

Frequency distribution of inflectional properties of nouns: data on written Italian

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The inflectional features of words show distributional peculiarities that affect the cognitive processing of language. For instance, it has been consistently reported that the association between the grammatical gender and other inflectional properties of nouns affects comprehension and production processes. However, reliable quantitative data about the distribution of nouns' inflectional properties are scarce. The paper analyzes the inflectional system of nouns in Italian, a language where nouns are inflected for gender and number and are organized into different inflectional classes. The DeGNI lexical database (De Martino *et al.*, 2019) was interrogated in order to obtain measures of the distribution of genders, gender suffixes and declensional patterns of the Italian nouns.

Keywords: inflectional morphology, noun inflection, grammatical gender, inflectional classes, language resource

1. Introduction

Inflectional morphology marks words' formal features which convey the grammatical information needed in different syntactic contexts; inflectional morphology also holds the relationship between form and meaning together. The whole set of inflected forms of a base-word constitutes the inflectional paradigm of the word and is determined by the grammatical categories available in a given language (Stump, 2017). In many languages, the noun inflection is related to the

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grammatical category of gender. Corbett (1991) defines the grammatical gender as a *nominal agreement class* since it allows the distinction among different categories of nouns, for instance, nouns with or without a transparent gender marker in their orthographic/phonological forms and nouns with different gender-dependent inflectional patterns.

The gender-related properties of noun inflectional paradigms have been found to be crucial for the cognitive-linguistic competence of speakers. For instance, the consistent association between abstract grammatical categories (i.e., the grammatical gender) and specific morphological markers displayed in noun surface forms (i.e., the gender suffixes) has been found to affect behavioral and neural responses in different languages, different populations, and different experimental settings. There is general evidence that when the orthographic or phonological form of a noun shows a reliable cue for the noun gender, the lexical processing is faster, effortless and more accurate (Caffarra, Siyanova-Chanturia, Pesciarelli, Vespignani & Cacciari, 2015; De Martino, Bracco & Laudanna, 2011; De Martino, Bracco, Postiglione & Laudanna, 2017; Cubelli, Lotto, Paolieri, Girelli & Job, 2005; Gollan & Frost, 2001; Leminen, Smolka, Duñabeitia & Pliatsikas, 2019; Nevat, Ullman, Eviatar & Bitan, 2017; Mirković, Seidenberg & Joanisse, 2011; Paolieri, Lotto, Leoncini, Cubelli & Job, 2011; Sá-Leite, Luna, Fraga & Comesaña, 2020; Russo, Esposito, Laudanna, Mancuso, Di Salle, Elia & De Martino, 2021).

It has been also hypothesized that the mental lexicon and its neural underpinnings exploit the recurrence of linguistic information shared by groups of words in a linguistic environment in order to organize and process linguistic information (Cibelli, Leonard, Johnson & Chang, 2015; Milin, Đurđević & del Prado Martín, 2009; Pykkänen, Feintuch, Hopkins & Marantz, 2004). As far as nouns are concerned, the hypothesis is that speakers are sensitive to the distributional properties of several gender-related factors: the orthographic-phonological properties of nouns (i.e. the degree of transparency of the gender suffixes), the distribution of nouns across the inflectional classes available in a language, the different size and/or degree of productivity of the inflectional classes (Dressler & Thornton, 1996). However, the specific role of each factor is unclear. The problem in this field is that reliable quantitative data about the frequency distribution of inflectional properties of nouns are scarce.

This paper provides quantitative data on the frequency distribution of the main properties of the noun inflectional paradigm in Italian, a language with rich and complex morphology where nouns are inflected for gender and number and are organized into different inflectional classes (Acquaviva, 2009; Thornton, 2009).

In Italian all nouns have mandatorily a grammatical gender, masculine or feminine, whether they refer to entities having a biological sex (nouns with animate referents, *sorella*, feminine, “sister”, vs. *fratello*, masculine, “brother”) or not (*sedia*, feminine, “chair” vs. *libro*, masculine, “book”); bi-gender nouns also exist (for instance, the noun *adolescente* designates both a teenager girl or boy); no neuter gender is admitted.

