Alessandra CORDA, Vincenzo LO CASCIO, Massimiliano PIPOLO, Faculteit der Letteren, Universiteit van Amsterdam

Automatic Reversal of a Bilingual Dictionary: Implications for Lexicographic Work.

Abstract

The aim of this paper is to examine to which extent the possibility to automatically reverse data that have previously been stored in a relational database can influence the realization of a bilingual dictionary. In the light of the experience of *Itolit*, an Italian-Dutch/Dutch-Italian bilingual bidirectional dictionary project carried out at the University of Amsterdam and directed by Vincenzo Lo Cascio, we will discuss how the information in the bilingual dictionary should be structured and coded in order to optimize the results of the reversal process. On the basis of the results of the reversal of the Italian-Dutch section, we will then focus on the implications for bilingual lexicography (e.g. treatment of senses, idioms, collocations) and we will show how lexicographers can take advantage from the material that has been obtained in this way, to quicken the editorial work, but also to improve the quality of the information.

Keywords: automatic reversal, bilingual dictionary, sense, collocation, relational database

1. Introduction

Database programs are nowadays widely used to storage lexical information, not only for research purposes, but also for dictionary projects. The *Itolit*-project aimed first of all at creating a relational database of the Italian language (intended for contrastive applications, as outlined in Lo Cascio 1990), and then at using the information stored in the database as input for an Italian-Dutch/Dutch-Italian bilingual bidirectional[1] dictionary (also stored in the same relational database). During the first phase of the *Itolit*-project, the structure of the relational database was laid out; then the database was filled with the data (Italian entries with grammatical and semantic information, definitions, examples, idioms and collocations).[2] At a second stage, data were selected, elaborated and translated into Dutch. In the third phase (currently in progress), after automatically reversing the Italian-Dutch section, Dutch-Italian entries are selected, elaborated and integrated with information from the Dutch lexical database VLIS.[3]

In this paper we will first discuss the general conditions for a successful implementation of the automatic reversal process (section 2), then we will deal with the problems arising from the reversal of grammatical and semantic information (section 3) and with the selection among translation equivalents generated by the reversal process (section 4). As we will see, reversing one dictionary section can produce a considerable amount of information, partly directly usable without further elaboration. The treatment of collocations in bilingual dictionaries will also be discussed in relation with the optimization of automatic reversal (section 5). We will conclude with general remarks about the efficacy of automatic reversal as a tool to construct bilingual dictionaries (section 6).

2. Constraints and purpose of the automatic reversal process

Automatic reversal (AR) can in principle be applied to all machine-readable dictionaries (MRDs), but this operation will result in a significantly better outcome if the electronic dictionary has been stored in a relational database[4], in which data can be systematically grouped in separate tables, and tables can be linked to each other. Starting from a Lx-Ly bilingual dictionary in database format, the aim of AR is to create a Ly-Lx bilingual dictionary which is as complete as possible, and in which the entries are as organized as possible. As a first consequence, the production of the dictionary can be considerably sped up; but AR is not only a way to quicken the editorial work. More importantly, it can also improve the quality of the information: the reversed database enhances the possibility for cross-check between the two sections of the bilingual dictionary, thus contributing to the coherence of the data.

The central question in designing an AR tool is: to which extent can AR provide accurate and adequate information, so that no further corrections or adjustments are needed? From another perspective: under what constraints can a translation equivalent (TE) X of a lexical input Y be reversed so that a lexical input X can have Y as TE? Generally speaking, TEs should not be reversed in the following cases:

a) if the SL (source language) input is marked (semantically or stylistically connotated) and the TL (target language) TE is unmarked. For instance, the Italian expression *orbe terrestre* ('globe'), connotated as 'literary', does not have a literary TE in Dutch; the only possible TE is *aardbol* ('world'). *Aardbol* should not be reversed, otherwise the entry *aardbol* in the Dutch-Italian section would get *orbe terrestre* as TE. Thus: *aardbol* is a good TE for *orbe terrestre*, but *orbe terrestre* is not a good TE for *aardbol* (a better one would be *globo (terrestre)*). Incidentally, connotations are not always explicitly indicated in monolingual dictionaries, but such information is very important for the AR process and should systematically be provided in the SL-TL section.

b) if the concept expressed by the SL input has no correspondent in the TL; in this case the TL TE is a description. For instance, Dutch *eenverdiener* ('sole/single wage-earner') has no TE in Italian and could be explained with *unico stipendiato in un nucleo familiare* ('sole wage-earner in a family').

