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Article

Quantifying folk perceptions of dialect boundaries. A case study from Tuscany (Italy)

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Abstract

This paper aims to understand the contribution of geographical information in the perception of linguistic variation. A total of 813 mental maps collected among young speakers from different cities in Tuscany have been analyzed via an open-access web dialectometric tool (Gabmap). In particular, the study seeks to verify the role of geographic distance and the place of residence of the respondents in modeling perceived variation. The relationship between dialect grouping as made by linguists and perceived taxonomies of sublinguistic areas is also investigated. Results show that geographical proximity between mapped areas significantly predicts the perception of dialect similarity. Our participants made their decisions looking at (1) a keen sense of spatial contiguity, and (2) the synchronic presence of linguistic differences between the Tuscan subregions. Moreover, classification uncertainty grows when the mapped areas are very close to, or very distant from, the participants' places of residence. Methodological and linguistic perspectives of mental maps in folk linguistics are finally discussed.

Keywords: Perceptual dialectology; geographic distance; mental maps; dialectometric analysis; Gabmap

1. Introduction

Studies addressing speakers' "naïve" perception of linguistic boundaries help both the sociolinguists and the dialectologists in understanding mechanisms and dynamics of language change and in questioning the validity of geolinguistic constructs, that is, the reality of linguistic boundaries drawn by the linguists as experienced by the speakers.

The complexity of its linguistic *repertoire* makes Italy an ideal territory for the analysis of perceived linguistic variation. In this respect, the Tuscan repertoire appears to be even more challenging. Indeed, since the Florentine dialect is at the origin of what is now Standard Italian, the relationship between the two poles of standard and vernacular is, in Tuscany, different from the rest of Italy. The boundaries between the two codes are blurred, with several dialectal features found even in formal contexts, and subregional variation manifests itself in peculiar ways. Speech varieties have the same phonological inventories and differ only in terms of the distribution of single phonemes (Calamai, 2017; Giannelli, 2000). Because the tracking of linguistic boundaries is particularly challenging, relying on speakers' perceptions of subregional linguistic variation could, thus, shed light on the role of isoglosses in the construction of mental maps.

In this article, we present research based on the analysis of mental maps collected among young speakers from different Tuscan cities scattered throughout the regional territory. Moreover, we propose a novel approach to the quantitative inspection of folk linguistic perception, one which relies on open-access web dialectometric tools. The paper is structured as follows: in Section 2 we detail the framework and the methods of perceptual dialectology, with a specific focus on perceptual dialectology in Italy; Section 3 addresses the challenges involved in a quantitative analysis of a map corpus; in Section 4 we offer a dialectological sketch of Tuscany and detail the corpus, the research questions, and the experimental design; Sections 5 and 6 contain the results of our experiments and a discussion of them. Lastly, Section 7 concludes our work.

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2. Perceptual dialectology

Perceptual dialectology aims at gathering data concerning what people think about and how people process social and geographical language variation (Niedzielski & Preston, 2000, 2009). PD deals with the regional distribution of linguistic features as observed by non-specialists, together with considering social and attitudinal factors in perceiving variation (Preston, 2018:177). Analyzing language attitudes and feelings of linguistical affiliation, together with the perception of linguistic borders, can be crucial in justifying language change and can also inform policies developed by educators and politicians so that such policies will take into account the attitudes of the speakers to whom the policies apply (Cramer, 2016).

Space appears to be a crucial concept for perceptual dialectology. It is, indeed, imbued with social meaning, being not only the *locus* of variation—languages and dialects vary across space, across cities and territories—but, above all, a lived space, in which people meet and interact with each other (Britain, 2010). Thus, the mental representation of space affects not only the perception of variation, but it plays a role in modeling variation itself, leading to the possible strengthening or repositioning of old and new isoglosses (Auer, 2005). It is indeed the community itself that recognizes its own borders and that decides then to fit in with them rather than conforming to borders imposed on communities (Iannàccaro & Dell'Aquila, 2001:267).

2.1 The draw-a-map task

Among the many techniques developed by Preston (1999) for the study of language regard, only the draw-a-map technique can be considered a real geographical task (Calaza Díaz et al., 2015). People are asked to reflect on orienting themselves not solely on their judgment, but they are given a tool—i.e., a real map—in which they have access to other information, such as geographical distance, names of the cities, etc. The draw-a-map technique is thus a task in which the main focus is, exclusively, on speakers' spatial correlates of linguistic difference.

The very first studies conducted with the draw-a-map technique tended to focus on "broad, non-local assessment of dialect distinctions" in vast geographical areas (Preston, 2010:128), whereas recent studies tend to focus on more restricted contexts (e.g., for the Qassim area of Saudi Arabia, Al-Rojaie, 2020; for Ohio, Benson, 2003; for California, Bucholtz et al., 2007, 2008; for southwestern Germany, Montgomery & Stoekle, 2013; for Northern England, Pearce, 2009, 2011). Nonspecialist perception of dialect similarity appears to be heavily grounded in geographic distance (Gooskens, 2005, 2012; Van Bezooijen & Heeringa, 2006): the more two dialects are spatially separated, the more they are perceived as dissimilar. Moreover, it has been shown that respondents tend to draw their dialect area first and to describe its surroundings with a high level of detail (Preston, 1999:xxxiv–xxxv). This effect is related to the idea that information about an area is more readily available to those living in its proximity (Montgomery, 2012, 2018).[1] Of course, this pattern is not mechanistic; geographical and cultural boundaries can alter the flow of information between adjacent areas. The analysis of mental maps usually shows that speakers have a multidimensional perception of space because they evaluate landscapes, economic flows, industrial development together with linguistic variation, which is commonly used by informants to identify at some level similarities and differences between dialects. These partitions sometimes recall strictly dialect grouping as made by linguists (Evans, 2011), whereas sometimes respondents happen to detect "subtle differences in specific linguistic markers of variety" (Preston, 2018:200).

2.2 Perceptual dialectology in Italy

Italian dialectology has been in close relation with folk linguistics. From its beginning, it has been focused on the relationship between speakers and their linguistic space and on the importance of the emotional and ideological dimensions of language (Telmon, 2002; Terracini, 1963). The concept of "lived space" has been interpreted as the terrain in which mental images about languages and speakers are deeply linked to geographic places, and this link between speakers and places is imbued with an emotional component, sensations, and perceptions, rather than being informed by the abstract spatial structure (D'Agostino, 2007). Perceptual dialectology in Italy has mainly privileged methods such as the matched guise techniques (Calamai, 2019; Calamai & Ricci, 2005; Marzo, Crocco & De Pascale, 2018), or qualitative investigations using focus groups, interviews, and linguistic autobiographies (Iannàccaro, 2002), often neglecting other experimental methods like the draw-a-map technique. Despite that, examples of maps that reflect subjective dialectal boundaries are in Iannàccaro (2002), Rabanus & Lameli (2011) and, for Tuscany, in Heinz (2004) and Calamai (2018). However, not all these works include extensive samples of informants. Additionally, sometimes they do not take into account adequate techniques for statistical analysis. For example, Calamai (2018) collected a corpus of 258 maps, but the analysis was conducted entirely on aggregate data. In this regard, this present paper represents the very first Italian research aiming at applying quantitative methods and statistical analysis to a conspicuous corpus of mental maps collected in Tuscany.

3. Maps, mapping, and quantitative data

The choice of using a specific semiotic object, i.e., the map, almost seems to reinforce the link between perceptual dialectology and dialectology itself. Linguistics appears to go hand in hand with cartography with the aim of providing visually handy representations of language documentation and interpretation (Girnth, 2010:100), and maps and cartographic processes were at the core of the first geolinguistic works. First-generation linguistic atlases were structured according to lexical criteria: variants of individual lexical forms were transcribed following phonetic conventions and charted on maps. The analysis of these maps led to identification of isoglosses, of regular patterns of variation, and to the theorization of areal norms by Matteo Giulio Bartoli (1945) (see, for example, Rabanus, 2018).