Table 1: Inflectional Classes of Italian nouns (Salvi & Vanelli, 2004).

| Inflectional class | Inflectional endings (singular/plural) | Prevailing gender | Examples |
|--------------------|--|------------------------|---|
| 1 | -o/i | masculine | <i>libro/libri</i> (book/books) <i>fratello/fratelli</i> (brother/brothers) |
| 2 | -a/-e | feminine | <i>casa/case</i> (house/houses) <i>sorella/sorelle</i> (sister/sisters) |
| 3 | -e/-i | masculine and feminine | <i>ponte/ponti</i> (bridge/bridges) <i>prete/preti</i> (piest/priests) <i>nave/navi</i> (ship/ships) <i>silfide/silfidi</i> (silph/silphs) |
| 4 | -a/-i | masculine | <i>poema/poemi</i> (poem/poems) <i>pirata/pirati</i> (pirate/pirates) |
| 5 | Invariable, singular=plural | masculine and feminine | <i>gru, bar, città, crisi, sosia</i> (crane/cranes, bar/bars, city/cities, crisis/crisis, double/doubles) |

In Italian, the inflectional morpheme that conveys grammatical information about grammatical gender and number is the ending vowel, which can be more or less strongly associated with the masculine and feminine gender. Both the ending vowel of the singular form and the grammatical gender determine the criterion for the generation of the number-inflected forms of the noun and for the distinction

of the inflectional classes², i.e. the different singular-to-plural mapping options. Different classifications have been proposed for Italian declensional classes; their number varies between 3 and 10 (Dressler & Thornton, 1996). Table 1 shows the classes most commonly reported in descriptive grammars.

2. Methods

In order to gather information on the frequency distribution of the inflectional properties of the Italian nouns, the DeGNI lexical database (De Martino, Postiglione, Bracco & Laudanna, 2019) was interrogated. It provides grammatical (gender), morphological (inflectional class) and orthographic/phonological information (inflectional ending) for 23.619 lemmas³ corresponding to the Italian nouns extracted from CoLFIS, a frequency lexicon of contemporary written Italian (Bertinetto *et al.*, 2005).

To our knowledge, the DeGNI database is the largest set of Italian noun lemmas that provides annotations of the entries for their inflectional properties. Other available resources are based on smaller samples of nouns. The BDVDB database (Thornton, Iacobini & Burani, 1997) provides annotations for 4.557 nouns (D’Achille & Thornton, 2003); the Flex-it database (Pescuma, Zanini, Crepaldi & Franzon, 2021) includes 33.367 annotated entries; however, in this database both the singular (*libro* “book”, *fratello* “brother”) and the plural form of a noun (*libri* “books”, *fratelli* “brothers”) are listed as single entries; thus, Flex-it provides data for fewer noun lemmas than DeGNI.

Different measures of the distribution of Italian nouns for each gender, inflectional class and gender suffix are provided in the following paragraphs. Percentage values are reported since they are easy to understand and allow us to draw comparisons among various phenomena.

3. Results

3.1 Gender

The values reported in Table 2 show that in Italian there is an asymmetry in the distribution of genders: masculine is the most frequent gender. This pattern is diachronically constant (see the data of D’Achille and Thornton, 2003).

² In this paper the terms declensional class and inflectional class are used interchangeably.

³ Each single entry in the DeGNI database corresponds to the citation form of an Italian noun as it is listed in the CoLFIS lemmas repertoire.

Table 2. Distribution of grammatical gender in written Italian

| Gender | Lemmas |
|------------------|---------------|
| Masculine | 55% |
| Feminine | 39% |
| Bi-gender | 6% |
| <i>Tot</i> | <i>100%</i> |

Since masculine is the more frequent value for the gender feature in Italian, it can be considered the “default gender” and the least-marked (Cacciari, 2001; D’Achille, 2003; Di Domenico, 1997). This hypothesis is corroborated by a number of phenomena; for instance, the observation that nominalizations of verbs take the masculine gender (e.g., *Viaggiare in macchina è comodo_M*, “Traveling by car is comfortable”), or the fact that the masculine prevails over the feminine in the plural whenever a masculine entity is part of a group (e.g., *I cavalieri_M e le dame_F erano attesi_M alla serata danzante* “The knights and ladies were expected at the evening dance”).

From a cognitive point of view, the default-based theories posit that the unmarked/default for a given feature requires lower mental effort, attention demands and processing time than the marked/non default (Givón, 1995). This is possible because the existence of a default option, i.e. masculine for the gender feature, implies that it is always activated and automatically retrieved during lexical processing of nouns, regardless of their grammatical gender (Pinker, 1998). However, data provided by De Martino *et al.* (2017) disproved the prediction of the default gender-based theories. The authors proposed that the lexical processing of nouns is more likely affected by the strength of the association between the gender suffix and the noun gender, rather than by the activation of a gender default option; however, they could not support their explanation with distributional data.