TEs like those in a) and b) should be marked in a particular way and not reversed.[5] The AR software should then aim at reversing selected TL TEs (belonging to senses and also to examples/idioms), together with grammatical and semantic information, in such a way as to obtain a reversed input which is as structured as possible: lemmas, divided into different grammatical categories, and under the grammatical categories the corresponding senses, examples and idioms.

3. Automatic reversal of grammatical and semantic information

If the input and the output languages are similar from a typological point of view, as is the case with Dutch and Italian, it is not difficult to reverse the grammatical information and to 'reconstruct' entries and grammatical categories in the reversed section. The major discrepancy in our case was the fact that adjectives and manner adverbs in Dutch generally form one

part-of-speech, because they are not morphologically distinguished, whereas in Italian they clearly belong to two different parts-of-speech.

However, this did not cause problems for the AR from Italian into Dutch, because the translation software by default assigns to the Dutch TE the grammatical category of the Italian lemma, unless otherwise specified. Interestingly, if the Dutch-Italian section had been selected for elaboration and reversal first, this default option would not have been so effective, because in the Dutch lexical database VLIS (and in most Dutch bilingual dictionaries) manner adverbs are not systematically registered as a separate grammatical category, as they are morphologically identical to the corresponding adjective.

According to the general formation rule of manner adverbs in Italian, the suffix *-mente* must be added to the adjective, like in *veloce* ('quick'), *velocemente* ('quickly'); if the adjective ends in *-o*, the feminine form in *-a* is used: *certo* ('certain'), *certamente* ('certainly'). But in a lot of cases a Dutch manner adverb cannot be translated by an Italian manner adverb ending in *-mente*. For instance, the Dutch adjective/manner adverb *eindeloos* ('endless(-ly)', Italian *infinito/infinitamente*) can in some contexts only be translated with the expression *all'infinito*, and not by *infinitamente*, like in *eindeloos herhalen - ripetere all'infinito* ('never stop repeating'). If we want the Dutch-Italian section to become a true 'bidirectional' instrument, as much useful information as possible for Dutch speakers wanting to translate into Italian must be added; of course, this information is in most cases superfluous for Italian speakers who translate into their mother tongue. All cases in which Dutch manner adverbs cannot be translated by an Italian *-mente* adverb should then be mentioned; but to find these cases, adverbs should be treated as a separate category.

This example shows that a bidirectional dictionary (of, at least, the section of a mono-directional dictionary meant for 'active' usage) is particularly suitable for AR. In our case, the Dutch-Italian section can be used by Dutch speakers to produce Italian texts and by Italian speakers to understand Dutch texts (and to produce Italian texts from Dutch originals). If the Dutch-Italian section had been principally intended for 'passive' usage by Italian speakers, the Italian-Dutch reversed output would have been less rich, and more integration work would have been necessary.

Reversal of semantic information is a much more complicated matter than reversal of grammatical information. However, it is not difficult to automatically list examples and idioms under a certain sense X2 in the reversed section, if these examples and idioms are also grouped together under the corresponding sense X1 in the source section. The TE of sense X1 becomes a lemma in the reversed section. This is for instance the result of the AR of the lemma *appetito* ('appetite'), as shown in Table 1. In this and in the following tables sense discrimination is given between [ ]; in the case of *appetito/eetlust* the notation [...] indicates that no sense discrimination had been given, because *appetito* had only one sense.

