Verbs of visual perception in Italian FrameNet*

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In this paper, we present a frame semantic analysis of a small group of Italian verbs expressing visual perception, which constitutes the first stage of a project for developing an Italian FrameNet. Our results show a close correspondence between English and Italian perception-related frames. The main element of novelty in our approach is that the creation and annotation of Lexical Units is grounded in distributional information automatically acquired from a large, dependency-parsed corpus, which is balanced against the annotator's linguistic intuition. We claim that this can help to overcome some of the shortcomings of the classical lexicographic method used to create FrameNet.

Keywords: frames, Frame Semantics, lexical semantics, lexicography, visual perception

1. Introduction

The main tenet of Frame Semantics (Fillmore 1982, Fillmore 1985, Fillmore & Atkins 1992), is that linguistic entities such as words, idioms, and grammatical constructions evoke frames in the mind of language users. A frame is an abstract conceptual schema of a situation or event, constituted by a series of participants called Frame Elements (FEs). The ideal goal of Frame Semantics is to individuate all the frames evoked by the words in a language. This goal has been pursued for

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English in the FrameNet project (*http://framenet.icsi.berkeley.edu/*), an electronic lexicon based on Frame Semantics and supported by corpus data. The development of FrameNet is one of the major achievements in present-day research on the semantic organization of the lexicon, and on the syntax-semantics interface. Its very existence proves the possibility of turning Frame Semantics into a real-scale, data-driven lexical resource spanning across a huge number of lexical domains. FrameNet is organized around the notion of Lexical Unit (LU), a pairing of a word and the frame it evokes, with polysemous or ambiguous words possibly appearing in more than one LU. Identification of the frames evoked by lexical items is carried out in part through the annotation of example sentences drawn from linguistic corpora. The main purpose of the annotation is to document all the semantic and syntactic combinatory possibilities (valence patterns) for a given word, reporting the way FEs are linguistically encoded.

One of the reasons of FrameNet's success is that it allows for fine-grained, in-depth lexical analyses, whose outcome consists in richly annotated corpora that are proving invaluable to develop computational applications able to address text content. It is this twofold soul that makes the development of FrameNet resources an attractive enterprise for theoretical and computational linguistics alike. Various projects have focused on the creation of FrameNet for languages other than English, such as Spanish (Subirats 2009), Japanese (Ohara 2008), and German (SALSA: Burchardt et al. 2009). Spanish FrameNet and Japanese FrameNet are very similar to the Berkeley FrameNet, both in descriptive goals and methodology. Their main goal, like FrameNet's, is to systematically describe all possible frames evoked by the lexical items in their language and to capture the whole span of each frame's syntactic realizations. Therefore, the analysis of lexical units is conducted frame by frame, in order to describe one frame completely before going on to the next. As in the Berkeley FrameNet, the annotation process is carried out manually, for the most part. SALSA uses manual annotation as well, but instead of describing all possible frames for German, its aim is to annotate an entire corpus with frame semantic information, in order to create a resource for semantics-based NLP applications. Since there is no requirement to describe all the frames in the language, the analysis of LUs is conducted word for word instead of frame by frame. Besides manual annotation, great interest exists nowadays in (semi)automatic approaches to bootstrap FrameNets for new languages, typically employing methods derived from machine translation, or multilingual language processing in general (see Chen & Fung 2004, Tonelli et al. 2009 among the others).

In this paper, we present a frame semantic analysis of a sample of Italian verbs expressing visual perception, as the first stage of a long-term project whose ultimate goal is the development of Italian FrameNet, a frame-based electronic lexicon for Italian similar to the original English FrameNet. The small-scale analysis

described in this paper exemplifies a more general methodology that we have set up for the development of Italian FrameNet.[1]

Notwithstanding the advantages of automatic approaches (especially concerning the speeding up of the annotation process), we decided to use a manual approach to the development of Italian FrameNet. In most respects, we tried to replicate the workflow of the original English FrameNet, just like Spanish and Japanese FrameNet. One important difference, though, is that LU creation and annotation in Italian FrameNet is directly grounded in distributional information automatically acquired from a dependency-parsed corpus. We used these data to draw a global map of the distributional preferences of the verbs, such as their most prototypical syntactic frames and the typical noun fillers appearing as arguments. These were then used as a guide for identifying the most representative occurrences of each LU, in order to extract a sample for annotation. They also proved to be useful in the encoding phase, for instance helping us to identify the frame evoked by a given verb. The sampling process was not entirely automatic, however, since we found that distributional data need to be complemented by human knowledge regarding the grammaticality of certain distributional patterns and their relevance in the linguistic system in order to yield a truly representative sample. We developed this approach in order to overcome some of the shortcomings of the sampling strategy adopted in FrameNet, which has sometimes been criticized for relying too heavily on the individual annotator's intuition. We therefore propose a more principled sampling strategy which balances the global distributional patterns of LUs against linguistic intuition, while maintaining the accuracy of a manual approach.

Even though our sampling and encoding processes take the corpus distribution of LUs into account, our main goal is to eventually describe all possible frames for Italian. This "lexicographical" approach is different from approaches like SALSA's, whose goal is to provide an entire corpus with frame semantic annotation. Our annotation therefore proceeds by studying frames (or groups of semantically related frames) one at a time, as in the Berkeley FrameNet, not one LU at a time.

The structure of the paper is as follows: Section 2 illustrates the details of our methodology and workflow. Section 3 presents the analysis of the visual perception verbs encoded so far in Italian FrameNet. We will conclude the paper with some considerations on how the distributional information acquired from corpora could be used to further enhance the FrameNet architecture and lexical encoding.

1. Ours is not the only current attempt to create an Italian FrameNet. We are a part of *Iframe* (*http://sag.art.uniroma2.it/iframe/doku.php?id=start*), a coordinated effort to create a frame-based lexical resource for Italian which involves various research groups in Rome, Torino, Trento, and Pisa.

2. Data and methodology

2.1 Verbs of visual perception

The verbs we analyzed so far are *avvistare* [to sight], *intravedere* [to glimpse or make out], *notare* [to notice], *osservare* [to observe or watch], *sbirciare* [to peek], and *scorgere* [to glimpse or spot]. We annotated about 770 sentences, all featuring one of these six verbs. There are nine frames involved in the annotation: some are related to perception (`Perception_experience`, `Perception_active`, `Becoming_aware`), whereas others represent a scenario of mental activity (`Awareness`, `Categorization`, `Coming_to_believe`, `Expectation`, `Opinion`) or of communication (`Statement`). In this work, however, we will almost exclusively discuss perception-related frames.

The reasons why we decided to start with this group of verbs are both practical and theoretical. We temporarily neglected the most central components of the semantic field, *guardare* [to look] and *vedere* [to see], because their high frequency and intricate polysemy (especially in the case of *vedere*) makes them more difficult to deal with, and because a large portion of the scientific literature is dedicated to these two verbs alone. We felt it would be more interesting, in a preliminary study, to collect data on those Italian verbs of visual perception which usually do not appear in most current linguistic analyses. Moreover, the verbs we selected have a perceptual meaning as their most prototypical sense. In contrast, many other verbs related to perception (such as for instance *contemplare* [to contemplate], *esaminare* [to examine], *fissare* [to stare] have a much wider polysemy range, and indeed it could be argued that their most "central" sense has nothing to do with perception.

2.2 The Italian FrameNet methodology

The method for developing Italian FrameNet follows the English FrameNet methodology as closely as possible.[2] We start by selecting a group of words belonging to the same lexical domain, which should plausibly evoke the same frame or frames related to one another. For each word, we scan a sample of attestations in a large corpus of Italian in order to get an idea of its possible senses and syntactic-semantic collocations; then, as a working hypothesis, we assign it to a frame, starting from the "frame ontology" developed for English. If the word is polysemous, we

2. For more information on FrameNet methodology, see Ruppenhofer et al. (2006) and Volume 16, Issue 3 (2003) of the *International Journal of Lexicography*, entirely dedicated to FrameNet and Frame Semantics.

only consider one sense, or frame, at a time. In the sampling phase, we select from the corpus a set of sentences that is representative of the most important FE combinations for the selected LU (i.e., those that have a hand in defining its semantics) and of their syntactic realizations. The selection is based on the LU's distributional preferences with respect to syntactic patterns and argument filler nouns. Then, in the encoding phase, we verify our assumptions on the frame evoked by the target LU by studying the example sentences and comparing them with data on other LUs. The distributional information is used in this phase, as well, as it helps determine which frame is associated with certain instances of a word. Finally, we annotate each sentence with semantic roles (FEs) and information on their syntactic realization using the *Berkeley FrameNet Desktop*, the annotation software developed for the creation of the English FrameNet.

The example sentences were all extracted from the *La Repubblica* Corpus, one of the largest corpora available for Italian, consisting of about 390 million tokens and based entirely on newspaper text (Baroni et al. 2004). We are aware that a newspaper-based corpus may present some problems for constructing a general-purpose lexical resource, as we would like Italian FrameNet to be, because journalistic discourse often follows particular stylistic conventions which are not typical of "standard" Italian. For example, in *La Repubblica* we sometimes found our verbs used in contexts that did not sound completely acceptable to us, such as in sentence (1), where *sbirciare* is followed by an indirect interrogative clause:

(1) […] e ora lui starà ancora a leggere e Nadia a **sbirciare** [se l'ira è passata].
*Now he's probably still reading, and Nadia is still **peeking** to see [if his anger is gone].*

However, besides the fact that there is no balanced corpus comparable to the British National Corpus available for Italian (for instance, CoLFIS — see Laudanna et al. 1995 — consists of only 4 million tokens), newspaper-based corpora have the advantage that they represent a linguistic norm that is closer to everyday language. Newspapers also have different sections dedicated to culture, sports, financial news etc., each featuring a different style, which gives the resulting corpus some linguistic variety.