In the following paragraph we provide the distributional data on the relation between gender and formal properties of the Italian nouns.

3.2 Inflectional Endings

The majority of nouns in Italian ends in a vowel. The most frequent endings and their distribution in the singular and in the plural are reported in Tables 3 and 4. Tables 5 and 6 provide the distributional measures that quantify the strength of the association between the ending vowels of the Italian nouns and the grammatical gender in the singular. Table 7 reports the distribution of plural inflectional endings across genders.

Table 3. Distribution of inflectional endings in Italian singular nouns

| Suffix | Lemmas |
|--------------|-------------|
| -a | 28% |
| -e | 26% |
| -i | 1% |
| -o | 33% |
| Other | 12% |
| <i>Tot</i> | <i>100%</i> |

Table 4. Distribution of inflectional endings in Italian plural nouns

| Suffix | Lemmas |
|--------------|-------------|
| -i | 54% |
| -e | 30% |
| Other | 16% |
| <i>Tot</i> | <i>100%</i> |

Data reported in Table 5 to 7 show to what extent the ending vowels of the Italian nouns are associated with a specific gender. In the singular, the nouns that end in *-o*, with a few exceptions, are masculine, the nouns that end in *-a* are mostly feminine, while the final vowels *-e* and *-i* are less biased toward one gender.

The distributional profile of the ending vowels of the Italian plural nouns reveals that the *-i* suffix is present in the majority of nouns and is consistently associated with the masculine gender. The other suffix for the plural, the ending vowel *-e*, is less frequent but unequivocally related to the feminine gender.

Table 5. Distribution of final vowels in Italian singular nouns across genders

| Suffix | Lemmas | | | <i>Tot</i> |
|-----------|-----------|----------|-----------|-------------|
| | Masculine | Feminine | Bi-gender | |
| -a | 5% | 87% | 8% | <i>100%</i> |
| -e | 51% | 38% | 11% | <i>100%</i> |
| -i | 47% | 47% | 6% | <i>100%</i> |
| -o | 99% | 1% | 0% | <i>100%</i> |

Table 6. Distribution of final vowels in Italian singular nouns across genders

| Suffix | Masculine | | Feminine | | Bi-gender | | Tot |
|--------------|----------------------------|--------|--------------------------|--------|-------------------------------------|--------|------|
| | Example | Lemmas | Example | Lemmas | Example | Lemmas | |
| -a | <i>pirata</i> (pirate) | 1% | <i>casa</i> (house) | 24% | <i>sosia</i> (lookalike) | 2% | 28% |
| -e | <i>ponte</i> (bridge) | 13% | <i>fonte</i> (source) | 10% | <i>cantante</i> (singer) | 3% | 26% |
| -i | <i>brindisi</i> (toast) | 1% | <i>tesi</i> (thesis) | 1% | <i>rubacuori</i> (heart-breaker) | 0% | 1% |
| -o | <i>libro</i> (book) | 33% | <i>mano</i> (hand) | 0% | - | 0% | 33% |
| Other | <i>bar</i> (bar) | 7% | <i>gru</i> (crane) | 5% | <i>chef</i> (chef) | 1% | 12% |
| <i>Tot</i> | | 55% | | 39% | | 6% | 100% |

Table 7. Distribution of inflectional endings in Italian plural nouns across genders⁴

| Suffix | Lemmas | | | Tot |
|-----------|-----------|----------|-----------|------|
| | Masculine | Feminine | Bi-gender | |
| -i | 47% | 47% | 6% | 100% |
| -e | 51% | 38% | 11% | 100% |

Psycholinguistic models of gender retrieval assign to gender formal cues a crucial role in lexical processing of nouns. Gollan and Frost (2001) propose that the language processing system analyses the gender information by means of two mechanisms. A lexical mechanism retrieves the abstract grammatical information of nouns as it is stored in the mental lexicon; as far gender is concerned, this mechanism provides information about the gender that is arbitrarily associated with a noun (e.g., the feminine gender associated with the Italian word *casa*, “house”). A non-lexical mechanism analyses the formal properties of the noun and exploits the correlation between gender and the noun formal cue bringing gender information (e.g., the ending vowel *-a* of the Italian feminine nouns). The model predicts a processing advantage for gender-transparent nouns because their gender

⁴ Nouns with a vowel-change from singular to plural have been included in the analyses reported in the table.

can be reliably recovered by both the mechanisms. On the contrary, only the lexical mechanism provides the correct gender information for opaque and irregular nouns.