Table 1

Microstructure	Italian-Dutch	(reversed) Dutch-Italian
Lemma	*appetito*	*eetlust*
Sense 1 'appetite'	[...]	[...]
Translation equivalent	*eetlust*	*appetito*
Examples/idioms: 1. 'stimulate the appetite'	*stuzzicare l'appetito*	*de eetlust opwekken*
Translation equivalent	*de eetlust opwekken*	*stuzzicare l'appetito*
Examples/idioms: 2. 'take away one's appetite'	*rovinare/guastare l'appetito a q.no*	*iem. de eetlust benemen*
Translation equivalent	*iem. de eetlust benemen*	*rovinare/guastare l'appetito a q.no*

The problems arise in cases in which for one sense (of idiom, or collocation) in the reversed section (Dutch-Italian) there are several TE in Italian, as in *eigeel* in Table 2:

Table 2

Dutch	Italian
eigeel ('egg yolk')	*rosso d'uovo* ('egg yolk') *tuorlo* ('egg yolk') *rosso* ('egg yolk')

To obtain the final result immediately, the reversal software should be able to reverse the lemmas *tuorlo* and *rosso* and the collocation *rosso d'uovo*, and to construct a lemma *eigeel* in Dutch with three TEs. This means that the computer programme should be able to recognize that these three TEs are synonyms, for instance through information retrieval from a lexical-semantic network, like that described in Fontenelle (1997), based on Mel'cuk's lexical functions. In our project, the input was not enriched with systematically coded information about lexical relations, and it would have taken considerable effort to create software able to group the senses together. As a consequence, the lexicographer has to systematize the reversed material; the reversed lemma *eigeel* is shown in Table 3.

Table 3

Microstructure	(reversed) Dutch-Italian
Lemma	*eigeel* ('egg yolk')
Sense 1	[...]
Translation equivalent	*rosso d'uovo* ('egg yolk')
Sense 2 ['egg yolk']	[*tuorlo*]
Translation equivalent	*rosso* ('egg yolk')

In this case, the programme has created two senses, one without specific sense discrimination, and one characterized by the sense discrimination [*tuorlo*]. The TEs *rosso* and *rosso d'uovo*

are synonyms, but the AR programme has no elements to identify the TEs as such, and thus to merge the two senses into one sense. A third possible TE, *tuorlo*, can be obtained from the sense discrimination; this shows another advantage of AR, that is, lexicographers can get suggestions for TEs not only from the reversed translations but also from metalinguistic indicators.

To get an idea of the differences between the source section and the reversed section, consider Table 4:

Table 4

Items	Italian-Dutch	Dutch-Italian (reversed)
Entries	41.068	59.158
Senses	75.616	114.555
Examples	63.297	57.861
Collocations and idioms	26.983	28.931
Translation equivalents of senses (lexicalised)	93.174	93.745
Translation equivalents of senses (not lexicalised)	8.435	14.526

In the reversed section the number of senses is higher (33,9% more) than in the source section, for the reason we explained above: the reversal programme merges senses together only if the senses are characterized by the same metalinguistic indicators, otherwise senses are listed separately. Differences in the number of entries (30% more in the reversed section) are due to the fact that in the source section a lot of TEs of senses, examples and collocations are lexicalised and generate a new entry in the reversed section. In the reversed section the number of examples is lower (8,59% less), because some examples of the source section have a lexicalised TE, which becomes an entry in the reversed section; the example will then become a not lexicalised TE under a sense.

On the other hand, the number of collocations is higher in the reversed section (6,74% more) because for collocations more TEs could be given than for examples and because not-lexicalised TEs of senses have become collocations. Finally, the higher number of not-lexicalised TEs (42% more) is a consequence of the fact that examples and collocations in the source section have lexicalised TEs, and these are transformed in entries (senses) in the reversed section. The total number of TEs of senses in the reversed section (108.271) is lower than the number of senses (114.555); this is because a lot of senses have been created by the reversal software just to 'append' examples/collocations, and have no TEs.