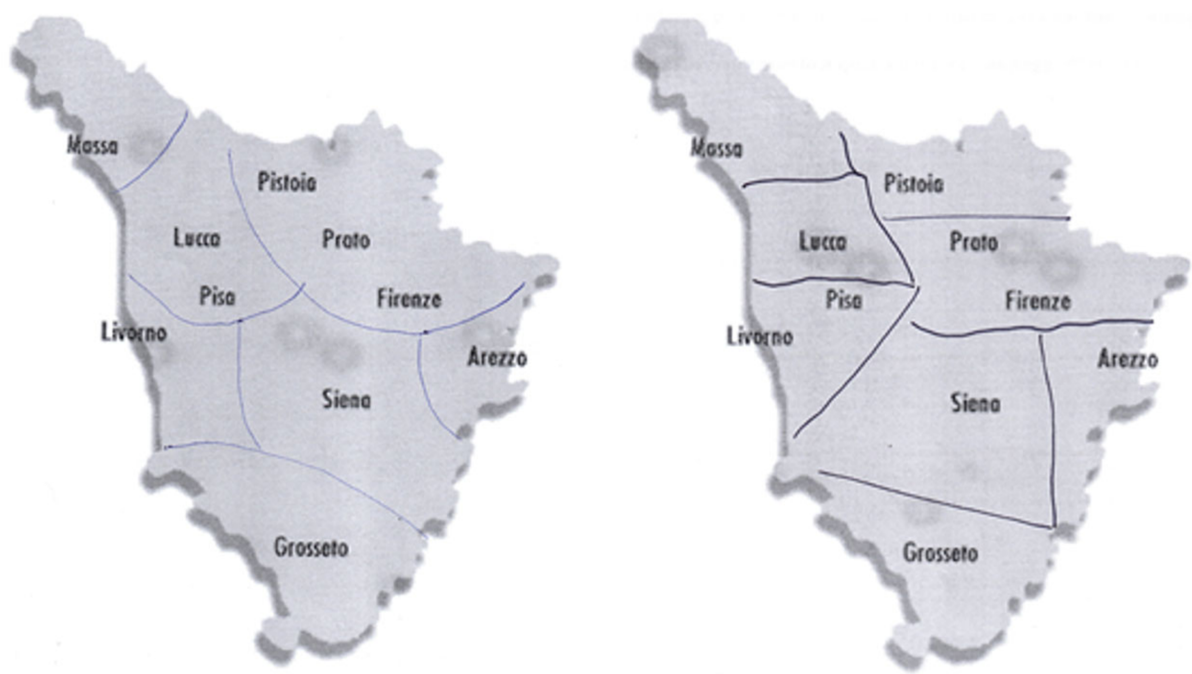
Nevertheless, until recently, the large amount of data represented in the linguistic atlases has scarcely benefited from sufficient techniques that would permit a thorough quantitative analysis. The emergence of dialectometry has allowed for the discovery, through the combination of statistical and cartographic methods with linguistic analysis, of abstract patterns that were difficult to observe through qualitative investigation (Goebl, 2018; Séguy, 1971; Wieling & Nerbonne, 2015).

Choropleth maps appear to be a peculiar tool in dialectometric analysis (Rabanus, 2018:356). Unlike a simple chorochromatic map, choropleth maps allow for the visualization of a statistically grounded gradience of similarity: areas that share a feature are filled with the same color in proportion to a statistical variable, so that the darker the color the higher the adherence of the subarea to the reference statistical variable. With this technique, linguists can easily offer a user-friendly visualization of patterns of variation across a territory.

Dialectometry also makes possible an in-depth analysis of the relationship between linguistic and geographic distance. The use of "as the crow flies" distances for the explanation of the diffusion of linguistic differences and their perception was called into question for those countries with huge geomorphological complexities given the risk of oversimplifying the spatial processes of linguistic diffusion (Gooskens, 2005). Alternative measures of distance, such as modern and old travel times between places, appear to improve the correlation coefficients with objective and perceived differences between places.

Thanks to new software and different kinds of quantitative analysis (Nerbonne, 2009), dialectometric techniques were applied successfully to different geographical and linguistic contexts (Goebl, 1981, 2007, 2008 with data coming from AIS) and to different levels of analysis of the linguistic system (see, for example, Heeringa, Johnson & Gooskens, 2009 for phonetic data; Elvira-García et al., 2018 for prosodic distance and, for the Tuscan context, Montemagni et al., 2012, 2013; Montemagni & Wieling, 2016 with evidence of linguistic change).

Map 1. The map used in the fieldwork.



Maps 2-3. Mental maps drawn by a participant from Florence (left) and Prato (right).

3.1. A perceptual dialectometry?

Until recently, perceptual dialectology did not have adequate tools for a real quantitative analysis of the perception of linguistic variation, probably because of the nature of the task itself, one that typically requires a freehand drawing on a blank map. Thus, the processing of large amounts of data was usually extremely time-consuming, with routines that commonly involved individual scanning and incorporation of the maps as layers. Additionally, the identification of the area is usually furnished with qualitative annotations (such as nicknames about places, shibboleth, etc.), and it is sometimes difficult to find a method to process these data (Montgomery, 2017). For example, Preston (1996) processed

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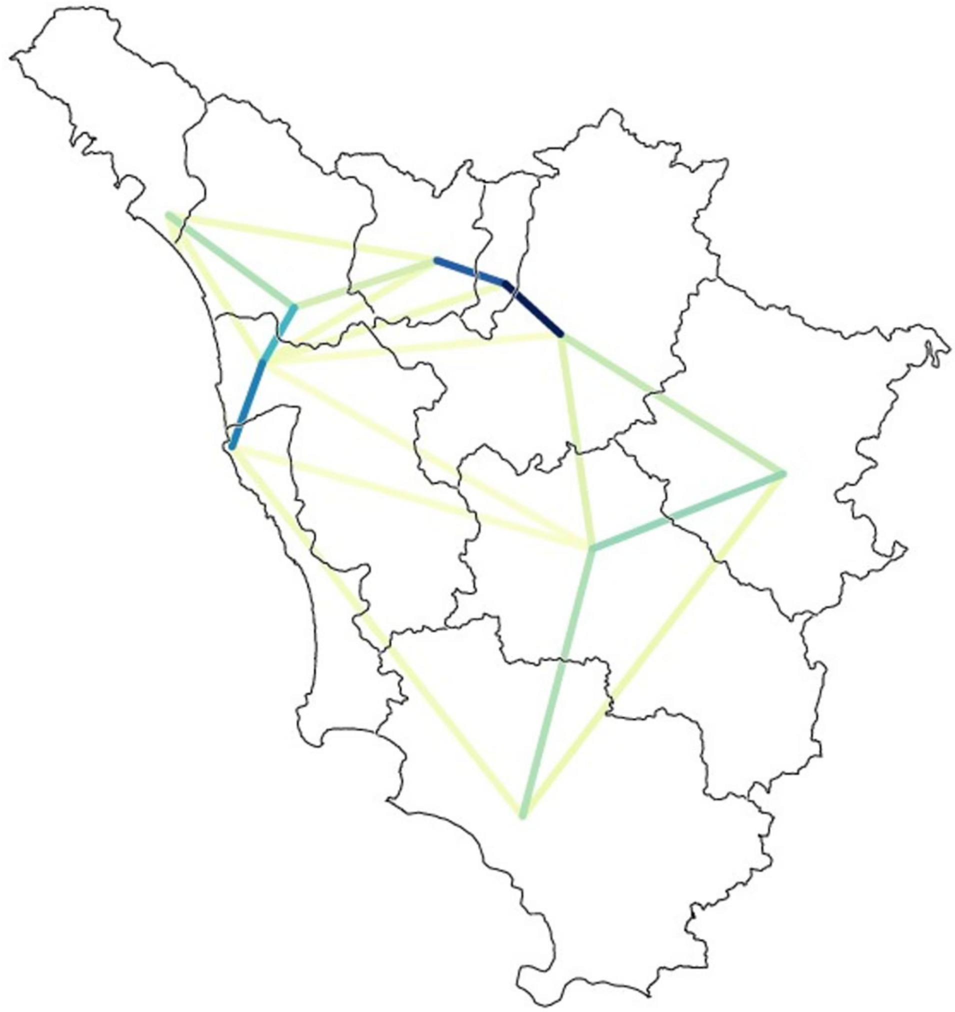