The quantitative data reported in Tables 5 to 7 support the hypothesis of Goljan and Frost and corroborate the available findings on the lexical processing of Italian (see Caffarra *et al.*, 2015; Cubelli *et al.*, 2005; De Martino *et al.*, 2017, 2011, among the others).

However, the distributional patterns of the gender suffixes are not sufficient to explain the cognitive mechanism that allows a speaker to activate and select adequately all the inflected variants of nouns. In fact, it is possible that a noun has a transparent suffix in one inflectional variant (i.e. the suffix *-i* of the masculine plural form *pirati*, pirates, see Table 6) and a non-transparent suffix in the other one (i.e. the suffix *-a* of the singular form *pirata*, see Table 5). Thus, a further possibility is that the distribution of the inflectional classes and their relation with the grammatical gender plays a role in this process.

3.2 Inflectional Classes

Table 8 shows the distribution of Italian noun lemmas across inflectional classes and genders: the inflectional patterns existing in Italian are ordered on the basis of their size, from the most frequent to the less frequent (see the percentage reported in the last column on the right). The last row on the bottom includes all the cases that do not conform to the classes indicated in descriptive grammars (cfr. Table 1). Nouns that can appear only in the singular (*singularia tantum*: *algebra*, “algebra”) or in the plural form (*pluralia tantum*: *nozze*, “wedding”) and lexical borrowings (*chef*, *sommelier*) have been included within the class of invariable nouns.

The majority of nouns are distributed across 4 major inflectional patterns (*-o/-i*, *-a/-e*, *invariable*, *e/-i*).

Three classes (*-a/-e*, *invariable*, *-e/-i*) out of 4 have comparable size, while the *-o/-i* class is slightly larger. This distributional pattern is consistent with previous data obtained by D’Achille and Thornton (2003) on a smaller corpus. The remaining 5% includes nouns with the *-a/-i* patterns (1%) and the peculiar phenomena in the singular-to-plural mapping listed below:

- compounds where the plural form requires the simultaneous changing of the ending vowels of both the constituents of the compound (*altoforno* / *altiforni* “blast furnace/blast furnaces”);
- nouns that have more than one option for their plural form (*lenzuolo* / *lenzuola*, *lenzuoli* “bed sheet/bed sheets”; *atleta* / *atleti*, *atlete*

“athlete/athletes”: in this case, the noun *atleta* can refer both to a male or a female athlete in the singular form, while, in the plural form, the noun has different forms for male athletes “*atleti*” and female athletes “*atlete*”);

- nouns ending in -o in the singular and in -a in the plural which have different gender values in singular and plural: *l'uovo* “the egg” (masculine) / *le uova* “the eggs” (feminine);
- loan words that are used in Italian in the inflected variants of the source language (*curriculum* / *curricula* “resume/resumes”, *conquistador* / *conquistadores* “conqueror/conquerors”).

Table 8. Distribution of nouns across inflectional classes and across genders in written Italian

| Inflectional class | Masculine nouns | | Feminine nouns | | Bi-gender nouns | | Tot |
|--------------------|-----------------|---|----------------|---|-----------------|--|-----|
| | Lemmas | Example | Lemmas | Example | Lemmas | Example | |
| -o/-i | 30% | <i>il libro/i libri</i> (the book/the books) | 0% | <i>la mano/le mani</i> (the hand/the hands) | 0% | - | 31% |
| -a/-e | 0% | <i>la casa/le case</i> (the house/the houses) | 23% | - | 0% | - | 23% |
| invariable | 14% | <i>il brindisi/i brindisi</i> (the toast/the toasts) | 6% | <i>la specie/le specie</i> (the species/the species) | 1% | <i>il, la sosia/ le, i sosia</i> (the lookalike/the lookalikes) | 21% |
| -e/-i | 9% | <i>il ponte/i ponti</i> (the bridge/the bridges) | 8% | <i>la fonte/le fonti</i> (the source/the sources) | 3% | <i>il, la testimone / i, le testimoni</i> (the witness/the witnesses) | 20% |

| | | | | | | | |
|--|-----|---|-----|---|----|--|------|
| -a/-i | 1% | <i>il fo- nema/i fonemi</i> (the pho- neme/ the pho- nemes) | 0% | <i>l'arma/le armi</i> (the weapon/ the weap- ons) | 0% | - | 1% |
| other declensional patterns | 1% | <i>il dito/le dita</i> (the fin- ger/ the fin- gers) | 1% | <i>la gom- mapiuma/ le gommepe- ume</i> (the foam rubber/ the foam rubbers) | 2% | <i>il, la ca- pofila/ i capifila, le capo- fila</i> the leader/the leaders <i>l'at- leta/gli atleti, le atlete</i> the ath- lete/ the ath- letes | 4% |
| | 56% | | 38% | | 6% | | 100% |

Table 9 reports quantitative data on the distribution of genders within the inflectional classes.