Aside from the choice of corpus, there are two major differences between the Berkeley FrameNet method and ours. First of all, we did not create our frames from scratch: instead, we decided to use the "ontology" of frames developed for English as a starting point. We were interested in comparing Italian frame structure with English frame structure, and determined to do so by verifying whether the frames developed for English verbs of visual perception were adequate for describing their Italian counterparts, as well. We found a very strong correspondence between English and Italian perception-related frames; the English frames can be

used to describe Italian LUs with almost no modifications. Further results will be described in Section 3 of this paper.

The second difference, as we mentioned above, is that our process of sentence sampling relies on information regarding the distribution of syntactic patterns and fillers associated with each target LU, automatically extracted from the corpus. The advantage of this approach is that it is more grounded in the actual corpus data, thus reducing the incidence of personal biases on the annotator's part in selecting the syntactic patterns.

To obtain this distributional information from *La Repubblica,* we used the following procedure. The corpus was first lemmatized and part-of-speech tagged with the ILC-UniPi Tagger (Dell'Orletta et al. 2007), and then dependency-parsed with the MaltParser, a stochastic dependency parser (Nivre et al. 2007) trained on the ISST-CoNLL treebank (Montemagni & Simi 2007).[3] We then developed a tool for extracting all the syntactic frames for a given verb from this dependency-parsed version of *La Repubblica*, along with information on their frequency. The parser accuracy in correctly identifying and labeling syntactic dependencies is 84.4%, which is in line with the state of the art on Italian parsing. In order to filter out the parsing errors, the extracted syntactic frames were manually analyzed to select the ones that were representative of the verb's semantic-syntactic combinatorial possibilities from a frame semantic point of view. Each syntactic frame consists of a (possibly empty) set of labeled slots, representing the number and types of its syntactic dependencies (e.g. subject, direct object, prepositional complements, etc.).

Finally, we expanded the tool so it could extract information on the distribution of the noun fillers for each syntactic slot. First of all, we extracted all the fillers occurring in the corpus with an LU, divided according to the slot they appeared in. The nouns were then ranked according to their salience or prototypicality with respect to a certain slot. Salience was measured with the *simple log-likelihood* association measure (Evert 2008), a simplified version of the widely used *log-likelihood ratio* (Dunning 1993). The result is a global view of the typical fillers for each verb frame, similar to the "word sketch" function available in the *Sketch Engine* (see Kilgarriff et al. 2004 and the website: *http://www.sketchengine.co.uk*). This information also turned out to be very useful as a complement to the distributional data on syntactic patterns.

The distributional data extracted from the corpus supported various stages of the process of LU encoding. First of all, quantitative data on verb syntactic distributions were the main criterion to select the relevant sentences to be annotated, as representative of the most salient argument realization schemes of a verb (see

3. The repertory of syntactic dependencies represented in the ISST-CoNLL treebank and identified by the parser can be found at: *http://medialab.di.unipi.it/wiki/Tanl_Dependency_Tagset*.

Section 2.4). Secondly, distributional data also guided the assignment of verbs to the semantic frames. Moreover, as illustrated in Section 3.3, frequency asymmetries in the syntactic patterns eventually prompted us to revise the frame system itself, in order to account for the specific behavior of Italian perception verbs.

We will now describe our workflow in more detail. In Section 2.3, we show how we extract a sample of sentences for annotation; in Section 2.4, we describe the encoding phase and the annotation process, discussing the verb *scorgere* as an example.

2.3 Sentence sampling

The process of sentence sampling consists of three phases: preliminary scanning of the data, study of the distributional data regarding syntactic patterns and study of distributional data on fillers. These steps lead to the selection of sentences for annotation.

2.3.1 *Preliminary scanning*

After isolating our six lexemes related to visual perception, we selected each one in turn as the target LU. First of all, we scanned corpus attestations of the target and began to note syntactic contexts and collocations. We also noted whether the target had senses entirely unrelated to visual perception, or if it had polysemies or figurative uses that were instead related to its perceptual sense. Here is a sample of five sentences extracted from *La Repubblica* with *scorgere* [glimpse] as the target LU:[4]

(2) …[dalle porte-finestre] puoi **scorgere** [che qualcosa già brucia sulle colline d'intorno].
*…[from the French doors] you can **glimpse** [that something is already burning on the surrounding hills].*

(3) Soltanto il portiere, ieri mattina, s'è stupito dell'[insolito disordine] [che] si poteva **scorgere** [dalle finestre].
*Yesterday morning, the only one who was surprised by [the unusual mess] [that] could be **glimpsed** [through the windows] was the concierge.*

(4) Poi tutto finisce, [Grazia Letizia] si gira, **scorge** [dietro quel vetro] [la gente accalcata, le telecamere]…
*Then, everything is over: [Grazia Letizia] turns around, and **glimpses** [behind that glass][the crowd and the cameras]…*

4. Unless otherwise specified, all examples in this paper are taken from *La Repubblica*. Some of them have been slightly simplified for purposes of exposition.

(5) Quando [la troupe] **scorge** [il muso dell'orso per nulla amichevole] [spuntare tra i cespugli] c'è solo il tempo di caricare tutto in fretta e furia e riprendere il sentiero che porta a valle.
*When [the television crew] **sees** [the unfriendly bear's snout] [sticking out between the bushes], there's only time to load everything back into the car and head back downhill.*

(6) [Gli amici] non avevano torto a **scorgere**, [dietro le apparenze spettacolari], [la saggezza di uno stoico antico].
*[His friends] weren't wrong when they **saw**, [behind his spectacular appearance], [the wisdom of an ancient Stoic].*

In sentence (2), we note that *scorgere* occurs with a declarative sentence introduced by *che* [that], which indicates the perceived phenomenon; in sentences (3) and (4), on the other hand, the perceived phenomenon is expressed by an NP which is the direct object of *scorgere*. In sentences (2), (3) and (4), we also note some PPs giving information on the location of the perceiver (2), the location of the phenomenon (4), and the direction of the perceiver's gaze (3). In sentence (5), the NP expressing the perceived phenomenon is followed by a verbal infinitive (*spuntare tra i cespugli*, loosely translated as "sticking out between the bushes"), which gives information on the event happening in the perceived scene. Finally, in sentence (6), we note that *scorgere* is used figuratively: the object, *saggezza* [wisdom], cannot be physically perceived, but it can be conceived mentally. From this and other examples, we derive the working assumption that *scorgere* may be used figuratively with meanings that refer to mental activity.

2.3.2 *Analyzing syntactic frame distribution*

After scanning a sample of attestations, we analyzed the syntactic frames extracted from the corpus. Our ultimate goal here was to select a sample of sentences that was representative of all of the target LU's semantic-syntactic combinatorial possibilities, in relation to one particular frame (or sense). Basically, a representative sample of sentences should exemplify:

1. every possible combination of the frame's core FEs (for a specific LU);
2. every possible syntactic instantiation of the core FEs in each combination.

However, in the case of verbs of visual perception, some non-core FEs are also interesting for the purposes of semantic description, so we looked for patterns that exemplified those, as well. In order to find the syntactic patterns that would allow us to create a sample exemplifying all possible FE configurations for an LU, of course we had to make a working assumption about the frame that is evoked by

Table 1. Syntactic patterns for *scorgere* and *sbirciare*

scorgere	**2783**	***sbirciare***	**491**
direct object	872	direct object	119
impers. + no arguments	258	no arguments	71
no arguments	230	*in* [in]-comp.	47
dir. obj. + *in* [in]-comp.	229	*da* [from]-comp.	30
impers. + dir. obj.	176	*tra* [between]-comp.	20
in-comp.	93	dir. obj. + *in*-comp.	12
dir. obj. + *a* [at/to]-comp.	84	*su* [on]-comp.	12
impers. + *in*-comp.	52	*a* [at/to]-comp.	12
dir. obj. + *su* [on]-comp.	25	*attraverso* [through]-comp.	9
a-comp.	24	*dietro* [behind]-comp.	9
impers. + dir. obj. + *in*-comp.	22	*verso* [toward]-comp.	7
dir. obj. + *a*-comp. + *in*-comp.	21	*dentro* [inside]-comp.	7
impers. + *a*-comp.	21	impersonal + no arguments	7
impers. + *da* [from]-comp.	20	dir. obj. + *da*-comp.	6
dir. obj. + *che* [that]-clause	17	*con* [with]-comp.	5
dir. obj. + *per* [for]-comp.	16	*sotto* [under]-comp.	5
…	…	…	…

that LU. This assumption then had to be verified during annotation and once again afterwards, by comparing all the LUs we assigned to the same frame.

Table 1 shows a sample of the syntactic frames extracted for the verbs *scorgere* and *sbirciare*. The numbers express the overall frequency of the verb in the corpus and the frequency of each syntactic frame with that verb. What we did was select all the patterns that seemed to reflect a significant FE configuration (with help from information on FE fillers — see the following section), usually favoring the high frequency patterns on the grounds that they were more representative of the use of the LU.

However, frequency cannot be used as the sole criterion to determine which syntactic patterns are truly relevant for the semantic description of a word. As proof, consider what the data in Table 1 show us. Clearly, there is a difference in syntactic patterning between the two verbs: apart from the first pattern (direct object), *sbirciare* occurs almost all the time with a locative PP, while *scorgere* has a more balanced distribution between locative and non-locative complements. This reflects a semantic difference between the two verbs: *sbirciare* always profiles the direction of perception, while *scorgere* does not.

The data on syntactic distribution contain at least two other important clues for defining the semantic characteristics of these verbs, but we would miss them entirely if we focused only on the most frequent syntactic frames. First of all, both *sbirciare* and *scorgere* occur with a number of fairly rare patterns which are typical, however, of verbs of perception in Italian. One of them, direct object + *mentre* [while]-clause, is exemplified in sentence (7) below.