4. Selection of translation equivalents

Lexicographers working on a bilingual dictionary not only have to find examples and adequate TEs; they often intervene in the structure of the SL entry, by adding new sense discrimi-

nations or by merging senses, depending on the TEs in the TL. In our experience, working on a reversed section does not simplify the systematization of the microstructure level, but facilitates search for appropriate TEs. This can be illustrated by the example in Table 5:

Table 5

Microstruture	Reversed Dutch-Italian	Microstructure final version Dutch-Italian	
Lemma	*Preek*	Lemma	*Preek*
Sense 1a.	[REL.]	Sense 1b.	[REL.]
TEs	*predica* ('sermon') *sermone* ('sermon')	TEs	*predica* ('sermon') *sermone* ('sermon')
Sense 2a.	[...]	Sense 2b.	[vermaning 'admonition']
TE	*paternale* ('lecture', in the meaning of 'scolding', 'talking-to', 'telling-off')	TEs	*predica* ('sermon') *paternale* ('lecture') *predicozzo* [SCHERTS.] ('talking-to', 'telling-off' *fervorino* [SCHERTS.] ('talking-to', 'telling-off')
Sense 3a.	[SCHERTS. 'jocular']		
TE	*pistolotto* ('dressing-down', 'talking-to')		
Sense 4a.	[UITBR. 'extendend']		
TE	*predica* ('sermon')		
Sense 5a.	[predicozzo 'talking-to', 'telling-off']		
TE	*discorsetto* ('talking-to', 'telling-off')		
Sense 6a.	[SCHERTS. 'jocular']		
TE	*fervorino* ('talking-to', 'telling-off')		

Sense 1b is identical to sense 1a; *sermone* and *predica* have been automatically grouped together because they were characterized by the same label (REL., 'religious'). Senses 2a, 3a, 4a, 5a and 6a have been grouped together under sense 2b 'admonition'. Sense 2b has four TEs: *predica* comes from sense 4a, *paternale* comes from sense 2a, *fervorino* comes from sense 6a; *pistolotto* (3a) and *discorsetto* (5a) have not been selected. *Pistolotto* is not very frequently used; *discorsetto* in this sense is almost only used in *fare/tenere un discorsetto a qualcuno* ('to give somebody a lecture'). Note that the TE *predicozzo* comes from the sense discrimination of 5a; the lexicographer decided to use it as a TE.

The metalinguistic indicators, which in the Italian-Dutch section help to distinguish senses, have a double function in the reversal process:
1) they are used by the AR software to establish whether senses, examples and collocations should or not be grouped together. In this way, examples/collocations that are grouped

together under a certain sense X1 in the SL-TL section will also be grouped together under the corresponding sense X2 in the reversed section (as in the case of *appetito - eetlust*, see Table 1). Moreover, if more TEs of the same entry are characterized by the same label, they will also be grouped together under the same sense (as in sense 1a, Table 5).
2) in many cases the sense discrimination in bilingual dictionaries is a synonym of the lemma (see 5a, Table 5: *predicozzo* and *discorsetto* are synonyms). As a consequence, the sense discrimination is a synonym of the TE in the reversed section and can therefore be employed as a new TE.

Also collocations generated by AR often have different TEs. For instance, Dutch *om de beurt* ('in turns', 'alternately', 'in rotation') has three TEs: *a turno* ('in turns'), *alternativamente* ('alternately') and *a rotazione* ('in rotation'). Again, the lexicographer has to select among the different possibilities, or to add metalinguistic information for Dutch speakers; in most cases one of the TEs can be used in the large majority of contexts (in the above example the most general TE is *a turno*).

It is also possible that all reversed TEs are collocations or idioms, while the reversed Dutch input is not idiomatic, like in the case of *talent* in Table 6:

Table 6

Microstructure	(reversed) Dutch-Italian
Lemma	*talent*
Sense 1 'talent'	[...]
Examples/idioms: 1. 'be talented'	*talent hebben*
TE	*avere della stoffa*
Examples/idioms: 2. 'have a talent for'	*talent hebbben voor*
TE	1. *avere disposizione per* 2. *avere il genio di*

The most neutral TEs *avere talento* ('be talented') and *avere talento per* ('have a talent for') do not occur, because they were not given as SL input in the Italian-Dutch section. In this case, the lexicographer may decide to add these 'unmarked' TEs and to operate a selection among the TEs generated by AR. Probably, the lexicographer would not have thought of *avere della stoffa*, and certainly not of *avere genio per* (quite unfrequent); this TE would almost certainly be excluded, because unmarked input should not be translated with marked input (at least, not in a dictionary section intended for 'active' usage by speakers of the input language). Generally speaking, it will often happen that, like in this case, not-connotated reversed input will have connotated TEs, while it is not probable that connotated reversed input will have not-connotated TEs (because in the source section not-connotated input is not normally translated with connotated output).