The inflectional class with the *-a/-e* mapping between the singular and the plural includes only feminine nouns. The inflected forms of the nouns from this class belong to a frequent inflectional pattern (23% of the whole set of Italian noun lemmas) and are gender-transparent both in the singular and in plural (see also Table 7). The same holds for the Italian nouns ending in *-o* in the singular and in *-i* in the plural.

In terms of lexical access, this distributional pattern corroborates the experimental evidence that the nouns from both these class are effortlessly processed. On the contrary, the cognitive processing of other nouns is not straightforward. For instance, in the Italian inflectional class of masculine nouns ending in *-a* in the singular and in *-i* in the plural, the transparency of the gender suffix changes within the paradigm of the noun: the singular forms have a misleading gender suffix (see Table 5 and 6) while the plural forms are highly transparent (see Table 7). Moreover, these nouns belong to an infrequent inflectional class (1%).

The inflectional pattern based on the mapping between *-e/-i* from singular to plural shows a balance between masculine and feminine genders (45% vs. 42%);

on the other hand, the relation between their gender and inflectional suffixes in singular and plural forms is not trivial: the suffix *-i* in the plural is biased in favour of masculine (78% vs. 16%), but the suffix *-e* in the singular is not (51% vs. 38%).

These distributional measures corroborate the different patterns of response latencies, accuracy and cognitive load obtained on singular and plural nouns from frequent vs. infrequent declensional classes in behavioural and fMRI experiments (De Martino *et al.*, 2011; Russo *et al.*, 2021).

Bi-gender nouns have less consistent inflectional patterns: the majority of these nouns have other declensional patterns (Table 9).

Table 9. Distribution of genders within inflectional classes in written Italian

| Inflectional Class | Gender | | | Tot |
|------------------------------------|-----------|----------|-----------|------|
| | Masculine | Feminine | Bi-gender | |
| o>i | 99,97% | 0,03% | 0% | 100% |
| a>e | 100% | 0% | 0% | 100% |
| invariable | 33% | 61% | 6% | 100% |
| e>i | 45% | 42% | 13% | 100% |
| a>i | 99% | 1% | 0% | 100% |
| other declensional patterns | 27% | 16% | 56% | 100% |

4. Conclusion

This paper is inspired by current psycholinguistic theories positing that there is a correspondence between the distributional characteristics of words and their mental representation and processing. Our aim is to provide a reliable research resource that describes, on distributional grounds, to what extent formal characteristics of nouns are related to their morphological, grammatical and semantic information.

A dataset on the noun inflection in contemporary written Italian has been obtained through analyses performed on a lexical database containing 23.619 noun lemmas. The data reported in the present paper provide qualitative and quantitative data on the mapping between gender and number of Italian nouns and on the different levels of consistency among inflectional classes.

Our results corroborate the findings of experimental research on lexical access: our quantitative frequency-based measures confirm that nouns belonging to large and consistent inflectional patterns and with gender cues that are strongly and reliably associated to a given gender effectively correspond to the nouns that have been found to be processed faster, effortlessly and more accurately.

The dataset can be profitably used for driving both future experiments designs and *post hoc* analyses of existing data. We encourage researchers to exploit our data in studies on lexical processing of nouns since the distributional weight of their inflectional properties have implications in different aspects of lexical access: noun selection from the mental lexicon, inflectional encoding, noun recognition and comprehension, gender retrieval, agreement. Our data could be taken into consideration for developing accurate psycholinguistic models in order to account for the specific role of inflectional properties of nouns in lexical processing.

An extended version of the described dataset is under construction and will integrate the data on noun lemmas with information on the individual forms of each lemma. These future data will help to disentangle the specific role of the whole word form frequency, the inflectional morphemes frequency (final vowels), the size of inflectional classes and the frequency of syntactic-grammatical properties (gender).

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