(7) **Ha scorto** [l'ex presidente delle Ferrovie]$_{\text{direct object}}$ [mentre faceva jogging in pigiama]$_{\textit{mentre}\text{-clause}}$.
*She **glimpsed** [the ex-president of the railway company] [while he was jogging in his pajamas].*

All of these patterns (which we will discuss in more detail in Section 3.2) have a similar interpretation. In sentence (7), for instance, the *mentre*-clause does not simply specify the temporal context of the viewing event (by denoting an event during which it occurred), but provides a description of the scene perceived by the viewer. Its function is to denote the object of perception along with the direct object of the verb: it is therefore part of the PHENOMENON FE. This is quite different from its usual function of temporal specification. This special interpretation could not arise if the main verb did not express perception; the occurrence of this and similar syntactic patterns with *sbirciare* and *scorgere* is therefore an important indication on the meaning of these verbs, and, consequently, the frames they must be assigned to.

The second clue is a difference in the syntactic distribution of *scorgere* and *sbirciare*: *scorgere* may occur with a *che* [that]-clause as the PHENOMENON FE, while *sbirciare* may not. The pattern is exemplified in sentence (2), repeated as (8) below.

(8) [Dalle porte-finestre] puoi **scorgere** [che qualcosa già brucia sulle colline d'intorno]$_{\textit{che}\text{-clause}}$.
*[From the French doors] you can **glimpse** [that something is already burning on the surrounding hills].*

In practice, however, this pattern occurs in the corpus with *scorgere* only eight times. The difference is therefore one of grammaticality, rather than frequency of occurrence. This feature distinguishes verbs belonging to `Perception_experience` (*scorgere*) from verbs belonging to `Perception_active` (*sbirciare*): the reason may be that the first group has a stronger tendency toward epistemic readings, which are typically triggered by declarative clauses. Knowing if this syntactic pattern is possible for a perception verb is therefore extremely useful for identifying the frame it evokes.

Based on these considerations, we conclude that information on the frequency of syntactic frames is necessary but not sufficient for the selection of a

representative sample of occurrences for an LU. This information must be complemented by a study of syntactic patterns based on different criteria, such as relevance with respect to the whole linguistic system (as in the case of those patterns that are particular only to perception verbs) or grammaticality (as in the case of the acceptability of the *che*-clause with these verbs). The annotator's linguistic intuitions and knowledge therefore still play an important role in this step of the process.

2.3.3 *Analyzing filler distribution*

Besides analyzing syntactic frames, we also looked at the nouns appearing as argument fillers of the frame slots. The fillers allowed us to imagine what kind of combination of FEs was represented by each syntactic pattern. In fact, we found that these data provide key information not only for determining what FEs are to be expected in a given syntactic slot with a given LU, but also — in the case of verbs — for describing the LU's selectional preferences, which can be used to identify the frame it evokes. As we will argue in Section 4.2, we believe that both the selectional preferences of LUs belonging to the same frame and the generalizations that can be drawn from these on the "selectional preferences" of the entire frame are essential for defining the semantics of the frame itself and should be integrated, ideally, into the LU and FE definitions inside the FrameNet database.

However, at this stage of our work, we mostly used the filler information to confirm our intuitions on which syntactic patterns should be selected for annotation (or discarded), and to make working assumptions on frame assignment for LUs with particular selectional preferences.

The following example shows how we used filler information for syntactic pattern selection. All the analyzed verbs appear, more or less frequently, with a PP introduced by *con* [with]. According to our intuition, and assuming these verbs evoke the `Perception_experience` or the `Perception_active` frame, this PP may instantiate the MANNER FE, the INSTRUMENT, or the BODY PART used to perceive, depending on the noun that occurs as its filler, as in the following sentences:

(9) Gli americani **osservano** [con crescente inquietudine].
*The American people keeps on **watching**, [with growing disquiet].*

(10) Una goccia di sangue **viene osservata** [con un microscopio tradizionale].
*A drop of blood **is being observed** [with a traditional microscope].*

(11) Il pilota si avvicinò al centro cittadino, **osservandolo** [con occhi fermi].
*The pilot came closer to the city center, **observing** it [with steady eyes].*

In sentence (9), the *con*-PP instantiates the MANNER FE; in sentence (10), the INSTRUMENT; in sentence (11), the BODY PART.

The data on filler distribution confirm this intuition: all the extracted nouns belong to one of the three categories expressed by the FEs above. The typical fillers for the BODY PART category are *occhio* [eye] and *coda dell'occhio* [corner of one's eye]; the only two that appear for INSTRUMENT are *binocolo* [binoculars] and *telescopio* [telescope]; for MANNER, there is a wide variety of realizations including *con chiarezza* [clearly], *con facilità* [easily], *con attenzione* [attentively], *con piacere* [with pleasure], etc. These possibilities give rise to three different combinatory patterns, all of them relevant for the semantics of verbs of visual perception and for the description of perception-related frames. Therefore, not only did we select this pattern for annotation, but we also made sure, when choosing the specific sentences that would make up the annotation sample, that we had at least one instance for each FE realization. In this case, the information on fillers did not just allow us to see what FE this syntactic slot instantiates, but it helped us "disambiguate" a syntactic slot with more than one corresponding FE. We used the same process when we were uncertain whether to discard a syntactic pattern: if, according to our intuition, a syntactic slot would only realize FEs that were not relevant for the description of a perceptual frame, we checked for its most frequent fillers, to see if we had forgotten its relevant uses. If not, we discarded the pattern.

We also used the extracted fillers to take note of each verb's selectional preferences. These data were useful for defining the semantic characteristics of each verb and, in some cases, for determining what frame they should be assigned to. For example, look at the prototypical objects of *scorgere*, *intravedere*, and *sbirciare*, shown in Table 2. The fillers are ordered by salience, measured with the simple log-likelihood (LL) association measure (see Section 2.2).

Scorgere and *intravedere* [glimpse or make out] are very close in meaning. Both refer to a visual perceptual experience that is uncertain, partial or very brief, due to its being hampered by adverse conditions of some kind (for example, there may be an obstacle covering the object of perception, or the object itself is difficult to see). Given such a strong similarity, we expected to find more correspondences among their fillers than with the fillers of *sbirciare* (which means "to peek"). This is in fact the case: *scorgere* and *intravedere* have eight salient objects in common (*fine* [end], *ombra* [shadow], *pericolo* [danger], *profilo* [outline], *rischio* [risk], *sagoma* [silhouette], *segnale* [signal], *sintomo* [symptom] — in italics in Table 2), while *sbirciare* has no objects in common with the other two verbs.

The objects for *intravedere* and *scorgere* belong to two types: nouns denoting perceivable or concrete entities (such as *ombra* [shadow], *sagoma* [silhouette], *segnale* [signal], *volto* [face]), and nouns denoting abstract entities, most of which make reference to the future (such as *futuro* [future], *possibilità* [possibility], *prospettiva* [prospect], *rischio* [risk]). *Sbirciare*, on the other hand, only has objects denoting concrete entities. The fact that *scorgere* and *intravedere* have two distinct

Table 2. Fillers of the direct object slot for *scorgere*, *intravedere* and *sbirciare*

scorgere	**LL**	**intravedere**	**LL**	**sbirciare**	**LL**
sagoma [silhouette]	223.40	possibilità [possibility]	1668.23	orologio [clock]	58.57
segno [sign]	198.71	spiraglio [chink of light]	567.84	taccuino [notebook]	31.71
segnale [signal]	78.67	*sagoma [silhouette]*	281.50	vetrina [shop window]	26.23
volto [face]	78.15	soluzione [solution]	216.14	oroscopo [horoscope]	24.25
ombra [shadow]	77.62	futuro [future]	156.36	busta [envelope]	24.14
sintomo [symptom]	73.04	*rischio [risk]*	154.53	foto-sexy [sexy photo]	21.66
traccia [trace]	71.39	scenario [scene or scenario]	129.91	pollastro [simpleton]	16.11
corpo [body]	55.72	*ombra [shadow]*	129.56	etichetta [label]	14.54
cadavere [corpse]	40.07	*pericolo [danger]*	128.19	faccia [face]	14.39
impronta [(foot) print]	30.65	*segnale [signal]*	118.95	marchetta [stamp]	14.13
rischio [risk]	30.30	*fine [end]*	113.60	madrina [godmother]	13.13
somiglianza [resemblance]	27.11	*profilo [outline]*	112.37	paccottiglia [junk]	13.00
pericolo [danger]	26.44	barlume [glimmer]	89.47	pagano [pagan]	12.92
filo [thread]	26.29	luce [light]	84.68	balera [dance hall]	12.47
profilo [outline]	25.66	via [way]	71.24	pagina [page]	12.32
luna [moon]	20.72	volontà [will]	70.73	fattezze [(facial) features]	11.75
prodromo [prodrome]	19.79	potenzialità [potential]	68.39	mutandine [panties]	11.57
fine [end]	19.76	contorno [contour]	54.42	scollatura [cleavage]	11.11
aurora [dawn]	19.55	*sintomo [symptom]*	50.88	trambusto [commotion]	11.01
elemento [element]	19.36	spettro [specter]	49.57	gamba [leg]	10.80
inclinazione [inclination]	19.20	sbocco [outlet, opening]	47.90	paravento [screen]	10.80
cupola [dome]	18.82	prospettiva [prospect]	46.69	classifica [ranking]	10.68
figura [figure]	18.81	miglioramento [improvement]	45.61	accoppiamento [intercourse]	10.65

groups of filler nouns (concrete and non-concrete) suggests that these two verbs (but not *sbirciare*) have at least two different senses, a literal one related to physical perception and a figurative one related to mental activity. Therefore, we expect that some instances will be assigned to a perception frame such as `Perception_experience` while others will belong to a frame like `Expectation`, which refers to expecting or foreseeing things in the future; this will depend in part on the semantic type of the object. This is one of the ways in which information on fillers can contribute to frame assignment. Moreover, *intravedere* has more abstract fillers than *scorgere* in Table 2; this leads us to believe that its figurative instances are more common, and (possibly) that its figurative sense is more strongly lexicalized.