Sometimes the reversed 'collocations' are well-formed Dutch expressions, that would not normally be listed in a bilingual dictionary because they do not habitually co-occur and are not 'fixed' enough. But from a contrastive standpoint it can be interesting to know if a certain

sequence of words in the reversed section is translated with a 'real' collocation or a lexicalised item in the SL. Not all cases, of course, are relevant for the purposes of a bilingual dictionary; the selection should be based on criteria of predictability and frequency.

For instance, Dutch *abrupte verandering* ('sudden change'), translated with *sbalzo* ('sudden change', 'jump') is not, strictly speaking, a 'collocation'. In this case there is no Dutch lexicalised TE for Italian *sbalzo* (mostly used in the combination *sbalzo di temperatura* 'a sharp rise (or drop) in temperature'). In other cases there are lexicalised and not-lexicalised Italian TEs, like for instance *onaangename ervaring* ('unpleasant experience'), translated with Italian *disavventura* ('mishap'). *Disavventura* also occurs as TE of the Dutch entries *incident* and *ongeluk* (both corresponding with 'mishap'); *onaangename ervaring* has clearly been added as a secondary possibility. Some of these 'collocations' can be explained through differences in morphosemantic patterns: in Italian, for instance, causatives and change-of-state verbs are more frequently lexicalised than in Dutch. In the reversed Dutch section there are therefore 'collocations' like *doen uitzetten* = *dilatare* 'to dilatate' or *besmet raken* = *infettarsi* 'to become infected'.

5. Sense differentiation and treatment of collocations in relation to automatic data reversal

Sense differentation in most bilingual dictionaries is based on the structure of monolingual dictionaries. Very often, monolingual dictionaries do not distinguish properly between senses and idioms or collocations; in Italian monolingual dictionaries this is often the case with the so-called *unità polirematiche*, lexical clusters like *ferro da stiro* ('iron') or *self-service*, i.e. idioms in the sense of Cruse (1986: 37). For instance, according to the Italian monolingual dictionaries Palazzi and Zingarelli, the lemma *stazione* ('station') has among others the sense of 'resort'. But the idioms listed under this sense (e.g. *stazione balneare* 'seaside resort', *stazione termale* 'spa', *stazione climatica* 'health resort') are the only cases in which *stazione* can be used in the sense of 'resort'. 'Resort' is thus not an independent sense of the lemma, but is actually derived from the sense of an *unità polirematica.*

Let us now consider the same lemma in two bilingual dictionaries, Italian-German (Sansoni) and Italian-English (SEI), whose structure is strongly conditioned by that of monolingual dictionaries. Both dictionaries individuate, like the monolingual ones, a separate sense 'resort' (German TEs 'Ort', 'Aufenthaltsort). If the data were reversed, the lemma 'resort' in the English-Italian would then get as TE *stazione*, which is not correct.

This example shows that, in order to take advantage from the AR of the data, lexical information has to be structured in a more systematic way than dictionaries usually do, and that more attention has to be paid to the distinction between senses and idioms/collocations. Simple tests can be developed for this purpose: for instance, a sentence like 'The Italian Riviera is famous for its resorts' cannot be translated with **La Riviera è famosa per le sue stazioni*, which would be interpreted as 'the Italian Riviera is famous for its (railway) stations'. The conclusion is that AR requires first of all a systematic differentiation between senses and idioms/collocations.