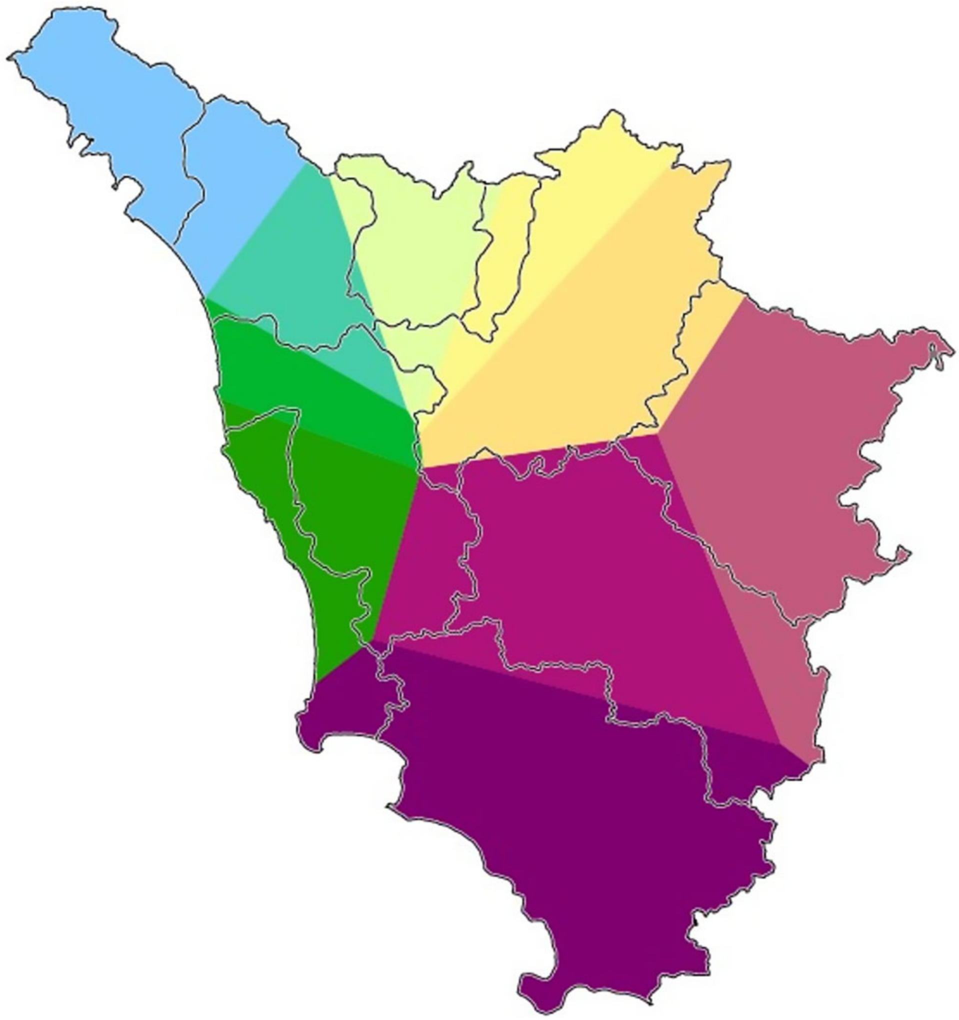
Map 4. Gabmap difference map showing different degrees of perceived linguistic solidarity between adjacent areas. The whole Tuscan corpus is the source data. Darker lines mean higher levels of perceived similarity (e.g., Florence-Prato-Pistoia, Pisa-Leghorn).

147 southeastern Michigan hand-drawn maps of US dialect areas using a light pen and a light-sensitive pad, but the task required the discarding of regions that were not identified by the respondents. Other studies conducted quantitative analyses only on survey answers, disregarding geographical information collected through the compilation of mental maps (e.g., Bucholtz et al., 2008), whereas others still decided to encode the maps on the basis of the groupings listed by the subjects (see Calamai, 2018).

Thanks to new instruments, we are now facing a turning point in the analysis of perceptual dialectological data. Tools such as GIS were proven useful in the analysis of maps, as shown by works that take into account multidimensional geographical information (Al-Rojaie, 2020; Calaza Díaz et al., 2015; Cukor-Avila et al., 2012; Evans, 2011, 2013, 2016; Kendall & Fridland, 2016; Montgomery & Stoeckle, 2013), and dialectometric analysis allowed researchers to consider the perceived distance expressed by the speakers as a factor in the evaluation of dialects (Gooskens, 2005; Gooskens & Heeringa, 2004, 2006).

Applying quantitative methods to perceptual dialectology not only allows investigators to retain the data usually collected in the field, but also to apply statistical techniques to enhance the analysis. Moreover, the application of dialectometric methods permits (1) to consider geographical information, such as distance in kilometers between points, and (2) to offer a visualization of the data in order to make them more readable, being graphicacy (Balchin & Coleman, 1966) a fundamental fourth ace for any research on spatial relationships.

Given these premises, and in order to investigate the role of the geographic component in the perception of dialect areas, we have relied on the dialectometric software Gabmap (Leinonen, Çöltekin & Nerbonne, 2016; Nerbonne et al., 2011) with the aim of proposing a novel pathway to graphicacy in perceptual dialectology. Gabmap is a free, web-based software that allows for the aggregation and clustering of large amounts of data. The Gabmap platform was not originally conceived for perceptual data (Nerbonne et al., 2011: 68–9). However, its easy-to-use and fast-to-process utilities can vastly benefit our field of interest as well. In particular, the processing of data with Gabmap enables researchers to achieve three different tasks: (1) analysis: the software itself permits automatic clustering; (2) visualization: the clustered data can be used to generate different kinds of maps that will facilitate the analysis and can be used as a tool in other nonspecialistic contexts; and (3) replicability: the maps, coded as matrices, can be reanalyzed by other scholars and, moreover, the corpus can always be updated. By performing a statistical clustering of people's subjective perceptions of dialect areas, Gabmap introduces ready-made cartographic realism (Hallisey, 2005:356).



Map 5. Gabmap multidimensional scaling map of Tuscany (whole Tuscan dataset). The colors of the three principal dimensions (I: red, II: green, III: blue) are plotted simultaneously, creating a visual representation of the perceived Tuscan dialect continua.

4. The experimental research

This section is devoted to the experimental research and it is conceived as follows. First, we will express the research questions, then we will offer a synthesis of the Tuscan taxonomy made by linguists. Finally, we will detail the experimental design and the sample.

4.1 Research questions

The broad goal of this paper is to understand the contribution of geographical and personal data information (e.g., residence of the respondent) to the perception of linguistic variation. We want to verify the role of geographic distance, as computed with different methods, and the place of residence of the respondents in modeling perceived variation. Additionally, we want to verify the relationship between dialect groupings as made by linguists and perceived taxonomies of sublinguistic areas.

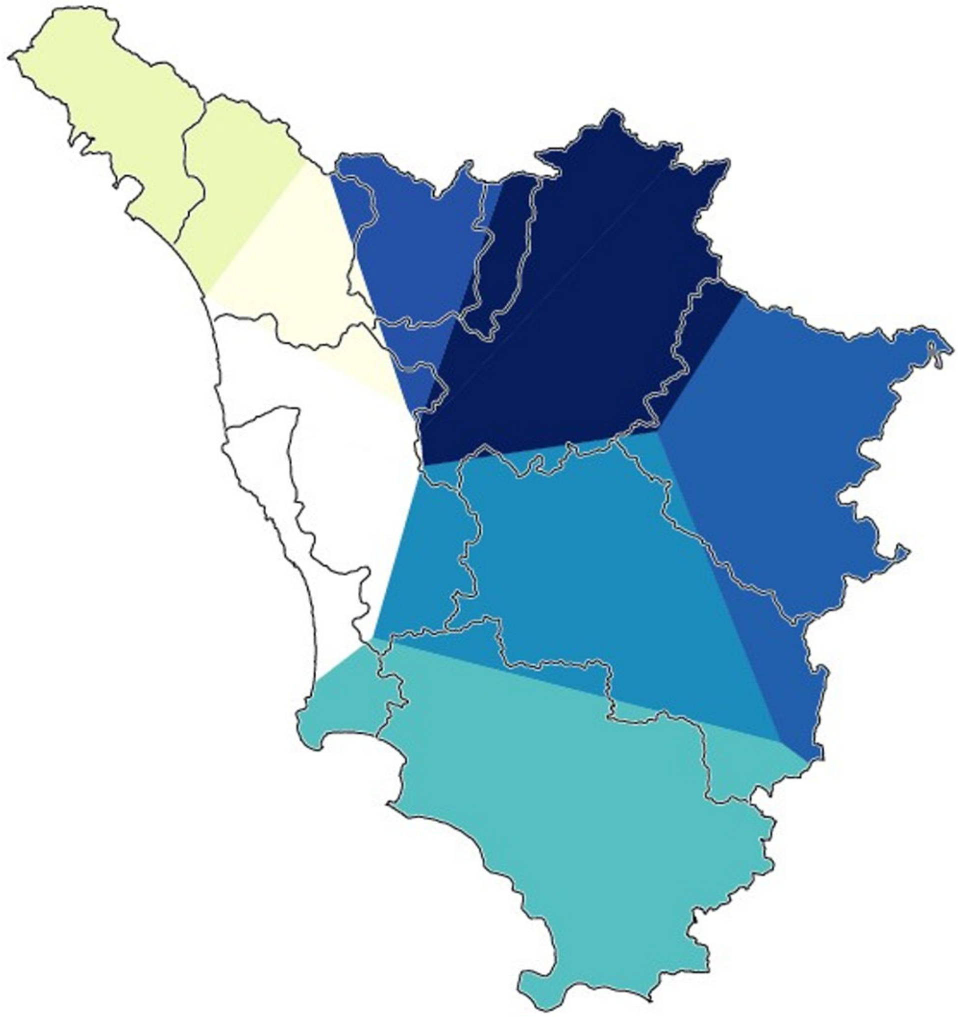
We will try to answer to the following research questions:

1. What are the *most common perceptual areas* in the region, regardless of the origin of the respondents?
2. What are the *effects of geographical distances* between subareas on our participants' classifications? Does the preference of distances by road instead of as the crow flies significantly contribute to our understanding of the draw-a-map results?
3. Is there a *proximity factor*, that is, do the borders vary according to the origin of the respondents? Do the responses become more uncertain as the distance between the participants' homeplaces and the clustered areas grows?
4. Which *"official" classification as made by dialectologists* appears to be the most consistent with speakers' classifications? Did speakers rely on their historical, synchronic, or sociolinguistic knowledge when completing the draw-a-map task? How do these dialect groupings coexist with spatial distance in the explanation of our participants' responses?