We can also note some differences among the concrete filler nouns for the three verbs. The concrete objects for *intravedere* are mostly entities that are difficult to discern, either because they are not visually well-defined (such as *contorno* [contour], *ombra* [shadow], *sagoma* [outline]), or because they take some effort to be discerned inside a greater whole, and inherently require interpretation on the perceiver's part (e.g. *segnale* [signal] and *sintomo* [symptom]). On the other hand, the most frequent objects for *sbirciare* are nouns denoting clearly defined concrete entities, such as *orologio* [clock], *busta* [envelope], *faccia* [face], *gamba* [leg], *vetrina* [shop window], etc.: almost the polar opposite of the vague and indefinite entities described above. *Scorgere* occurs with both kinds of nouns: indefinite ones like *segno* [sign] and *traccia* [trace], and highly defined ones like *cadavere* [corpse], *corpo* [body], *cupola* [dome]. Therefore, there seems to be a gradient of concreteness among the objects of these verbs, with *sbirciare* at one extreme (highly concrete objects) and *intravedere* at the other (highly abstract ones). This is an interesting indication on the semantics of these verbs, which cannot be represented merely through the assignment of frames. We believe that the semantic description of LUs would be greatly enhanced by integrating this information on their selectional preferences in the FrameNet database.

2.4 Encoding and annotation

So far, we have described our method for creating a sample of sentences for annotation. After studying the corpus data for a given target LU, we finally select a set of syntactic patterns representing all possible core FE configurations and valence patterns for that LU. Then, we randomly extract a varying number of sentences (from 1 to 10) for each syntactic pattern, making sure that all FEs are covered in the "ambiguous" cases. As an example, Table 3 shows the syntactic patterns we selected for *scorgere*.

The patterns represent all possible core FE configurations and many non-core FE configurations that we believe are interesting for the description of verbs of

Table 3. Syntactic patterns of *scorgere* selected for annotation

Syntactic frame	Frequency
1. direct object	872
2. dir. obj. + *in* [in]-comp.	229
3. dir. obj. + *a* [at/to]-comp.	84
4. dir. obj. + *su* [on]-comp.	25
5. dir. obj. + *a*-comp. + *in*-comp.	21
6. dir. obj. + *che* [that]-clause (relative)	17
7. dir. obj. + *da* [from]-comp.	16
8. dir. obj. + *con* [with]-comp.	16
9. dir. obj. + *dietro* [behind]-comp.	10
10. *che*-clause (declarative)	8
11. dir. obj. + predicative	7
12. dir. obj. + *mentre* [during]-clause	6
13. dir. obj. + *quando* [when]-clause	6
14. dir. obj. + *tra* [between]-comp.	5
15. dir. obj. + *attraverso* [through]-comp.	5
16. impersonal + dir. obj. + *oltre* [beyond]-comp.	3

visual perception. Assuming that *scorgere* evokes the `Perception_experience` frame, the core FEs are the PERCEIVER PASSIVE, the perceived PHENOMENON and the BODY PART used to perceive. Based on corpus attestations, we noted that the PERCEIVER PASSIVE is usually expressed as the subject (12). Since Italian is a pro-drop language, however, the subject argument was not included in the patterns extracted by our tool. The PHENOMENON's realizations are more varied. In the vast majority of cases it is expressed as a direct object (12): this is reflected by the very high frequency of this syntactic pattern. It can also be expressed as a declarative *che* [that]-clause (see sentence 13). We already saw that this pattern is quite rare with *scorgere*. Both patterns were included in our selection.

(12) È stato [un macchinista]$_{\text{subject}}$ a **scorgere** per primo [l'ordigno]$_{\text{direct object}}$ sui binari.
*[A (train) engine driver] was the first to **notice** [the explosive device] on the tracks.*

(13) Dalle porte-finestre puoi **scorgere** [che qualcosa già brucia sulle colline d'intorno]$_{\textit{che}\text{-clause}}$.
*From the French doors you can **glimpse** [that something is already burning on the surrounding hills].*

We also included the perception verb-specific patterns of realization of the PHENOMENON that we mentioned in Section 2.3.2 while discussing the syntactic distribution of *scorgere* and *sbirciare*: direct object + predicative adjective (14), direct object + "pseudorelative" clause (15),[5] direct object + *mentre* [during]-clause or *quando* [when]-clause (16). The constituents following the direct object serve the purpose of describing the perceived scene, and are therefore part of the PHENOMENON.

(14) Il medico **scorge** nell'altra stanza [il duca]$_{\text{direct object}}$ [prostrato dalla malattia]$_{\text{predicative adjective}}$.
*The doctor **glimpses** [the duke], [stricken with illness], in the other room.*

(15) Il magistrato **scorge** [un signore dall'aria distinta]$_{\text{direct object}}$ [che si allontana in tutta fretta]$_{\text{pseudorelative clause}}$: è il professor Berardi.
*The judge **glimpses** [a distinguished-looking man], [who is walking away as quickly as possible]: it's professor Berardi.*

(16) **Ha scorto** [l'ex presidente delle Ferrovie]$_{\text{direct object}}$ [mentre faceva jogging in pigiama]$_{\textit{mentre}\text{-clause}}$.
*She **glimpsed** [the ex-president of the railway company] [while he was jogging in his pajamas].*

Finally, the BODY PART may be expressed as a *con* [with]-complement (17) or as the subject (18).

(17) Ad un certo punto **scorge**, [con la coda dell'occhio]$_{\textit{con}\text{-complement}}$ una pattuglia della polizia.
*At some point he **glimpses** a police patrol [out of the corner of his eye].*

(18) [L'occhio allenato di Di Grazia]$_{\text{subject}}$ **scorge** due collanine d'oro.
*[Di Grazia's practiced eye] **glimpses** two gold necklaces.*

Most of the other patterns we selected feature locative PPs: they are introduced by the prepositions *a* [at/to], *attraverso* [through], *da* [from], *dietro* [behind], *in* [in], *oltre* [beyond], *su* [on], and *tra* [between]. Locative PPs generally represent non-core FEs expressing the location of the PHENOMENON (GROUND: (19)), the direction of the gaze (DIRECTION: (20)), and the location of the PERCEIVER (LOCATION OF PERCEIVER: (21)).

(19) È stato un macchinista a **scorgere** per primo l'ordigno [sui binari]$_{\text{GROUND}}$.
*A train engine driver was the first to **notice** the explosive device [on the tracks].*

5. "Pseudorelative" clauses are constructions that occur with perception verbs in Italian. They are introduced by the relative pronoun *che* [that], but many of their structural characteristics differentiate them from regular relative clauses. For a discussion on the structural and semantic characteristics of pseudorelative clauses, see Guasti (1993: 141–147).

(20) Alle tre di mattina cominciava a **scorgere** [attraverso i vetri della finestra]$_{\text{DIRECTION}}$ le prime luci dell'alba.
*At three in the morning he began to **glimpse** the first light of dawn [through the window panes].*

(21) [Da una terrazza dell'appartamento di Alberto Moravia, alto sul Lungotevere]$_{\text{LOCATION OF PERCEIVER}}$, si **scorge**, oltre il fiume, Villa Balestra.
*[From a balcony in Alberto Moravia's apartment, high on the Tevere], one can **glimpse** the Balestra villa, beyond the river.*

We selected so many patterns of this kind because we wanted to document the various ways these FEs are realized, each time with a slightly different meaning depending on the preposition that is used. During our study, we also found that some verbs (such as *sbirciare*) express a situation where the direction of the gaze is profiled, while others do not; it is therefore interesting to compare the distribution of locative FEs in relation to these two types of verb. We will discuss this in some detail in Section 3.3.

Finally, we also selected a pattern featuring a *con* [with]-PP. We already discussed the role of *con*-complements with verbs of visual perception: they may instantiate the BODY PART used to perceive, the MANNER of perception, or the INSTRUMENT that aids it. Here are some examples for *scorgere*, with the *con*-PP expressing MANNER (22) and INSTRUMENT (used in a figurative sense, in this case: 23):

(22) La duchessa **aveva scorto** [con preoccupazione]$_{\text{MANNER}}$ il nome dell'ammiraglio Benussi nella lista degli invitati.
*The duchess **noticed** admiral Benussi's name in the guest list [with some preoccupation].*

(23) Cercherò di **scorgere** [con l'immaginazione]$_{\text{INSTRUMENT}}$ il lampadario sospeso sulla tavola da pranzo di mia zia, quando da bambino la visitavo.
*I'll try to **see**, [with my imagination (in my mind's eye)], the chandelier hanging over my aunt's dinner table, when I visited her as a child.*

Once we had a representative sample of sentences for an LU, we checked to see whether the frame assigned to it could indeed be used to describe the situations expressed in the sentences (we also compared the sample sentences with the annotated examples of that frame in English, to see if the evoked situation was comparable in both languages). Then we checked whether the FEs belonging to the frame were adequate to label the arguments of the target, or if it was necessary to introduce new ones, discard some of them, or change their status. This step was fairly easy when dealing with perception-related frames: in most cases, we were satisfied with the frame structure as it was, and proceeded to annotate the sentence

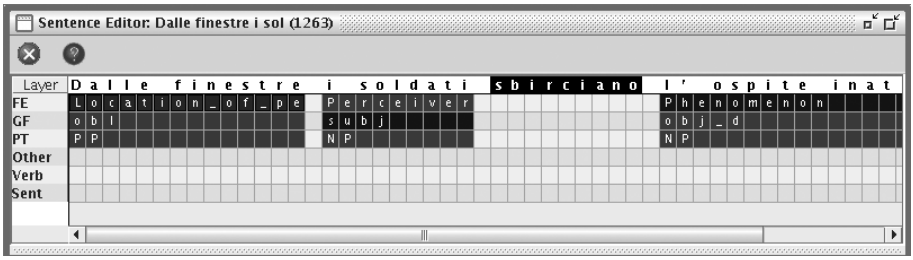

Figure 1. An annotated sentence in the FrameNet Desktop

using the Berkeley FrameNet Desktop. The typical annotation schema includes the frame evoked by the target LU, the FEs instantiated by various constituents in the sentence and their grammatical function (GF) and syntactic phrase type (PT). Therefore, every argument of the LU is given at least three labels (one semantic and two syntactic). The FrameNet Desktop encodes and displays this information using parallel aligned layers of annotation: in this way, different kinds of information related to the same constituent may be viewed easily without causing confusion. Figure 1 shows an example.