Why do monolingual dictionaries not make this distinction in a systematic way? This is because they have a hierarchical structure: at the top the lemma (characterized by a particular

grammatical category), at the intermediate level the senses and at the lowest level usage contexts (examples, idioms and collocations).[6] In order to guarantee a more adequate representation of semantic information in the lexical database, this should not be structured according to the above mentioned hierarchical principle, but in a flexible way. In the representation tree idioms and collocations should not only be listed under a sense, but also, if necessary, at the same level as the senses. In bilingual dictionaries, then, information about TEs shoud be grouped separately for senses and idioms, in order to optimize the AR process. Collocational dictionaries as the one described in the DECIDE project (Heid 1997, Grefenstette et al. 1996) could be profitably used for AR purposes.

6. Optimization and results of the automatic reversal process

The more grammatical and semantic information about TEs is given in the SL-TL section, the more accurate the reversed TL-SL section will be. One strategy could be developing software which allows lexicographers to access a work-in-progress version of the reversed dictionary, while they are still working on the first section, in order to put together or distinguish senses, to list idioms and collocations under the appropriate sense and to add senses and lemmas that cannot be obtained through the AR process. But this would lead to much more work for the lexicographer and would also increase the number of mistakes; in our experience, lexicographers find it difficult to concentrate at the same time on both sections.

We believe that a better strategy is to codify grammatical and (to some extent) semantic information in the SL-TL section, while selecting which TEs are suitable for reversal; once the SL-TL section has been completed, the data can be reversed. The structure of the reversed section will then be systematized and missing senses, lemmas and idioms/collocations will be added. Lexicographers cannot work on both sections at the same time, but the information obtained through the reversal of the SL-TL section can remarkably speed up the work in the second section. Lexicographers will not, in most cases, have to look for TEs; the major job will be organizing, selecting and integrating the reversed data.

Senses in the SL which have only one correspondent in the TL[7] (this is the case with a lot of technical words) can in any case be reversed without requiring further systematization. In the reversed Dutch-Italian dictionary, on a total of 59.158 lemmas, 27.369 lemmas (46,36%) have only one sense and one TE; moreover (but the total amount is difficult to calculate) there are also lemmas with two or more senses in which at least one of the senses has only one TE in the other language, like for instance the polysemous Dutch lemma *es* (Table 7). In this case the reversed entry does not need further elaboration:

Table 7

Microstructure	(reversed) Dutch-Italian
Lemma	*es*
Sense 1 'e-flat'	[MUZ.]
TE	*mi bemolle*
Sense 2 'es'	[PSYCH.]
TE	*es*
Sense 3 'ash'	[PLANTK.]
TE	*frassino*

Even if longer and complexer lemmas still have to be systematized, these data show that AR is an efficient tool for the construction of a bilingual dictionary. Summarizing, we can indicate the following conditions for the successful implementation of AR:

- data must be stored in a relational database;
- not all information must be reversed (for instance, not-connotated TEs of connotated input should not be reversed);
- data about senses and collocations must be carefully distinguished;
- as much semantic and grammatical information as possible about the usage of TEs must be provided (as in a SL-TL section meant for 'active' usage by SL speakers).

AR presents the following advantages for lexicographic work:
- quicker research of adequate TEs for polysemous entries;
- greater possibilities for cross-checking between the two sections of the dictionary;
- very limited or no editing work for entries with only one sense (in most dictionaries these entries represent 35%-45% of the total number).

In our case, the disadvantages mostly consist in the organization of the reversed input, which for long entries is complicated and time-consuming. The need for human intervention could be reduced by linking the SL-TL data to a lexical network, so that senses belonging to the same semantic area could be automatically grouped together.

7. Notes

[1] 'Bidirectional' indicates that each section of the dictionary is meant for translating into and from both languages; in the Italian-Dutch section both speakers of Dutch and speakers of Italian will find the necessary information to translate from Italian into Dutch. See Marello (1989: 18-21) for a discussion of the term 'bidirectional'.