4.2 Tuscan dialects: The taxonomies made by linguists

The present section is devoted to an excursus concerning the linguistic classification of the region from Medieval times to the present. It would be rather hard to be exhaustive, and the scrutiny of all the known authors would probably occupy an entire volume on the topic. Nevertheless, even a limited selection of the sources reveals some recurrent patterns.

Medieval Tuscany was usually divided into four fundamental linguistic varieties[2]: Pisan-Lucchese, Florentine, Sienese, and Eastern Tuscan (Arezzo, San Sepolcro, Cortona). Pratese and Pistoiese (with several influences from Western Tuscan), Volterran (influenced by Pisan), and Sangimignanese-Colligiano (conditioned by Sienese) are considered minor dialects.



Map 6. Gabmap multidimensional scaling map of Tuscany (whole Tuscan dataset). The map shows the areas lying on the first dimension that were discerned by the algorithm.

The short treatise *Degl'idiomi toscani* by Celso Cittadini is usually considered the very first work of geolinguistic study after Dante's *De vulgari eloquentia* (Faithfull, 1962:269; Poggi Salani, 1994:448). Cittadini listed six speech varieties: Florentine, Sienese, Pisan, Pistoiese, Lucchese, and Arretine, a classification which remained more or less the same until the nineteenth century (see infra). In the second half of the sixteenth century, the "image" of Tuscany as a unified region, despite political fragmentation, is apparent in the essays by Claudio Tolomei, Orazio Lombardelli, and Celso Cittadini (Poggi Salani, 1992:403). In this period, it was quite common to emphasize both the linguistic homogeneity of the different dialects in the region and, simultaneously, the phonetic and lexical differences among the different speech varieties, as Claudio Tolomei's text demonstrates:

> *Laonde, se ben riguardiamo, non una sola lingua o una sola pronunzia è in Toscana, ma sono molte e molte, secondo le diversità de le cittadi e de le castella, perché e in accenti e in parole son diversi gli Aretini da' Volterrani, i Senesi da' Fiorentini, i Pisani da' Pistolesi, i Lucchesi da que' di Cortona [. . .] e per ogni luogo v'è varietà di pronunzie e di vocaboli. [. . .] se cerchiamo questa cosa col martello de la verità affinare, vedremo così minute esser cotali differenze, che coloro che fuor di Toscana son nati o nissuna differenze tra 'l Fiorentino, Senese, Pisano, Lucchese e altre simili favelle conoscano, o con grandissima loro difficultà la comprendano* (Claudio Tolomei, Il Cesano, in Castellani Pollidori, 1996:26, 71).[3]

Thus, a superimposed Tuscan variety exists despite the different dialects of the region (whose differences are mostly in the realm of phonetics and morphology).

The number six appears to be consistent in the majority of the consulted sources. The traditional dialectological literature also divides the territory of Tuscany into six dialects: Florentine, Sienese, Western Tuscan (split in turn into Pisan, Leghornese, and Elban), Arretine, Grossetan-Amiatine, Apuan. The same number of dialects is also present in older descriptions by linguists and grammarians prior to the nineteenth century. From Girolamo Gigli in his *Vocabolario Cateriniano* (under the heading *pronunzia*, Mattarucco, 2008) to Carl Ludwig Fernow, scholars are all inclined to identify six varieties (Florentine, Sienese, Pistoiese, Pisan, Lucchese, and Arretine), with Pistoiese in place of "*Grossetan-Amiatine*" (J.C. Adelung, 1809:516; F. Adelung, 1824:60; Blanc, 1844:628; Fernow, 1808:264).

However, alternative proposals are also documented in the history of Italian dialectology. A relevant example is the work of Francesco Cherubini, whose partition appears to be highly refined. In his *Prospetto nominativo dei dialetti italiani* the following speech varieties are enumerated: Florentine, Sienese, Pisan (split into "true Pisan," *Pisano proprio*, and *Sassarese*), Lucchese (together with Garfagnine), Pistoiese, Pesciatine and Pratese,

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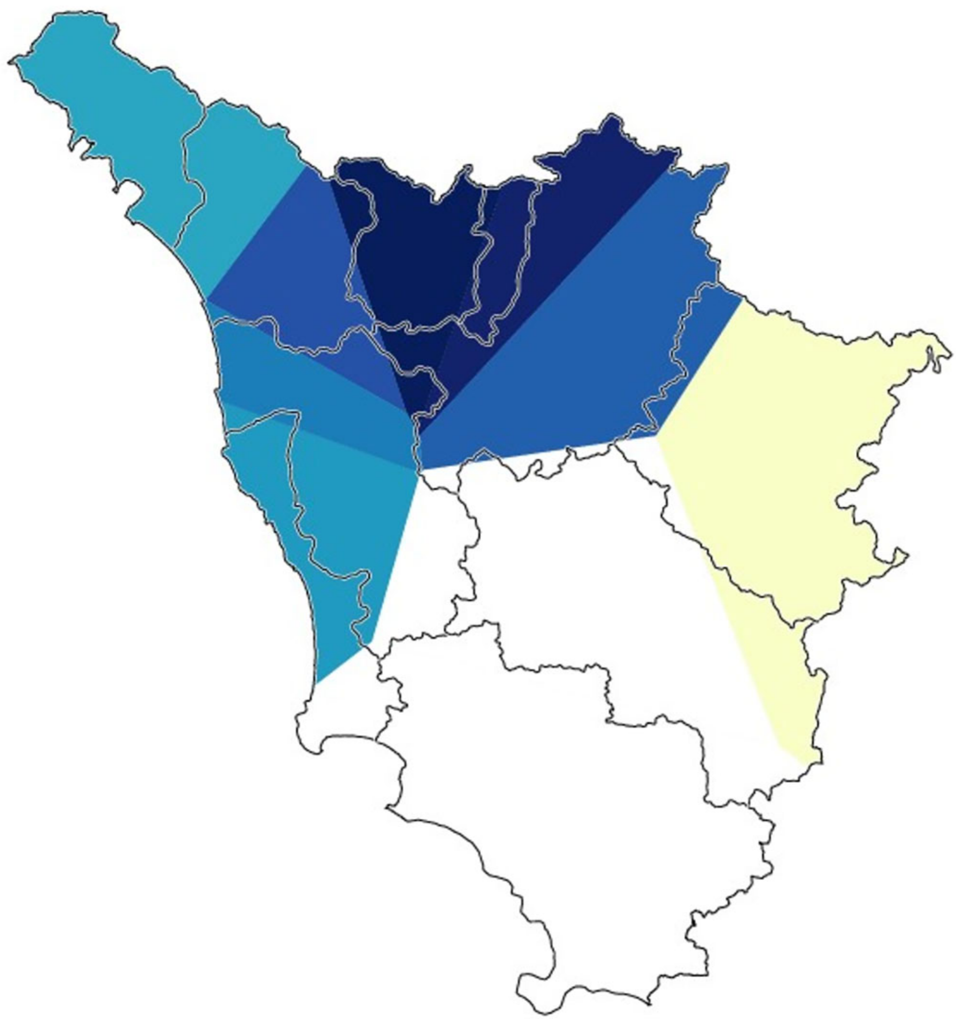

Map 7. Gabmap multidimensional scaling map of Tuscany (whole Tuscan dataset). The map shows the areas lying on the second dimension that were discerned by the algorithm.

Leghornese, Elban, Arretine and Cortonese, Maremman, Volterran, Corsican, and Massese (Cherubini, 1824:114). The handwritten materials that were intended to be used as a general description of the Italian dialects (the project was unfortunately aborted) proved an uncommon and deep knowledge of the Italian linguistic landscape (Faré, 1966:43). With respect to Tuscany, the partition described in the handwritten material is quite similar to the one presented in the *Prospetto* but with an additional note concerning the characterization of the Leghornese variety, which is divided into two subvarieties (*suddialetti*, in his terminology): "true Leghornese" (*livornese proprio*) and "low Leghornese" (*livornese plebeo*).