In principle, any number of layers may be used for annotation in the FrameNet Desktop; however, in standard practice, the most used are the FE, GF and PT layers. In addition, the Other layer is used to encode other information about the syntactic characteristics of the FEs, such as the presence of a relative pronoun, while the Sentence layer encodes information relative to the entire sentence (e.g. special constructions such as passive, impersonal, Raising, etc.). Each layer has its own set of labels: the FE layer, for instance, contains all the FEs relevant to the frame evoked by the target, whereas the GF layer has a fixed set of labels (subject, direct object, oblique complement, etc.) and so does the PT layer (NP, PP, clause, etc.). For the GF layers, we used the syntactic dependency labels specified in the *Tanl Dependency Tagset* (see note 3), while for the PT layer we used the same phrase labels as the Berkeley FrameNet.

3. Analysis of verbs of visual perception

3.1 Assigning frames to LUs

There is a fairly large number of frames that are somehow related to perception in the FrameNet database. The ones that may be used for describing the verbs we analyzed are `Perception_experience`, which describes a passive PERCEIVER having a perceptual experience (for verbs like *vedere* and *sentire* in Italian, i.e. *see* and *smell* or *hear* in English), `Perception_active`, which describes an active

PERCEIVER intentionally directing his or her attention to a PHENOMENON in order to have a perceptual experience (for verbs like *guardare, ascoltare, annusare* in Italian, i.e. *look, listen, sniff* in English), and `Becoming_aware`, which features a COGNIZER adding some PHENOMENON to his or her model of the world, with the condition that the awareness be achieved through perception (for verbs like *notare, osservare, scoprire* in Italian, i.e. *notice, observe, discover* in English). At this time, we did not take into consideration verbs where the PHENOMENON is a subject and the PERCEIVER is implied or expressed as a dative, such as *sembrare, suonare, sapere di* (*appear, sound, smell* or *taste* in English), as in *Questo libro sembra interessante* (*This book looks interesting*). These verbs are described by the `Appearance` frame in English.

Assigning semantic frames developed for English LUs to Italian ones is not a straightforward procedure, as it might seem *prima facie*. The frames contained in the Berkeley FrameNet were developed on the basis of the semantic and syntactic distribution of English words, and are therefore at least partly language-specific; there is no *a priori* guarantee that the Italian translations of the English LUs belonging to a certain frame will evoke exactly the same frame, either because that frame doesn't exist in Italian, or because it is evoked by a different set of LUs. However, our study found that the three frames described above may be used for describing our Italian verbs with almost no significant changes. `Perception_experience` and `Becoming_aware` can be transposed to Italian as they are (except for some differences in their non-core FEs, due, however, to chance differences in the sentence sample selected for annotation). The `Perception_active` frame, on the other hand, needs to be split into two distinct subframes in order to accurately represent the semantic characteristics of its LUs; however, we discovered that the split is necessary for Italian and English alike. We will describe it and its motivations in Section 3.3 below. Here, we will carry out our discussion using simply `Perception_active`, since the semantic characteristics that we will refer to are shared by both its subframes.

How can such a strong similarity be motivated? To be sure, perception is a cognitively central experience for human beings in general, but this does not necessarily mean that all languages describe it in the same way, although we may expect some overlap between the "frame ontologies" related to this domain in different languages. Motion, for instance, is another cognitively central experience for all human beings, and still we find considerable cross-lingual differences in the argument realization of motion verbs, even among European languages (see e.g. Talmy 1991).

We believe that the main reason has to do with how close Italian and English are, both typologically and geographically. A brief overview of other European languages, such as French, Spanish, and German, shows that all of them share a

similar way of structuring the lexical domain of perception into three groups of verbs, which may be represented by the Perception_experience, Perception_active and Appearance frames. These languages (as well as Greek) also share very similar argument structures for verbs of visual perception; for instance, they all share constructions similar in form and meaning to the one realized by *I saw a man cross/crossing the road*, which are often called "perception verb complements" in the literature. The similarity in the structuring of the lexical domain and in argument realization is also confirmed by Spanish FrameNet and by SALSA, which have adopted the English perception frames without substantially altering their structure (the annotation of perception-related LUs in the Spanish FrameNet is just at the beginning, however, so there might be changes in the future).

The main differences between Italian and English verbs of visual perception may be found in their extended or figurative uses, which we will not focus on in this article (some of the extended uses of *vedere*, *intravedere* and *scorgere* are described in Johnson, forthcoming). *See*/*vedere* and *look*/*guardare* in particular have many extended uses which vary between English and Italian. For example, *see* in English can mean "to accompany someone", as in *I'll see you to the door;* this interpretation is not possible in Italian. These differences in meaning are not reflected in frame structure, but in the choice of different frames to represent the meaning of the LU in that context. In other cases, the meaning coincides (or is similar), but the syntactic realization is somewhat different. For instance, *see* can be used to express "meet with or visit someone", as in *I went to see my aunt yesterday*. In Italian, *vedere* has the same sense which may be expressed exactly as in English, but there is an alternative construction which features a reflexive form of the verb and a complement introduced by *con* [with], as in *Con Maria non ci vediamo molto spesso* ("Maria and I don't see each other often") or even *Ieri ci siamo viste con Maria* ("I met Maria yesterday"). These differences would lead to some slight variations in the structure of the Meet_with frame for Italian.

We will now discuss the semantic features associated with Perception_experience, Perception_active and Becoming_aware. Table 4 shows how LUs were assigned to one or more frames (next to each LU is the number of instances annotated for each frame). In order to do this, we first studied the specific meaning of the frame by reading its definition on the FrameNet website and looking at the English LUs that evoke it. Then, we verified whether the meaning of the LUs we were studying could fit with that frame.

Perception_active and Perception_experience describe a basic perceptual situation, where a PERCEIVER perceives a PHENOMENON, with no further specifications related to the context. Becoming_aware, on the other hand, describes a cognitive activity (the act of adding something to one's awareness) which is the consequence of a perceptual experience. The first distinction to make is therefore

Table 4. Frames assigned to each LU

Frame	Assigned LUs
Becoming_aware	*notare* (117), *osservare* (20)
Perception_active	*osservare* (258), *sbirciare* (63)
Perception_experience	*avvistare* (40), *intravedere* (179), *scorgere* (72)

between the verbs that express perceptual activity and those that express cognitive activity. *Notare* [notice] definitely belongs to the latter group: the event that it refers to is a Cognizer noticing something, not a Perceiver having a perceptual experience (see sentence (24)).

(24) Un gruppo di automobilisti **ha notato** il ragazzo ai margini della superstrada e ha chiamato il 113.
*A group of automobile drivers **noticed** the boy at the edge of the freeway and called 113 [the emergency number].*

Osservare, on the other hand, has two alternative readings in the perceptual domain: it may express a simple act of perception, or an act of noticing, like *notare*. We must therefore distinguish two LUs for *osservare*. In the former case, the LU clearly belongs to `Perception_active` (see sentences (25) and (26)). The latter case is somewhat more complex: *osservare* retains a perceptual element of meaning even when it refers primarily to the conceptual act of noticing (see sentences (27) and (28)). The `Becoming_aware` frame, on the other hand, does not necessarily feature a perception component (its LUs include *discover* and *learn*). Apparently there is a gradient in lexical meaning from "perceiving" to "becoming aware", with the "noticing" sense of *osservare* situated somewhere around the middle. This kind of word sense gradience is often difficult to represent within the frame ontology, especially while trying to avoid an unnecessary proliferation of frames. In this case, we finally decided that `Becoming_aware` is sufficiently adequate to define these instances of *osservare*, since it features various LUs that clearly have a perceptual component, such as *detect, discern,* and *spot.*

(25) **Ho osservato** di nuovo il paesaggio, qualche tempo dopo il tramonto, e ho capito che era ancora lontano dalla bellezza che mi ha impressionato ieri sera.
*I **looked** at the landscape again, some time after sunset, and I realized that it was still far from the beauty that had impressed me last night.*

(26) Grazie a questa tecnica è possibile **osservare** il collo e il corpo dell'utero, distinguendo alterazioni della grandezza di due micron.
*Thanks to this technique, it is possible to **observe** the neck and body of the uterus and to detect alterations down to two microns in size.*

(27) Altre installazioni **sono state osservate** a sud, poco distante da Hormuz.
*Other installations **were noticed** to the south, not far from Hormuz.*

(28) Discutendo con gli studenti, anche con quelli senza barba e collare, si **osserva** in genere che le loro convinzioni religiose sono profonde, autentiche.
*If one talks with the students, even the ones without a beard and collar, one generally **notes** that their religious beliefs are profound, authentic.*

`Perception_experience` and `Perception_active` are distinguished by the intentionality of the perceptual experience they describe. For `Perception_active`, it is an intentional act of perception; for `Perception_experience`, an unintentional experience. We can therefore apply a typical intentionality test to the remaining verbs, such as constructing an imperative sentence, to see which frame is best suited for them. According to examples (29) and (30), *avvistare, intravedere*, and *scorgere* may not be used as imperatives and therefore express unintentional perception, while *osservare* and *sbirciare* are intentional. Therefore, we assigned *osservare* and *sbirciare* to `Perception_active`, and *avvistare, intravedere* and *scorgere* to `Perception_experience`.

(29) *__Avvista/intravedi/scorgi__ quella nave all'orizzonte!
__Sight/make out/glimpse__ that ship on the horizon!

