikai. Reading Tutor does not have other versions (see Table 3). None of the above work offline.

	<i>Rikai</i>	<i>WWWJDIC</i>	<i>Reading Tutor</i>
Other form	add-on/plugin	None	None
Online or offline	Online	Online	Online

Table 3. Ubiquity of e-glossaries.

3.3.3. Functions

Coverage was evaluated using numbers and percentages of highlighted characters (indicating information is available). As the definition of a *word* is not well-defined in Japanese (Kato, 2006), characters rather than words were counted in order to determine the proportion of coverage. Firstly, for each passage, total characters per passage were counted, after deleting all punctuation. Secondly, the highlighted characters in each system were counted, and percentages were then calculated. The overall low coverage across the e-glossaries (see Table 4) appears to be due to insufficiently covering function words and post-verb bound morphemes showing tense, aspect, voice and modality.

	Total # of characters	<i>Rikai</i>	<i>WWWJDIC</i>	<i>Reading Tutor</i>
Passage 1	173	71 (41%)	136 (79%)	122 (71%)
Passage 2	245	120 (49%)	186 (76%)	152 (62%)
Passage 3	205	80 (39%)	148 (72%)	143 (70%)

Table 4. Numbers of characters and percentages of information provided.

Not all highlighted characters contribute to the provision of information. Several cases of over-segmentation of multi-word units (hereafter MWU) are observed in Reading Tutor and, to a lesser extent, in Rikai; for example, 馬の耳に念仏 [not heeding what others say] into 馬 [horse], 耳 [ears], and 念仏 [Buddhist prayer]. MWU refers to a combination of words that conveys a meaning on its own, including noun compounds, compound verbs, collocations, idioms, proverbs, fixed phrases and other lexical bundles. In WWWJDIC, this type of error is rare, as it provides the definitions of MWU as a

whole. However, a few wrong segmentations of another sort are identified. For example, *ということわざもある* [there is a proverb saying ...] should be segmented into *という / ことわざ / も / ある*. However, WWWJDIC mis-segments it, and provides information for *ということ* [such a thing], leaving *わざ* un glossed. This is because WWWJDIC uses a greedy algorithm (searching for a longest match in the dictionary). The coverage of accurate information, after removing mis-segmented parts, is shown in Table 5.

	Total # of characters	Rikai	WWWJDIC	Reading Tutor
Passage 1	173	62 (36%)	123 (71%)	110 (64%)
Passage 2	245	114 (47%)	186 (76%)	146 (60%)
Passage 3	205	74 (36%)	146 (71%)	108 (53%)

Table 5. Numbers of characters and percentages of accurate information provided.

The e-glossaries were then examined to determine whether information of content words and function words was provided. Rikai displays almost no function words. On the other hand, WWWJDIC has its strength in displaying functions words. Reading Tutor has abundant information for content words, but little information for function words (see Table 6).

	Information	Rikai	WWWJDIC	Reading Tutor
Passage 1	Content word	YES 25 types	YES 29 types	YES 35 types
	Function word	NO	YES 6 types	YES 3 types
Passage 2	Content word	YES 42 types	YES 34 types	YES 45 types
	Function word	NO	YES 8 types	YES 3 types
Passage 3	Content word	YES 27 types	YES 32 types	YES 40 types
	Function word	YES 1 types	YES 5 types	YES 3 types

Table 6. Information provided for content words and function words.

3.4. Discussion

In terms of user-friendliness, Rikai and WWWJDIC might be slightly more user-friendly than Reading Tutor because they allow users to paste web-addresses, and WWWJDIC can be more user-friendly than others if the learner's language is one of the many languages that this e-glossary covers. Their display formats are very different from each other, which may also affect user-friendliness. For ubiquity, all of them are for online use. However, since Rikai only shows essential information (no details), the small screen of a smartphone does not hinder users. On the other hand, WWWJDIC and Reading Tutor do not have that degree of compatibility (they are not made for smartphone use). This incompatibility might be a reason why only a handful of students use e-glossaries.

A reason for the overall low coverage in the e-glossaries seems to be that verb conjugations and post-verb bound morphemes are not adequately covered. For instance, none of the systems gives information about verb conjugations although WWWJDIC provides notes mentioning conjugation forms, such as "it is possibly the volitional form". Understanding conjugations accurately is crucial for reading comprehension (Shiotsu & Weir, 2007). As Japanese is an agglutinative language, meaning-determining information, such as tense, aspect, voice and mood, are all expressed in seemingly one single MWU, which carries critical information for comprehension. Provision of some explanation for the 'conjugation' MWU is required.