In Biondelli ([1846] 1856:186), the partition is somewhat different:

> *Il ramo tosco, posto nella parte settentrionale, suddividesi propriamente in quattro gruppi distinti, che abbiamo denominato Fiorentino, Sienese, Tiberino e Corso. Il gruppo Fiorentino abbraccia tutto il bacino dell'Arno, non che le valli del Serchio e di Cecina. Ivi è suddiviso in molti dialetti, dei quali è principal tipo il fiorentino. [. . .] Le sue varietà più distinte sono: il lucchese, il pisano, che si estende lungo le valli dell'Era e della Cecina, ed il livornese, ch'è il più corrotto.*[4]

According to Parodi (1889:590), there are four main dialects of Tuscany: Central Tuscan, Western Tuscan, Sienese, and Arretine. According to Nieri (1901:v–vi), the Tuscan linguistic landscape is as follows (with varieties other than Florentine listed from the most similar to the most diverse from Florentine itself): Florentine, Pistoiese, Sienese and Maremman, Pisan and Leghornese, Arretine and Lucchese. Four subregions appear in Devoto & Giacomelli (1971:65): the eastern area (with influences from Umbria), the southern area (with influences from Latium), the western area (Leghornese, Pisan, Lucchese), and the central area (Sienese and Florentine). In Giovan Battista Pellegrini's renowned classification (*Carta dei dialetti d'Italia*), again six varieties are listed: Florentine, Sienese, Western Tuscan, Arretine, Grossetan-Amiatine, and Apuan. Western Tuscan is further divided into Pisan-Leghornese-Elban, Lucchese, and Pistoiese (Pellegrini, 1977:30).

In the seminal work by Giannelli ([1976]2000), ten different varieties are identified, mostly according to morphological and syntactical features. These are comprised of Florentine, Sienese, Pisan-Leghornese, Lucchese, Elban, Arretine, Amiatine, Low Garfagnine-High Versiliese, High Garfagnine, and Massese. Furthermore, eight "gray" varieties are identified (Viareggine, Pistoiese, Casentinese, High Valdelsan, Volterran, Grossetan-Massese, Chianine, the dialects spoken in the southwestern area of Grosseto). These are more difficult to isolate as they present features originating from disparate varieties. A rather different perspective emerges from Giannelli (1988:604), whereby a partition within single dialects and areas of sociolinguistic influence is presented. The seven areas of sociolinguistic influence are, according to size, as follows: Florentine influence, Pisan and

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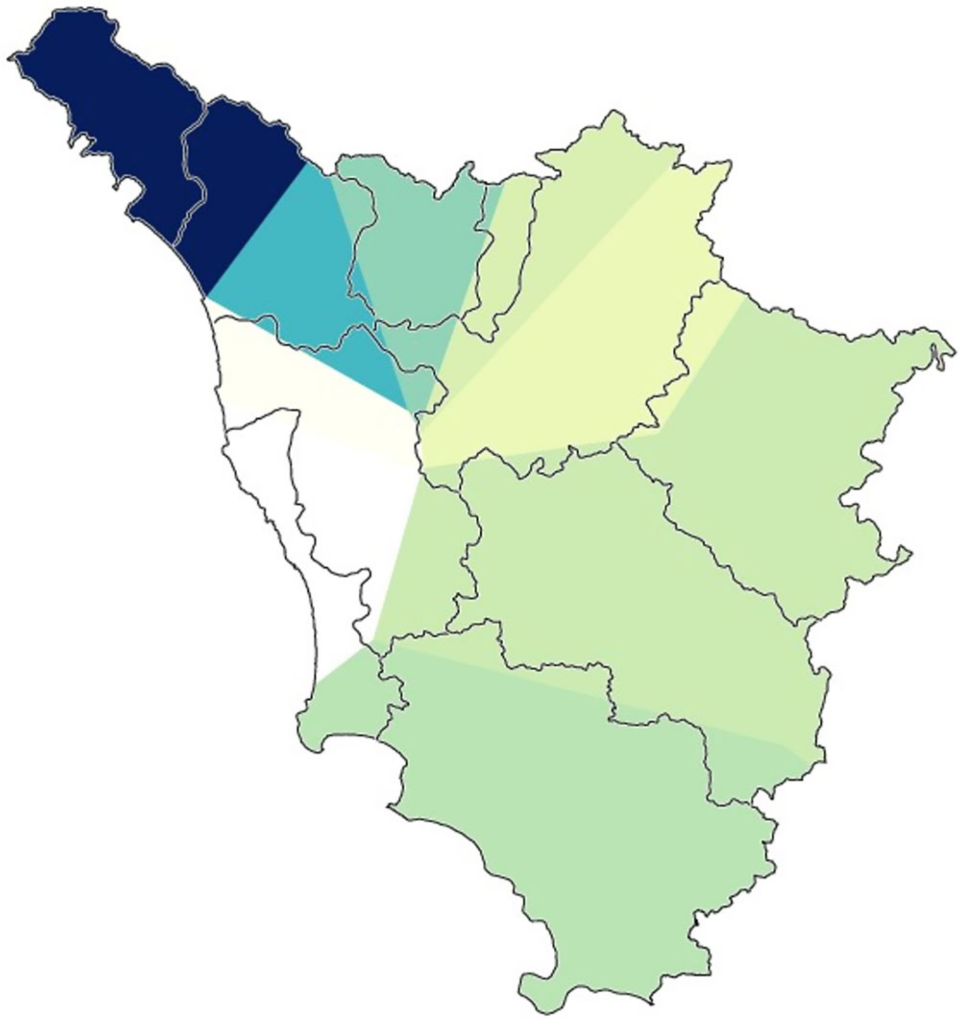


Map 8. Gabmap multidimensional scaling map of Tuscany (whole Tuscan dataset). The map shows the areas lying on the third dimension that were discerned by the algorithm.

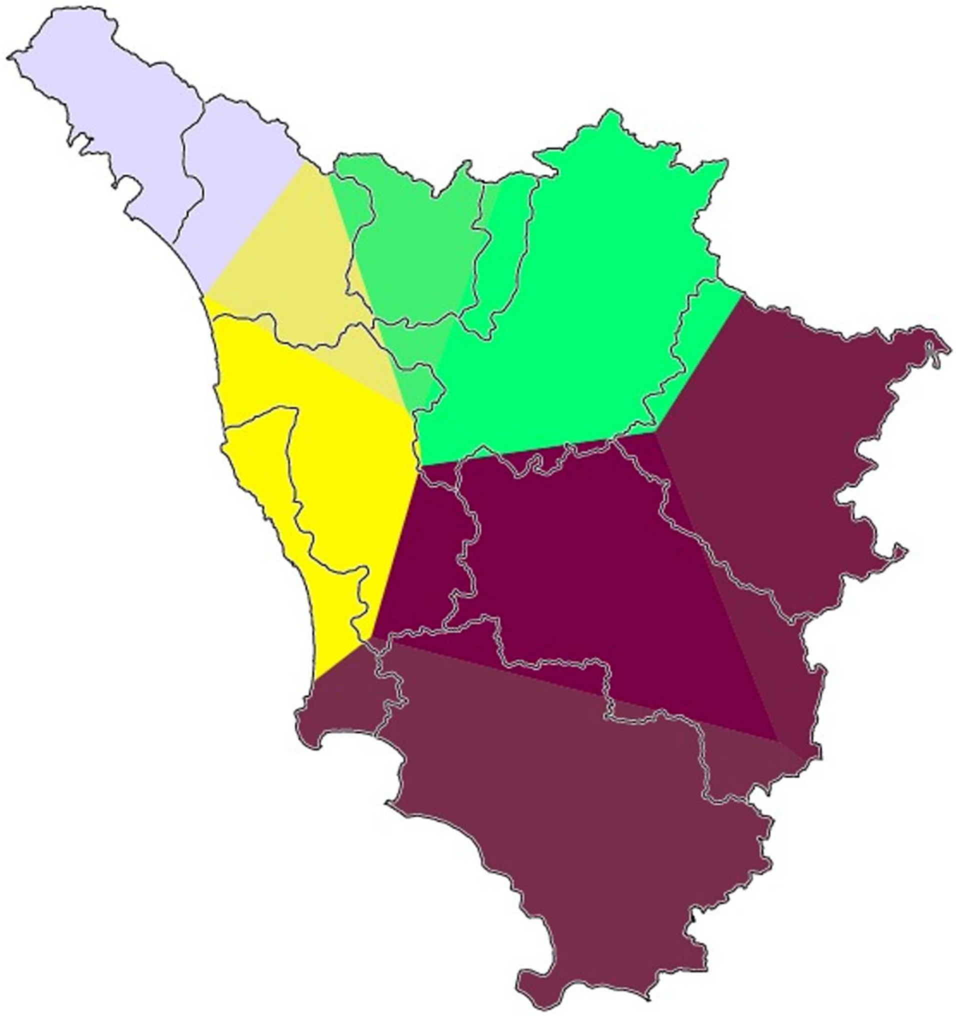
Leghornese influence, Sienese influence, Lucchese influence, Grosseto influence, Arezzo influence, and Pistoiese influence. The dialects whose influence is not expanding are Chianine (seemingly stemming from the Sienese dialect), Casentine, Amiatine and southern Maremma, Elban, the Capraia dialect (of Corsican origin), Garfagnana/northern Versilia/Massa dialects, and the dialects of the North (or, at least, mixed varieties). Within this picture, a transitional area is also identified between the areas influenced by the Pisan-Leghornese and Grosseto dialects with the following label: Volterran, Massetan, Piombinese transition area.[5]