(30) __Sbircia/osserva__ il titolo del libro di John!
__Peek at/observe__ *the title of John's book!*

We mentioned before that `Perception_active` and `Perception_experience` express a simple perceptual situation, with no further specifications. They are therefore more abstract than frames like `Scrutiny` and `Touring` (both children of `Perception_active`), that refer to a perceptual scene with a fairly specific context: in `Scrutiny`, the PERCEIVER is searching for something against a GROUND, while in `Touring`, he or she is experiencing a specific PHENOMENON, i.e. a tourist attraction. The LUs we are studying are not quite so specific, but they do add some contextual information to the perceptual experience by specifying the manner in which it occurs, its external conditions, the intentions of the PERCEIVER, and so on. *Avvistare* refers to a situation where the PERCEIVER sees something from afar, usually in a context where he or she was already keeping watch (similarly to English *sight*). *Intravedere* and *scorgere* evoke a situation where perception is hampered by adverse conditions of some kind, giving rise to a "doubtful" experience that is usually partial or very brief. In English, two distinct verbs reflect different aspects of the meaning of *intravedere* and *scorgere*: *make out* is more relevant to partial or obstructed perception, while *glimpse* has more to do with short temporal duration.

Osservare expresses a situation where the PERCEIVER looks at the PHENOMENON with special attention and thoroughness, usually for a long period of time (this verb often refers to scientific observation). Its possible translations in English are *watch* and *observe*. Finally, *sbirciare* refers to an act of perception that is done furtively and — in most cases — briefly: the main intention of the PERCEIVER is not to be noticed while looking (like *peek* in English). A more granular classification of these LUs is possible, then, but we would end up with a lot of highly specific frames with only one or two verbs each. We believe that grouping them together inside two perception frames is the most useful solution for our purposes; also, it reflects the fact that they all describe the same basic type of situation, featuring the same core group of FEs.

3.2 Frame Element structure

In this section, we give a brief description of the FE structure of the three frames involved in this study. Table 5 shows the FEs belonging to each frame; in the interest of concision, we excluded all extra-thematic FEs except LOCATION OF PERCEIVER, which is particularly relevant for verbs of perception. Due to the small number of LUs analyzed for `Becoming_aware`, this frame is not complete. A conclusive definition of how many FEs belong to this frame must wait until a suitable number of LUs is studied (including e.g. *accorgersi* [become aware], *discernere* [discern], *scoprire* [discover]).

Table 5. FEs belonging to `Perception_experience`, `Perception_active`, and `Becoming_aware`

	Perception_ experience	**Perception_active**	**Becoming_aware**
Core	PERCEIVER PASSIVE PHENOMENON BODY PART	PERCEIVER AGENTIVE PHENOMENON BODY PART DIRECTION	COGNIZER PHENOMENON
Peripheral	DEGREE DIRECTION DURATION GROUND INSTRUMENT MANNER MEANS PLACE TIME	DURATION GROUND INSTRUMENT MANNER MEANS PLACE TIME	GROUND MANNER TIME
Extra-thematic	LOCATION OF PERCEIVER	LOCATION OF PERCEIVER	

Here is a brief description of the core FEs and the most important peripheral ones. The PERCEIVER is a sentient being having a perceptual experience; in the case of the PERCEIVER PASSIVE, this is not necessarily on purpose (see (31)), while the PERCEIVER AGENTIVE is one who performs some action in order to have a perceptual experience (see (32)). In the `Becoming_aware` frame, the being who has the experience is not a PERCEIVER, but a COGNIZER (see (33)), since the activity of becoming aware is more of a cognitive than perceptual nature. These FEs are usually realized as the subject of an active sentence.

(31) Finalmente [Giovanni]$_{\text{PERCEIVER PASSIVE}}$ **intravede** con la coda dell'occhio la mano di un uomo che si sporge misericordiosa dalla riva e ci si aggrappa con gratitudine.
Finally, out of the corner of his eye, [Giovanni] ***glimpses*** *a man's hand stretching out mercifully from the shore and grabs onto it with gratitude.*

(32) Davanti a Buckingham Palace ogni mattina [immense folle di turisti]$_{\text{PERCEIVER AGENTIVE}}$ **sbirciano** tra le inferriate del palazzo sperando di vedere Elisabetta o Filippo o lady Diana.
In front of Buckingham Palace, every morning [huge throngs of tourists] ***peek*** *between the palace's iron bars, hoping to see Elizabeth, Philip or Lady Diana.*

(33) Intanto dalla strada [alcuni passanti]$_{\text{COGNIZER}}$ **hanno notato** del fumo filtrare dalle tapparelle di un balcone.
Meanwhile, [some passersby] ***noticed*** *the smoke filtering from a balcony's shutters.*

BODY PART is the FE that expresses the body part used for perceiving (therefore, it is not present in `Becoming_aware`). It is not often expressed explicitly, since in most cases the body part used to perceive is implied by the sensory modality of the verb itself. This is true for LUs related to visual perception, because there is only one sensory organ dedicated to vision in the human body, so it is not necessary to indicate it unless it has some special characteristics that the speaker wants to mention. With verbs of tactile sensation, such as *sentire* [feel] and *toccare* [touch] (also belonging to `Perception_experience` and `Perception_active`), the BODY PART is usually expressed, because these verbs are underspecified with respect to the body parts where the sensation can be experienced (see sentence (34)). As mentioned in Section 2, this FE is usually realized as a *con* [with]-PP or as the subject of the sentence.

(34) La ragazza avrebbe detto ai carabinieri di **aver sentito** un brivido [lungo la schiena]$_{\text{BODY PART}}$.
The girl apparently told the police she ***felt*** *a shiver [along her back].*

The PHENOMENON is the entity that is perceived (or of which the COGNIZER becomes aware). This FE has a wide variety of syntactic realizations, which may be classified into two broad types: "simple" and "complex". In the "simple" cases, the PHENOMENON is instantiated by a single constituent — typically an NP (35) or an indirect interrogative clause (36). In `Perception_experience` and `Becoming_aware`, it can also be a declarative *che* [that]-clause (37) (but not in `Perception_active`, as we mentioned in Section 2).[6]

(35) Giuseppe Nella, guardiacaccia, il 13 agosto scorso **ha avvistato** per ben due volte [l'orso bruno]$_{\text{PHENOMENON.NP}}$ proprio nella sua valle.
*Giuseppe Nella, gamekeeper, **has sighted** [the brown bear] not once, but twice, on August 13th, in his own valley.*

(36) I dati contrastanti non ci permettono di **intravedere** con una certa sicurezza [quale sarà l'evoluzione futura del commercio estero americano]$_{\text{PHENOMENON.INDIRECT INTERROGATIVE}}$.
*These contrasting facts do not allow us to **foresee** with some certainty [what the future evolution of American foreign trade will be].*

(37) Dalle porte-finestre puoi **scorgere** [che qualcosa già brucia sulle colline d'intorno]$_{\text{PHENOMENON.che-clause}}$.
*From the French doors you can **glimpse** [that something is already burning on the surrounding hills].*

In the "complex" cases, the NP instantiating the PHENOMENON is followed by another syntactic constituent, which contributes in an essential way to the semantic interpretation of the PHENOMENON (we already discussed these constructions, briefly, in Section 2). The "complex" types come in the following realizations for Italian: NP + infinitive verb (38), NP + "pseudorelative" clause (39), NP + predicative complement, instantiated by an adjective phrase or past participle ((40) and

6. There is a wealth of studies on the difference in semantics between declarative clauses and other constructions (particularly NPs and "complex" constructions) as perception verb complements. It has been noted that, when a *che*-clause occurs with a verb of perception, the verb no longer refers to an experience of perception, but to an act of deduction or reasoning based on perceivables. The proposed reason for this is that declarative clauses express a proposition, or, in intuitive terms, an epistemic content, whereas other constructions denote objects or events, i.e. entities in the world. It is possible to perceive an entity in the world, but not a propositional content, which is an abstract entity. It might be that the reason why the PHENOMENON cannot be instantiated by a declarative clause with `Perception_active` verbs is that they are not as open to epistemic interpretations as `Perception_experience` and `Becoming_aware` verbs. We will not expand further on the subject in this setting. For a more detailed discussion on the semantics of perception verb complements, see for example Kirsner & Thompson (1976), Declerck (1981), Barwise (1981), and Higginbotham (1983).

(41), respectively), NP + *quando* [when] or *mentre* [while]-clause (42). Interestingly, similar constructions also exist in English, where the direct object of a perception verb may be followed by a bare infinitive or by a verb in its *-ing* form, as shown in the translations of sentences (38) and (39). These constructions are both syntactically and semantically similar to those found in Italian.

(38) Ride di cuore quando **sbircia** [un fotografo]$_{NP}$ [inciampare nei fili delle cineprese]$_{inf}$, si sente un protagonista.
*He laughs heartily when he **sees** [a photographer] [trip/tripping on the camera cables]; he feels like the hero of the story.*

(39) Il magistrato **scorge** [un signore dall'aria distinta]$_{NP}$ [che si allontana in tutta fretta]$_{pseudorelative}$: è il professor Berardi.
*The judge **glimpses** [a distinguished-looking man] [walk/walking away as quickly as possible]: it's professor Berardi.*

(40) Una pattuglia della Polstrada **ha notato** [il tir]$_{NP}$ [fermo su una piazzola di sosta]$_{predicative\ adjective}$ in autostrada e si è avvicinata.
*The traffic police **noticed** [the truck] [as it was standing still in a rest area] on the freeway and approached it.*

(41) [Le donne]$_{NP}$ si **intravedono** dietro le porte, [sedute su sofà senza tappezzeria]$_{predicative\ past\ participle}$.
*One **glimpses** [the women] behind closed doors, [sitting on sofas with no upholstery].*

(42) **Ha scorto** [l'ex presidente delle Ferrovie]$_{NP}$ [mentre faceva jogging in pigiama]$_{\textit{mentre}\text{-clause}}$.
*She **glimpsed** [the ex-president of the railway company] [while he was jogging in his pajamas].*

At first sight, it might look like the NP actually denotes the perceived PHENOMENON, while the element following it expresses some additional description of its characteristics, not essential to the basic situation described by the sentence. This is not so, however. The whole "NP + infinitive/ pseudorelative/ predicative/ temporal clause" complex describes a scene that is, *globally*, the object of the perceptual experience expressed by the verb: for instance, the subject in sentence (38) doesn't laugh just when he sees a photographer, but when he sees a photographer tripping on the camera cables. Taking away *inciampare nei fili delle cineprese* would change the core meaning of the sentence. The information contributed by the element following the NP is therefore an integral part of the perceived PHENOMENON. This interpretation was first proposed for English in the Berkeley FrameNet: it was expressed by annotating both the NP and the constituent following it as the

PHENOMENON. The information that the two are distinct syntactic constituents is preserved by annotating them with different labels on the GF and PT layers. We followed the same annotation strategy in our work. In sentence (40), for example, both *il tir* and *fermo su una piazzola di sosta* are labeled as the PHENOMENON, but the former is then labeled as a direct object (GF) and as an NP (PT), while the latter is tagged as a predicative complement (GF) and as an AP (PT).