[2] We use the terms 'idiom' and 'collocation' in the sense of Cruse (1986). An idiom is 'lexically complex and semantically simplex' (1986: 37), i.e., it consists of more than one lexical constituent and forms a single minimal semantic constituent (e.g. *to cook someone's goose, to kick the bucket*). A collocation is a sequence of lexical items 'which habitually co-occur, but which are nonetheless fully transparent in the sense that each lexical constituent is also a semantic constituent' (1986: 40), e.g. *fine weather, torrential rain, heavy smoker, to foot the bill.* See also Heid (1994) and Lo Cascio (1997) for definitional and descriptive problems about collocations.

[3] For a description see Schutz (1994).

[4] For exploitation of bilingual MRDs for research purposes and converting MRDs in relational database format see Fontenelle (1997: 275-278 and 282)

[5] For a more detailed treatment of this problem see Lo Cascio, Boraschi and Corda (1995).

[6] About this problem see also Corda (forthc.).

[7] Previously (Lo Cascio, Boraschi, Corda 1995) we called this relation 'semantic equivalence': in this case there is a 'bijection' between SL input and TL output (each piece of semantic information conveyed by SL input corresponds with only one piece of semantic information of TL output, and the other way round).

8. References

Corda, A. (forthcoming) Treatment of senses and collocations in dictionaries: an issue for lexicology and lexicography, in: K. Hengeveld & H. Olbertz (eds.), *Proceedings of the VIIth International Congress in Functional Grammar*, vol. 2. J. Benjamins, Amsterdam/Philadelphia.

Cruse, D.A. (1986) *Lexical Semantics*. Cambridge: Cambridge University Press.

Fontenelle, T. (1997) Using a bilingual dictionary to create semantic networks. *International Journal of Lexicography*, Vol. 10, n. 4, pp. 275-303.

Grefenstette G., Heid, U., Schulze, B.M., Fontenelle, T. & Gérardy, C. (1996) Multilingual Collocational Extraction: the DECIDE project, in: M. Gellerstam et al. (eds.) *Euralex '96 Proceedings*. University of Göteborg, pp 93-107.

Heid, U. (1994) On Ways Words Work Together - Topics in Lexical Combinatorics, in: W. Martin et al. (eds.), *Euralex '94 Proceedings*. Vrije Universiteit Amsterdam, pp. 226-257.

Heid, U. (1997) Costruzione di un dizionario delle collocazioni, in: T. De Mauro and V. Lo Cascio (eds.), *Lessico e grammatica*. Bulzoni, Roma, pp. 47-62.

Lo Cascio, V. (1990) La lessicografia italiana al confronto con quella europea, in: V. Lo Cascio (ed.), *Lingua e cultura italiana in Europa*. Le Monnier, Firenze, pp. 96-118.

Lo Cascio, V., Paolo Boraschi and Alessandra Corda (1995) Correspondence between senses and translation equivalents: automatic reversal of a bilingual dictionary, in: M. Thelen and B. Lewandowska-Tomaszczyk (eds.), *Translation and Meaning, part 3*. Universitaire Pers, Maastricht, pp. 221-231.

Lo Cascio, V. (1997) Semantica lessicale e i criteri di collocazione nei dizionari bilingui, in: T. De Mauro and V. Lo Cascio (eds.), *Lessico e grammatica*. Bulzoni, Roma, pp. 63-88.

Marello, C. (1989) *Dizionari bilingui*. Zanichelli, Bologna.

Schutz, R. (1994) VLIS: Van Dale Lexicographic Information System, in: W. Martin et al. (eds.), *Euralex '94 Proceedings*. Vrije Universiteit Amsterdam, pp. 511-522.

8.1. Dictionaries

1997 *Il Nuovo Zingarelli - Vocabolario della lingua italiana*. Zanichelli, Bologna

1982 *Dizionario inglese-italiano, italiano-inglese*. SEI, Milano.

1992 *Dizionario Palazzi della lingua italiana*. Loescher, Torino.

1987 *Dizionario Sansoni tedesco-italiano, italiano-tedesco*. Sansoni, Firenze.

1997 *DISC - Dizionario Italiano Sabatini Coletti*. Giunti, Firenze.