It is known that not all parts of the Tuscan region use Tuscan dialects. In Massa-Carrara and in very small areas of the Apennines (the so-called *Romagna Toscana*), Northern Italian dialects are spoken, whereas in the southern part of the region (Mount Amiata, in particular) some features of the so-called *Italia mediana* permeate. Here, the repertoire is assumed to be similar to the rest of Italy, where code-switching is at work. The identification of boundaries is easier in the North where Tuscan dialects are delimited by the bundle of isoglosses of the "La Spezia-Rimini line"[6] and where historical and geographical features make the identification of Tuscan dialects (versus non-Tuscan dialects) straightforward. On the contrary, the identification of Tuscan features is more difficult along the southern and eastern borders at the boundary between Tuscany, Umbria, and Latium (Giannelli, 1997).

It is challenging to track the boundaries among speech varieties that, in most cases, have remarkable phonological similarities and differ only in terms of the distribution of single phonemes. Tellingly, from a sociolinguistic point of view, the main areas are listed as follows: Florentine, Pisan-Leghornese, Lucchese, Arretine, Sienese, Grossetan (Agostiniani & Giannelli, 1990:221). Central Tuscan has already absorbed the Prato and Pistoia varieties. The Leghorn variety has come to the forefront in the last two centuries, showing some expanding features along the coast (Calamai, 2005). Given the above, Section 5 will show how such linguistic diversity is mirrored in perceptual maps.

4.3. The experimental design and the sample

In the map-drawing task, informants were given a simplified map of the region under investigation (see Map 1) and asked to draw borders identifying the locations where they believed that different dialects existed. This method provides information about how the participants mentally represent dialect areas, since they would be indicating on their map all of the places where they believe people talk in the same way. The fieldwork was run in Tuscan high schools. Students were provided with simplified



Map 9. Gabmap cartographic visualization of the probabilistic dendrogram shown in Figure 1 (whole Tuscan dataset).

Tuscan maps showing only the names of the provinces. We restricted the information contained on the maps to avoid any influences that could have come from additional geographical information.[7] Participants were asked to identify relevant areas using circles and/or dividing lines (see Maps 2 and 3) and to provide additional information such as labels, shibboleths, or specific dialectal features. Students were reassured of the following conditions: anonymity of their answers and absence of the "right" answer (that is, it was important for each informant to give his/her own point of view on the task). A total of 813 secondary school students were involved in the map-drawing task in several parts of the region. Data were always collected by one of the authors of the present paper (SC), thus assuring complete homogeneity in the style of data collection. In the data preprocessing phase, each map was identified by progressive numbers together with the acronym of the town in which the fieldwork was carried out (e.g., LU1, LU2 . . . , GR1, GR2 . . .).

Data discussed in the present paper were collected in the years 2010–2020 in the following towns, listed in alphabetical order[8]:

- Arezzo (school 1, 35 respondents; school 2, 97 respondents)
- Lido di Camaiore – Lucca (98 respondents)
- Montevarchi – Arezzo (36 respondents)
- Grosseto (73 respondents)
- Empoli – Florence (70 respondents)
- Massa (73 respondents)
- Prato (school 1, 80 respondents; school 2, 15 respondents)
- Florence (school 1, 29 respondents; school 2, 36 respondents)
- Siena (43 respondents)
- Pisa (128 respondents)

The ten samples correspond to different linguistic areas.[9] Elba Island was excluded from the fieldwork since Elban appears to be a dying variety (Giannelli, 2000).

5. Results

Maps were processed through the Gabmap web application in order to generate a visual, statistically grounded representation of the main perceptual clusters elicited by the participants. Gabmap requires two files in order to perform its functionalities: a map (.kml or.kmz) and a data (.txt) file. We first recreated the map of Tuscany that was administered to our participants by means of the add polygon and add placemark functions of Google Earth.[10] Placemarks were directly imported from the software. Province boundaries were added to the original map with the

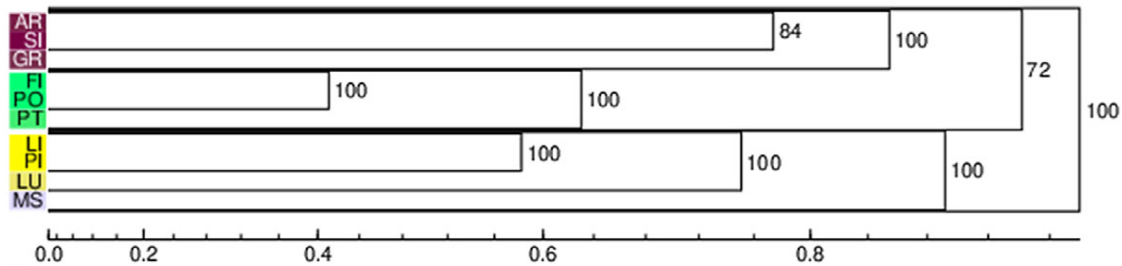


Figure 1. Gabmap probabilistic dendrogram (whole Tuscan dataset).

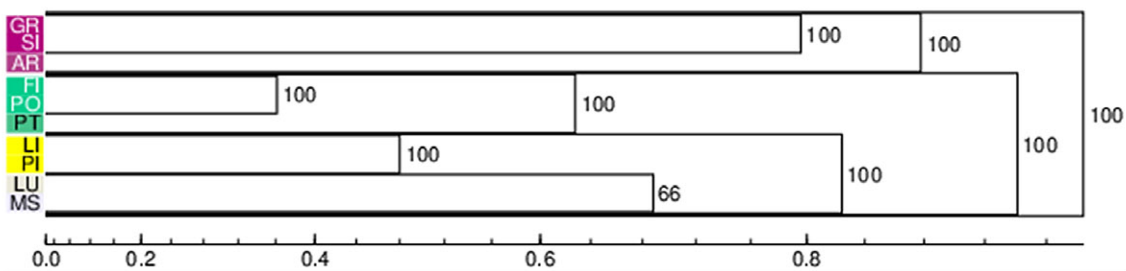


Figure 2. Gabmap probabilistic dendrogram (Arezzo dataset).

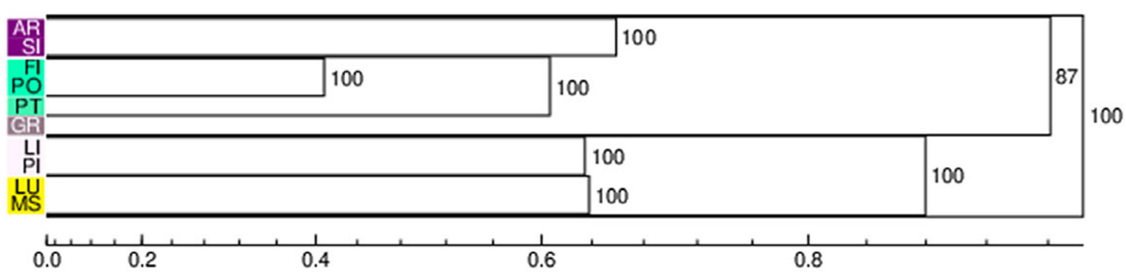


Figure 3. Gabmap probabilistic dendrogram (Florence dataset).

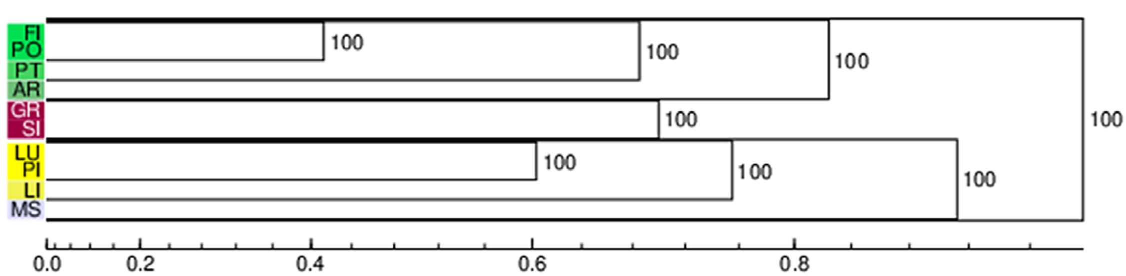


Figure 4. Gabmap probabilistic dendrogram (Grosseto dataset).