Among the peripheral FEs, the most important for verbs of visual perception (both in English and Italian) are GROUND, PLACE, and DIRECTION. In `Perception_active` and `Perception_experience`, the GROUND is the perceptual background against which the PHENOMENON is experienced by the PERCEIVER. The PLACE is the general location within which the act of perception takes place. The difference between GROUND and PLACE is exemplified in the following sentences:

(43) Da quel momento lo squalo **è stato avvistato** [a Camogli e a Rapallo, a Punta Chiappa e a Punta Pedale]$_{\text{PLACE}}$.
*Since then, the shark **has been sighted** [at Camogli and Rapallo, at Punta Chiappa and Punta Pedale].*

(44) I tre cetacei **sono stati avvistati** [a circa trenta miglia a sud-est dalla costa]$_{\text{GROUND}}$ dall'equipaggio di due imbarcazioni da diporto.
*The three porpoises **were sighted** [about thirty miles southeast of the coast] by the crew of two pleasure crafts.*

In sentence (43), the phrase *a Camogli* [at Camogli] would typically be taken as expressing the location where the event occurred. In sentence (44), *a trenta miglia a sud-est dalla costa* [thirty miles southeast of the coast] expresses the location of the PHENOMENON, rather than the location where the entire event occurred. At some level, though, both sentences are ambiguous between these two readings.

The DIRECTION FE describes how the PERCEIVER's attention is directed during the act of perception. In the case of verbs of visual perception, this FE describes the direction of the PERCEIVER's gaze (see (45) and (46)).

(45) Teneva gli occhi chiusi, con le ciglia aggrottate, ma ogni tanto **sbirciava** [in su]$_{\text{DIRECTION}}$; poi richiudeva le palpebre.
*She kept her eyes shut, frowning, but once in a while she would **glance** [up/upwards]; then she closed her eyelids again.*

(46) Alle tre di mattina cominciava a **scorgere** [attraverso i vetri della finestra]$_{\text{DIRECTION}}$ le prime luci dell'alba.
*At three in the morning he began to **glimpse** the first light of dawn [through the window panes].*

Due to the more abstract meaning of `Becoming_aware`, the DIRECTION FE is not present in this frame; also, the GROUND is not necessarily a perceptual background for the PHENOMENON, but the background or context against which a COGNIZER becomes aware of it.

3.3 Splitting `Perception_active` into two subframes

In Section 3.1, we temporarily assigned *sbirciare* and *osservare* to the `Perception_active` frame, with the motivation that they both express an intentional act of perception. This reflects the first stage of our analysis, where we make an assumption about the frame evoked by each LU, with the intent of verifying it after the study of corpus examples. However, after analyzing the data on *sbirciare* and *osservare*, we noticed that DIRECTION did not seem to be a core FE for both verbs: it behaved like a core FE for *sbirciare*, but like a peripheral one for *osservare*. Here is the evidence that supports this hypothesis.

First of all, the quantitative distribution of the DIRECTION FE is significantly different with *sbirciare* and *osservare*. Out of all the occurrences of *osservare* in *La Repubblica*, only 7% are followed by a PP introduced by a preposition which expresses the DIRECTION (i.e. *attraverso* [through], *dietro* [behind], *oltre* [beyond], etc.), whereas for *sbirciare*, the occurrences with a DIRECTION-PP rise to 38%. As a point of comparison, the percentage of occurrences with a direct object (the most common instantiation of the PHENOMENON FE) is 38% for both verbs. We can therefore conclude that DIRECTION occurs much more often with *sbirciare* than with *osservare*, and that this difference is significant, since the PHENOMENON (a core FE) occurs relatively often with both verbs.

Secondly, there is a difference in the frequency of occurrence of certain syntactic patterns. Even though both *osservare* and *sbirciare* can occur with the PHENOMENON only (47), with the DIRECTION only (48), or with both (49), the quantitative distribution of the different patterns varies for each verb.

(47) a. Grazie a questa tecnica è possibile **osservare** [il collo e il corpo dell'utero]$_{\text{PHENOMENON}}$, distinguendo alterazioni della grandezza di due micron.
*Thanks to this technique, it is possible to **observe** [the neck and body of the uterus] and to detect alterations down to two microns in size.*

b. Francesco sta leggendo un libro. **Sbircio** [il titolo]$_{\text{PHENOMENON}}$: "Il caos".
*Francesco is reading a book. I **peek** [at the title]: "Chaos".*

(48) a. **Osservando** [attraverso un microscopio chirurgico]$_{\text{DIRECTION}}$, il medico procede all'intervento.
*While **observing/watching** [through a surgical microscope], the doctor proceeds with the operation.*
b. Una graziosa signorinetta dai lunghi capelli **sbircia** frettolosamente [dentro le vetrine]$_{\text{DIRECTION}}$.
*A pretty young woman with long hair hurriedly **peeks** [inside the store windows].*

(49) a. Lo scrittore Alberto Moravia **osserva** [ciò che accade sul Lungotevere]$_{\text{Phenomenon}}$ [attraverso la vetrata del suo appartamento]$_{\text{DIRECTION}}$.
*The writer Alberto Moravia **observes** [what happens along the river Tiber] [through the window of his apartment].*
b. All'ospedale, Raffaello ha potuto **sbirciare** [da un vetro]$_{\text{DIRECTION}}$ [il padre]$_{\text{PHENOMENON}}$.
*At the hospital, Raffaello could **peek** [through a glass pane] [at his father].*

Our annotated data show that *osservare* almost always occurs with the PHENOMENON alone, and almost never just with the DIRECTION: this construction occurs in only 3 out of 277 examples (about 1%). On the other hand, *sbirciare* occurs with the DIRECTION alone in almost 65% of the annotated sentences. This trend is mirrored by the fact that, to a native speaker, sentences with *osservare* followed by DIRECTION only sound quite marked (see (48a)), while similar sentences with *sbirciare* sound perfectly normal.

This difference in the distribution of syntactic patterns is connected to a difference in meaning: in sentences featuring DIRECTION only, the PHENOMENON (which, being a core FE, is still implied in the sentence even though it is unexpressed) receives a different interpretation depending on the verb involved. *Osservare* requires the unexpressed PHENOMENON to have a definite interpretation, which must be retrieved from the preceding context. In sentence (48a), therefore, it is understood that the doctor is observing a definite object, specified earlier in the text. With *sbirciare*, on the other hand, the unexpressed PHENOMENON remains indefinite; in fact, one could argue that the DIRECTION becomes a way of expressing the object of the act of perception, to the point that specifying a PHENOMENON is completely superfluous. This is the case in sentence (48b): we do not need to know exactly what the young woman is peering at in the store windows for the sentence to make sense. The indication that she is looking inside the windows is sufficient for its semantic well-formedness.

Such differences in syntactic-semantic patterning seem to reflect semantic differences between *sbirciare* and *osservare*. *Sbirciare* profiles the element of direction in perception, to the point that it is implied in the verb's meaning even when it is

unexpressed syntactically. This is in line with the semantics of English verbs such as *look at*, where the expression of a direction towards which the PERCEIVER turns his or her gaze in order to see a PHENOMENON is obligatory (as suggested by the fact that even the PHENOMENON must be introduced syntactically by the directional preposition *at*). *Osservare*, on the other hand, has no such implications: instead, it foregrounds the manner (extreme attentiveness) and prolonged duration of the act of perception.[7]

We then found that these semantic and syntactic distinctions are not just limited to *sbirciare* and *osservare*: a cursory look at data on other verbs of agentive perception revealed that some, such as *scrutare* [scan] and *guardare* [look], align with *sbirciare*, while others (e.g. *considerare* [consider], *contemplare* [gaze/contemplate], *esaminare* [examine], *fissare* [stare]) have the same syntactic distribution as *osservare*. Based on these data, we propose that agentive verbs of perception in Italian should be divided into two groups: *sbirciare*-type verbs, for which DIRECTION is a core FE, and *osservare*-type verbs, for which it is peripheral. The difference is also semantic: the former type profiles an act of directing one's gaze, while the latter describes a more general act of directing attention to it. We therefore decided to split the `Perception_active` frame into two subframes, `Perception_active_directed` and `Perception_active_undirected`, with corresponding FE structure. In order to encode the fact that these two frames are nevertheless closely related, we put them in an Inheritance relation with the `Perception_active` frame, which thus became a non-lexical frame. In this way, we extended the English frame ontology by creating an additional ramification at the end of the hierarchy.

At first, one might argue that the difference in frame structure between English and Italian reflects a difference in lexicalization patterns. However, when we look at the LUs belonging to `Perception_active` in English, we find that they present the same semantic differences that we observe in the Italian LUs. *Gaze, glance, look, peek, peer* and *stare*, among others, definitely foreground the PERCEIVER's act of directing his or her gaze to the PHENOMENON; on the other hand, *admire, observe, view* and *watch* do not seem to give particular relevance to it, as may be seen from a comparison between sentences (50a)–(50b) and (51).