The results have revealed that segmentation errors can be caused by two distinct reasons: over-segmentation of MWU and identification of longest matches. Over-segmentation of MWU in Reading Tutor seems to be due to the morphological analyser being used. Most available Japanese morphological analysers use a small meaningful unit (i.e., a grammatical unit that carries semantic distinction) for the segmentation of a text, often conflicting with the size of the unit with which Japanese language learners are familiar (Yamauchi, 2008). On the other hand, WWWJDIC uses a greedy algorithm (searching for a longest match in the dictionary), and successfully finds MWU, provided they are in their dictionaries. A downside of using this algorithm is occasional inappropriate segmentations.

The results of the evaluation showed that e-glossaries gloss a number of content words, but glossing of function words is insufficient. In order to understand an unmodified text, information concerning function words is crucial. Jin & Deifell (2013) found, in their survey investigating the use and perception of online dictionaries across L2 learners of eight different languages, that Google (Google Search and Google Translate) and wordreference.com (both the dictionary and forum facilities) were the most frequently used sites. Their data revealed that the L2 readers preferred to use Google and wordreference.com forum in conjunction with other online dictionaries (which often only give content words) because they could look up the meanings of function words and MWU. If an e-glossary provides such information, learners do not need to consult multiple dictionaries.

4. Conclusion

The main aim for the current study is to investigate the usage and efficacy of e-dictionaries for Japanese, a language without boundaries between words. This article reported the results of two studies concerning e-dictionaries: a survey study investigating the use of e-dictionaries (particularly e-glossaries) by L2 Japanese learners, and a comparative study evaluating existing e-glossaries for Japanese.

The results on the use of e-dictionaries have clearly shown that using e-word dictionaries on various devices is becoming a trend. For reading an e-text, it is expected that the use of an e-glossary, which segments a text and glosses linguistic items, would be preferred over the use of an e-word dictionary. However, the results of the survey suggest that few L2 learners use an e-glossary, or even know of the existence of such. Whether the e-dictionaries that L2 learners use are the results of informed choices is questionable. Previous studies (e.g. Pasfield-Neofitou, 2009) and personal comments from some of the participants of the current survey suggest otherwise.

The second study was conducted to evaluate e-glossaries, their features and characteristics, to determine the reasons for their low usage. Although the generalisation of the current results has limitations due to the study's small sample size, it was found that the restricted platforms on which e-glossaries can run may be a reason for limited adoption. The results also suggest that e-glossaries have various functions, but lack some requisite functions, such as accurate segmentation and showing function words and MWU.

Due to increased internet connectivity and platforms, the survey study showed a dramatic increase of users of online dictionaries and smartphone apps, compared to three years ago. However, most available e-dictionaries are e-word dictionaries, in which the user can look up individual words. In other words, L2 learners need to be able to identify words (i.e., boundaries of words), appropriately segment function words and MWU (including components showing tense, aspect, voice and modality) and change them into their root forms in order to look up properly in an e-word dictionary. However, at present, the ubiquity of e-word dictionaries is preferred over the informativeness of e-glossaries. The evaluation of e-glossaries revealed that there is still room for improvement; it was discussed that an e-glossary would benefit by the provision of information for those linguistic components crucial to the target language. This study suggests that technical issues revolving around the lack of spaces between words may be a reason for the lag in usage and efficacy of e-glossaries for languages without word boundaries.

It has been reported that educators consider dictionary use to be something learners do on their own on their own responsibility (e.g., Liou, 2000), and with a marked increase of e-dictionary availability, it is becoming ever harder for educators to grasp the whole picture. For this reason, studies concerning usage and efficacy of e-dictionaries, such as this one, are valuable. For learners and educators to make judgements about e-dictionaries, their evaluation is as necessary and as beneficial as the effects of their use by learners.

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E-glossaries analysed:

- Reading Tutor <http://language.tiu.ac.jp>
- Rikai <http://www.rikai.com/perl/Home.pl>
- WWWJDIC <http://www.edrdg.org/cgi-bin/wwwjdic/wwwjdic?1C>