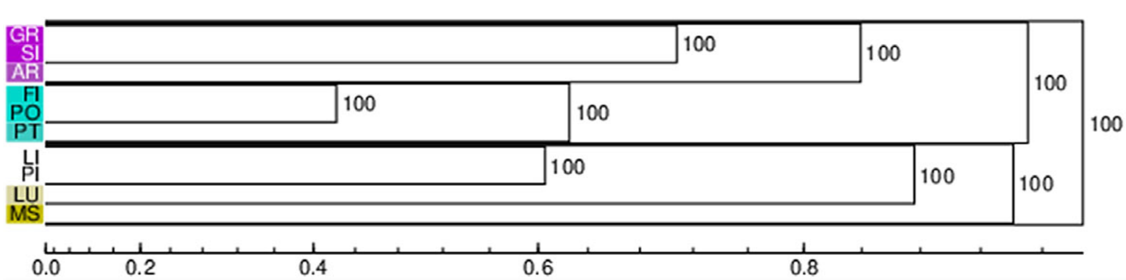


Figure 5. Gabmap probabilistic dendrogram (Lucca dataset).

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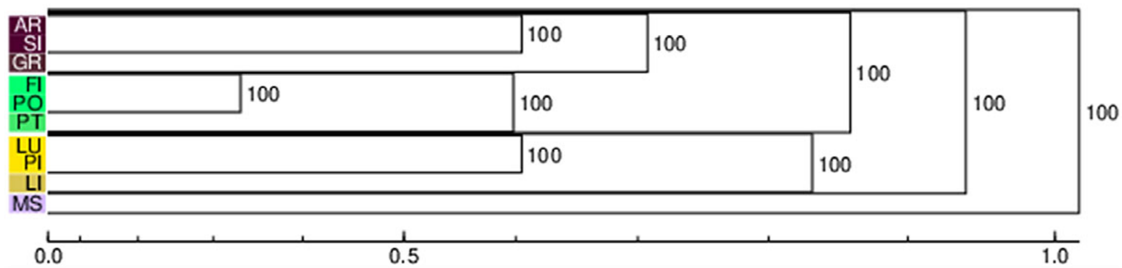

Figure 6. Gabmap probabilistic dendrogram (Massa dataset).

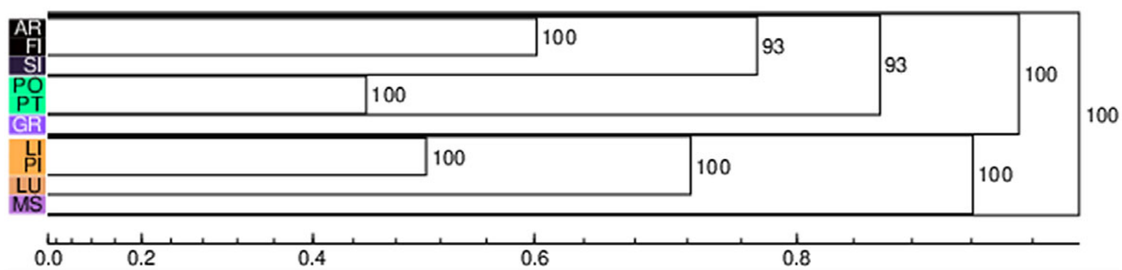

Figure 7. Gabmap probabilistic dendrogram (Pisa dataset).

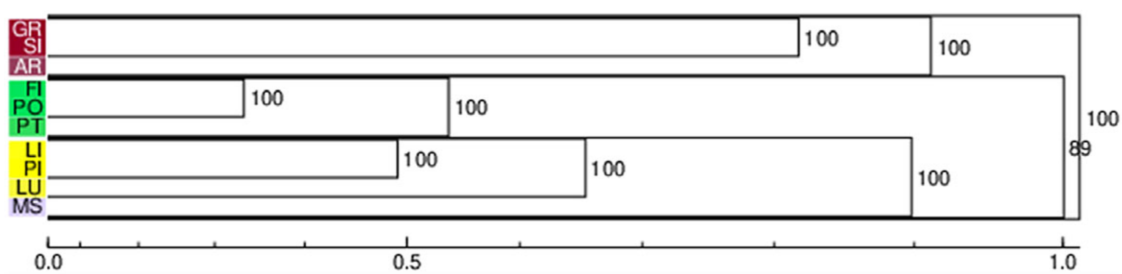

Figure 8. Gabmap probabilistic dendrogram (Prato dataset).

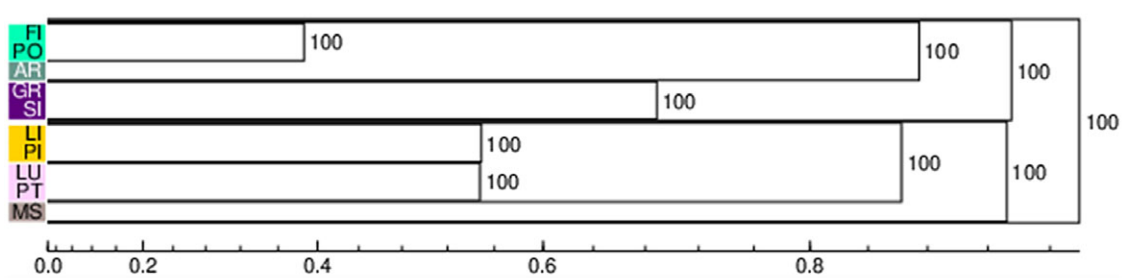

Figure 9. Gabmap probabilistic dendrogram (Siena dataset).

aim of visually enhancing the understanding of the geopolitical properties of the Tuscan region for the benefit of non-Italian readers. For the reason explained above (Section 4.3), the Tuscan Archipelago was not included on the map.

Then, the 813 maps constituting our corpus were manually coded into difference matrices (one matrix per map coded in a separate Excel worksheet). A difference matrix is a symmetric matrix containing pairwise linguistic distance values. In our case, the matrices had a 10×10 grid; each row and column corresponded to a Tuscan province. For this first Gabmap-based perceptual study, we devised a coarse-grained binary distance measure: the areas that were clustered together in the respondent's map were coded as 0 in the pertinent slot of the matrices, whereas the areas which were kept separate were coded as 1. Therefore, the diagonals of the matrices were composed by zeroes in compliance with the data format requirements of Gabmap.[11] Following a common practice in difference data treatment (e.g., Preston, 1993:356–59), we computed the mean between the matrix values using Excel 3D-reference formulae. Mean difference matrices were generated at the following levels of analysis: all Tuscan maps (813),

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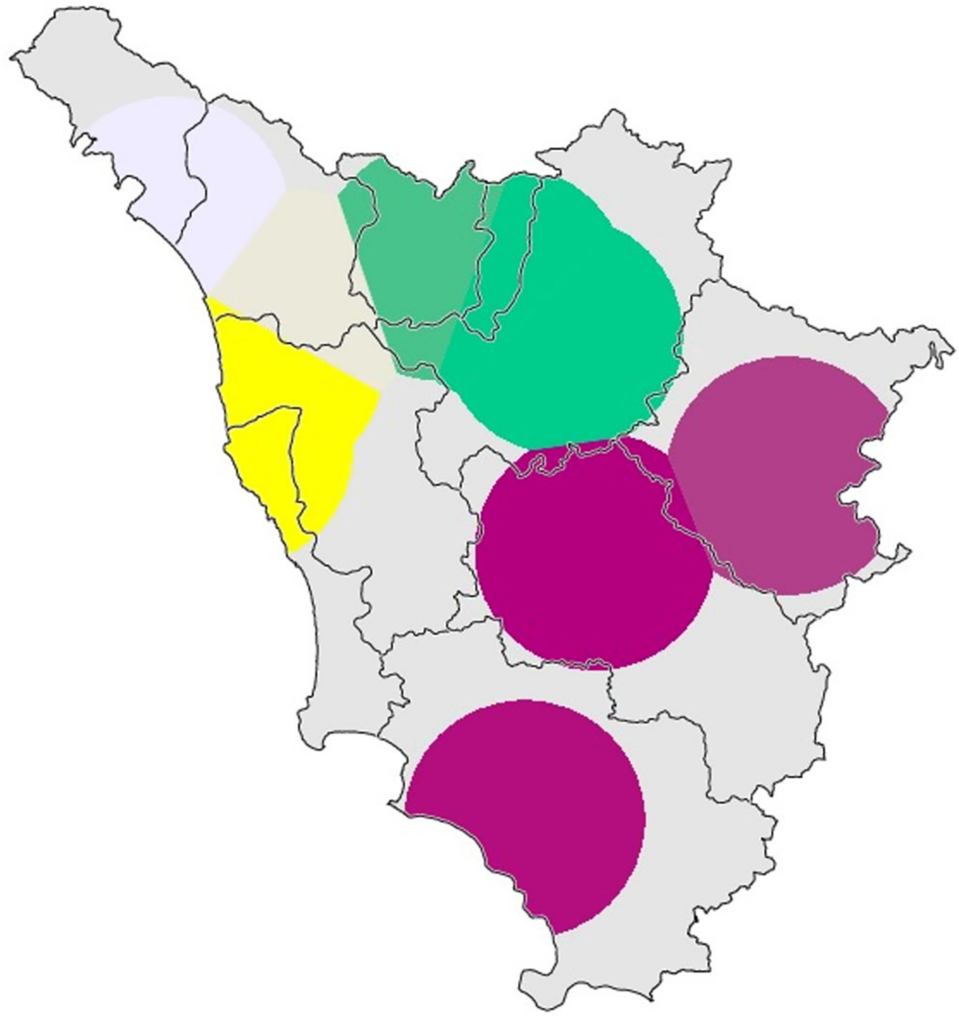

Map 10. Gabmap cartographic visualization of the probabilistic dendrogram shown in Figure 2 (Arezzo dataset).

maps produced by the respondents from the provinces of Arezzo (168), Florence (135), Grosseto (73), Lucca (98), Massa (73), Pisa (128), Prato (95), and Siena (43). Each of the eight mean matrices were imported as a .txt file in separate Gabmap projects.