7. We decided to describe the semantic difference between these two verbs in terms of profiling, because at some level, all verbs of visual perception involve the act of directing the gaze towards the PHENOMENON: it is necessary in order to have a visual experience, given the way human beings work. It is true, however, that each perception verb profiles different aspects of the human perceptual experience, and some of them — such as *osservare* — simply do not put a specific focus on this component.

(50) a. Sometimes my brothers and I were allowed to get out of the car with him and **peek** at the movie in progress while he spoke to the manager or cashier.
b. Lais ran through the villa **peeking** into rooms as she passed.

(51) Every summer, visiting day trippers could be seen enviously **watching** the local people enjoying themselves out on the sand.

This is further supported by the fact that verbs like *admire, observe, view* and *watch* cannot occur with DIRECTION alone, while *gaze, glance*, etc. can and do. This is the same distinction that subsists between *osservare* and *sbirciare*. Finally, raw quantitative data support this hypothesis as well. We used the Word Sketch from Sketch Engine (based on the BNC) to count how many times each one of these verbs occurred with a PP instantiating the DIRECTION FE, and found that there is a significant difference between the two groups of verbs: while *glance, gaze* and the like occur with such PPs in about 40% of their total occurrences, the frequency of *watch, view*, etc. in the same contexts is under 1%. Based on these observations, we propose that splitting `Perception_active` into two subframes would be appropriate for English as well, even though a more detailed study of the syntactic patterns occurring with `Perception_active` verbs might be necessary in order to support this claim.

We conclude that the difference that exists at the moment between the structure of `Perception_active` in English and Italian is actually the effect of a different annotation choice, and not of a structural difference between the two languages. At this point of our discussion, then, we can confirm the results we anticipated in Section 2: based on what we've seen so far, the lexical domain of visual perception has turned out to be structured in almost exactly the same way for English and Italian, from a frame-semantic point of view. As we mentioned before, this result is not unexpected: it is motivated both by the linguistic similarity between English and Italian and by the fact that perception is a basic human experience, which tends to be conceptualized in similar ways across languages and cultures.

It is also worth remarking that the splitting of `Perception_active` was mainly motivated by distributional differences among perception verbs, in turn correlated with differences at the semantic level. This again supports the importance of complementing the FrameNet methodology with quantitative, distributional data, such as those we automatically extracted from the Italian corpus.

4. Conclusions

4.1 Results

In this paper, we presented the results of a frame semantic analysis of a small group of Italian verbs expressing visual perception. The aim of this small-scale, highly focused project was to test the general methodology we set up for our long-term goal: creating Italian FrameNet, a frame-based electronic lexicon for Italian.

We described our methodology for creating a lexical entry, which replicates the three main phases of the Berkeley FrameNet approach: preliminary scanning of the data on the lexical unit, selection of a representative sample of example sentences from a corpus, and encoding of the related frame-semantic information (which includes annotation of the examples with FEs and syntactic information). The main difference is that the processes of sentence selection and encoding are based on distributional information automatically acquired from a dependency-parsed corpus. By doing so, we hope to define a sampling strategy that models the corpus distribution of lexical units more closely, thereby avoiding an excessive reliance on the annotator's linguistic intuition. The distributional information is used in the encoding phase, as well, as it helps determine to which frame certain instances of a word must be assigned.

For the analysis presented in this paper, we selected six Italian verbs related to visual perception and, by applying the method described above, identified the frame or frames they evoke. As a result, we now have a set of annotated sentences for each LU, with detailed information on the FEs realized in each sentence and their syntactic instantiations. Our study of these verbs revealed that the frame ontology for perception in Italian is almost exactly analogous to the one constructed for English. This may seem surprising, since other FrameNet projects, such as Spanish or Japanese FrameNet, have usually evidenced differences with English in many domains. However, a closer look at the structure of the lexical domain of perception in general and at the argument patterns associated with verbs of visual perception in various European languages shows that they are all quite similar in this respect. Our findings reflect this similarity, which is probably due to typological and geographical vicinity.

There seem to be more differences between Italian and English in relation to the figurative uses of visual perception verbs. For the sake of simplicity, in this paper we tried to restrict our discussion as much as possible to the "literal" interpretations of these verbs, especially the cases where they denote concrete events of perception; an exception is constituted by the instances of *scorgere* and *intravedere* with non-concrete objects shown in Table 2, Section 2.3.3, which are clearly figurative. The distinction between literal and non-literal meaning isn't always easy to

make; there are many instances of perception verbs followed by a *che*-clause that oscillate between a literal and a figurative interpretation, for example. We tried to select the instances that showed the least amount of ambiguity. We believe the figurative uses of verbs of visual perception are also an interesting field of study; as we mentioned above, some of the observations resulting from our work in that area are discussed in Johnson (forthcoming).

4.2 Further developments: A distributional approach to Frame Semantics

During the course of this project, we noticed that the most delicate (and potentially risky) part of the process of creating a lexical entry is the selection of a representative sample of occurrences. Fillmore et al. (2003) describe how this step is implemented in the Berkeley FrameNet: the lexicographer selects an LU from a list of words that he or she thinks refer to the same frame (in at least one of their senses) and scans its corpus attestations, "[noticing] the syntactic and collocational contexts that are most likely to select the intended sense" (Fillmore et al. 2003: 298). He or she then uses this information (which is also the basis for defining the FEs belonging to the putative frame) to extract representative examples from the corpus, using the Subcorporation Query Tool. This is more of a "top-down" procedure than a strictly "bottom-up" one: the lexicographer goes looking in the corpus for examples that support his or her hypotheses on the use of the word. The possibility that the resulting example set is truly a representative one depends a lot on the lexicographer's experience, ability, and linguistic intuition.

This approach has been criticized in particular by Patrick Hanks, the creator of Corpus Pattern Analysis (CPA: Hanks 2004, Hanks & Pustejovsky 2005). According to Hanks, there is a difference between the "cognitive salience" of a word or pattern and its actual frequency of use. Unusual senses of a word are more likely to be consciously registered and stored in the mind than unremarkable, everyday uses. Therefore, if the search for a word's patterns of use is conducted starting from introspection, it is possible that its most frequent, normal uses end up being overlooked. In contrast, CPA — which Hanks is adopting to create a "Pattern Dictionary of English Verbs" (*http://nlp.fi.muni.cz/projekty/cpa/*) — is essentially a "bottom-up" approach to finding word senses or uses. Through the analysis of large samples of corpus data, an attempt is made to identify all the prototypical (or "normal") syntagmatic patterns with which words in use are associated. Only when this process is complete do the compilers of the dictionary attach a word sense to each pattern. The main assumption of CPA, in fact, is that word meaning may only be determined in context.

Syntagmatic patterns, as Hanks intends them, include information on the semantic roles of verb arguments and on the semantic type of their filler nouns.

This is because the combination of different semantic types in the same syntactic pattern often gives rise to different word senses: for example, *shoot* in the sentence *shoot a person* could conceivably be ambiguous, depending on whether the subject of the sentence is an armed attacker or a film director (see Hanks & Pustejovsky 2005: 68). The sense of the verb depends on the semantic type of the NP appearing as its subject.

The methodology we proposed in this paper is an attempt to include the "bottom-up" approach adopted by data-driven approaches like CPA in the FrameNet development process. In doing so, we do not believe we abandoned the principles FrameNet is based on: indeed, we enhanced one of the basic features of FrameNet by making it even more grounded in corpus data.

Another goal of this attempt was to overcome potential deficiencies in the resource by reducing the incidence of lexicographers' personal biases in the process of creating it. This does not mean we are dismissing the importance of linguistic intuition for the development of FrameNet: as we explicitly stated in our discussion of the most representative syntactic contexts for *scorgere* and *sbirciare* in Section 2.3.2, distributional data always require interpretation and should not be taken uncritically. However, we do believe that giving distributional data a more important role in the FrameNet development process would definitely increase the value of the resulting resource. In fact, we suggest that it would be useful to go beyond what we have done here, and integrate some elements of CPA directly in the FrameNet methodology.

First of all, adopting CPA's rigorous and clearly defined method for the analysis of a word's syntactic distribution (with the final goal of identifying all "normal" patterns) would allow FrameNet lexicographers to collect an example set of sentences that is exhaustively representative of the behavior of the LU they are studying, without risking involuntary omissions.

Second (and perhaps more interesting), we propose that information on the distribution of syntactic argument fillers and their semantic types should be taken into account during the FrameNet development process, as well. As we mentioned above, the main reason why this is done in CPA is that the syntactic context of a word alone is not sufficient to determine its meaning: different semantic types in the same syntactic slot can cause different interpretations of the same word. Therefore, in FrameNet, the semantic types of argument fillers are an essential criterion for defining the frame membership of an LU and can be used in concert with syntactic information to identify which frame it evokes, when studying corpus data. They can also be used to distinguish different FEs with identical syntactic realizations inside the same frame, as we showed in our discussion on *con* [with]-PPs appearing with the verb *osservare*: even though the syntactic constituent is always

the same, it may instantiate three different FEs (BODY PART, MANNER, and INSTRUMENT) depending on the semantic type of the filler.

Information on fillers and semantic types could also be included in the FrameNet database, to make it available for further studies and computational applications. This information can be used to determine the selectional preferences of various LUs inside the same frame, in order to define semantic differences or similarities among them (as exemplified in the discussion on the fillers of *intravedere* and *scorgere* in Section 2), or to describe the "selectional preferences" of an entire frame. The Berkeley FrameNet sometimes specifies the semantic type associated with a frame's core FEs (for instance, the PERCEIVER PASSIVE in `Perception_experience` must be a SENTIENT). As illustrated in Lenci et al. (2010), studying the distributional information on fillers makes it possible to associate with each core FE a list of the semantic types related to its fillers, ranked by frequency of occurrence or by salience. We can also include in the database the most prototypical nouns instantiating each semantic type for each frame. Information on the semantic types of FEs, complemented with a saliency index and with a sample of lexical realizations for each type would be useful both for projects related to the automatization of the FrameNet annotation process (in particular, for automatic FE recognition) and for NLP applications that require semantically annotated data.

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