For further statistical analyses, the Gabmap matrix format was then reformulated in tables with one variable per column. The pairwise relationships of the matrices were translated into a "Combination" column including each of the 45 possible items (for example, for the pairwise relationship between the provinces of Prato and Siena, a "SI_PO" item was created). Three "official" grouping solutions (i.e., Agostiniani & Giannelli, 1990; Giannelli, 2000; Pellegrini, 1977; see below Section 5.4) were coded in three separate columns using the same binary values of the participant's matrices (0 = the two provinces are grouped together; 1 = the two provinces are considered as different linguistic areas). Two conceptualizations of spatial distance (see below Section 5.2) between the chief towns of the provinces for each "Combination" slot were also entered into the table. Following the dialectometric tradition, we ran correlation analyses between the aforementioned factors and aggregate linguistic differences (i.e., the values that were previously fed to Gabmap in order to obtain the cartographic representation of the whole Tuscan dataset). However, in order to evaluate the best explanatory combination between distance and objective grouping solutions through regression analyses, we created a second table substituting the aggregate difference column with one including the individual participant's binary responses. By doing so, we were able to build questionnaire-like regression models, including random intercepts for each participant (i.e., map) and combination (i.e., pairwise relationship between Tuscan provinces).

5.1 Perceptual areas in the region

In this section, we offer three different visualizations for our perceptual data in order to answer question 1. With respect to difference data, Gabmap can indeed process up to three main types of linguistic maps: (1) difference maps; (2) choropleth maps; and (3) automatic clustering of dialect varieties.

Difference maps (1) (e.g., Goebl, 2010:69–70) can be useful tools for the visualization of linguistic similarities between adjacent areas. Lines are drawn connecting the placemarks; the strength of the dialect analogies are underscored through an intuitive color-coding, with darker lines suggesting stronger connections. Map 4 exemplifies this map type using the whole Tuscan database. In our

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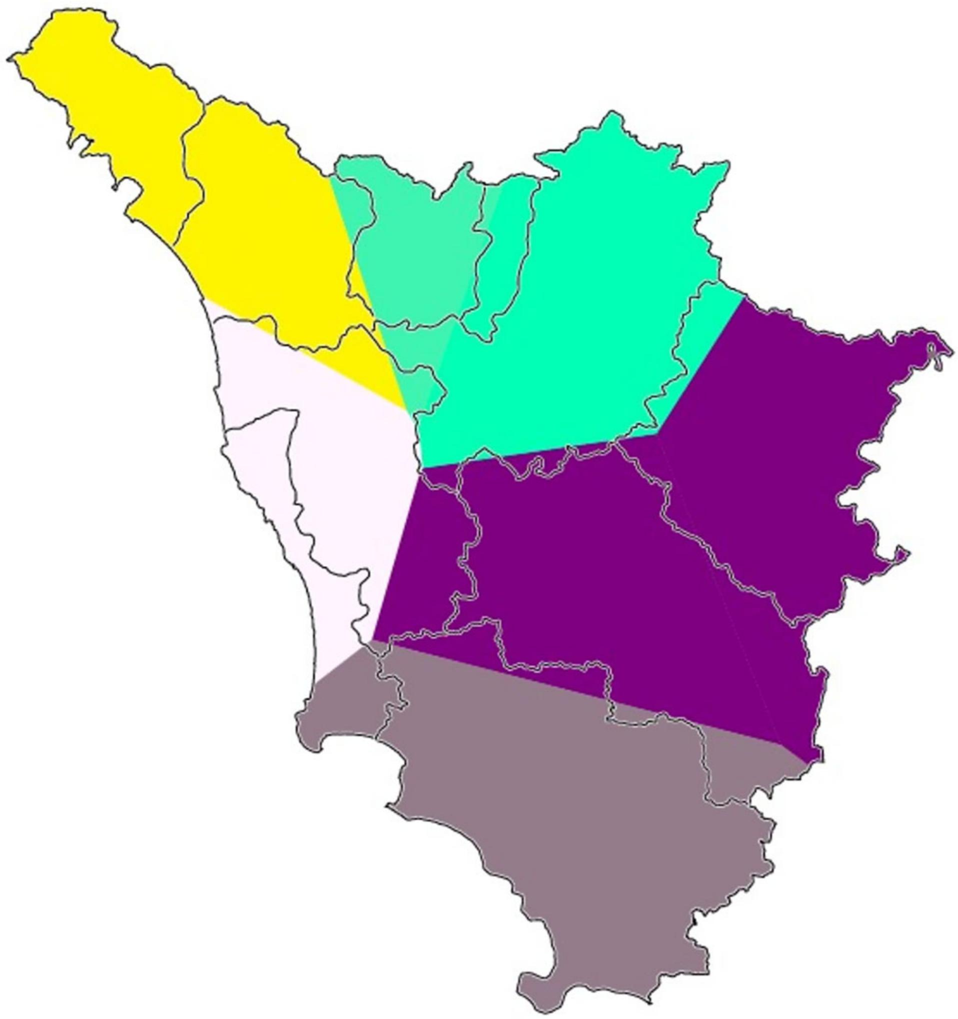

Map 11. Gabmap cartographic visualization of the probabilistic dendrogram shown in Figure 3 (Florence dataset).

case, the lines represent impressions of similarity between subregional areas. Apparently, closeness is a particularly effective correlate of similarity in the case of the areas of Pistoia-Prato-Florence and Leghorn-Pisa-Lucca.

Second, Gabmap relies on multidimensional scaling (Black, 1973; Embleton, 1993) in order to generate (2) choropleth maps of dialect continua. Multidimensional scaling is a family of statistical techniques used to represent the properties of large amounts of data in an underlying low-dimensional space following similarity criteria.[12] The first three dimensions usually manage to explain over 90% of the data variance (e.g., 98% in Prokić & Nerbonne, 2008). Gabmap assigns a color to each of the first three dimensions using a hue, saturation, value representation of the RGB color model. By doing so, Gabmap generates a map that represents the perceived linguistic similarity of each area with each of the other ones, simultaneously. By superimposing the maps pertaining to the first three dimensions, the RGB model allows the user to obtain a compact visualization of the perceived dialect continua. Red areas of the map are associated with the first dimension, green with the second, and blue with the third (Leinonen, 2010:208). Map 5 displays the RGB multidimensional scaling map using our whole Tuscan dataset, while Maps 6, 7, and 8 contain the choropleth maps for each of the first three dimensions taken separately. The most evident interruption in the continuum of perceived similarity is the one between Pisa-Leghorn and Siena-Grosseto. In fact, the pure green of the former cluster suggests the pertinence of the western provinces to the second dimension; however, Siena and Grosseto do not reside on this dimension at all, while being part of the third and, for the most part, of the first one.

The last cartographic functionality of Gabmap is the most similar to the draw-a-map task of perceptual dialectology. The platform presents several built-in algorithms to perform (3) the automatic clustering of dialect varieties. Four (complete link, group average, weighted average, and Ward's method) algorithms provide solutions for discrete clustering. However, these methods are extremely sensitive to minimal changes in the difference matrix, leading to instability (Nerbonne et al., 2008:649), and require validation analyses. For this reason, we will rely on the noisy clustering technique (ibid.). This method consists in running the clustering algorithm several times on the data matrices, with a random portion of noise added each time. The procedure outputs a probabilistic dendrogram, which retraces the clustering operations while adding a probability percentage to each node. This estimates the number of encounters of a cluster over the number of runs of the algorithm. The results of the noisy technique are also plotted in a map, in which the color-coding of the clusters corresponds to the

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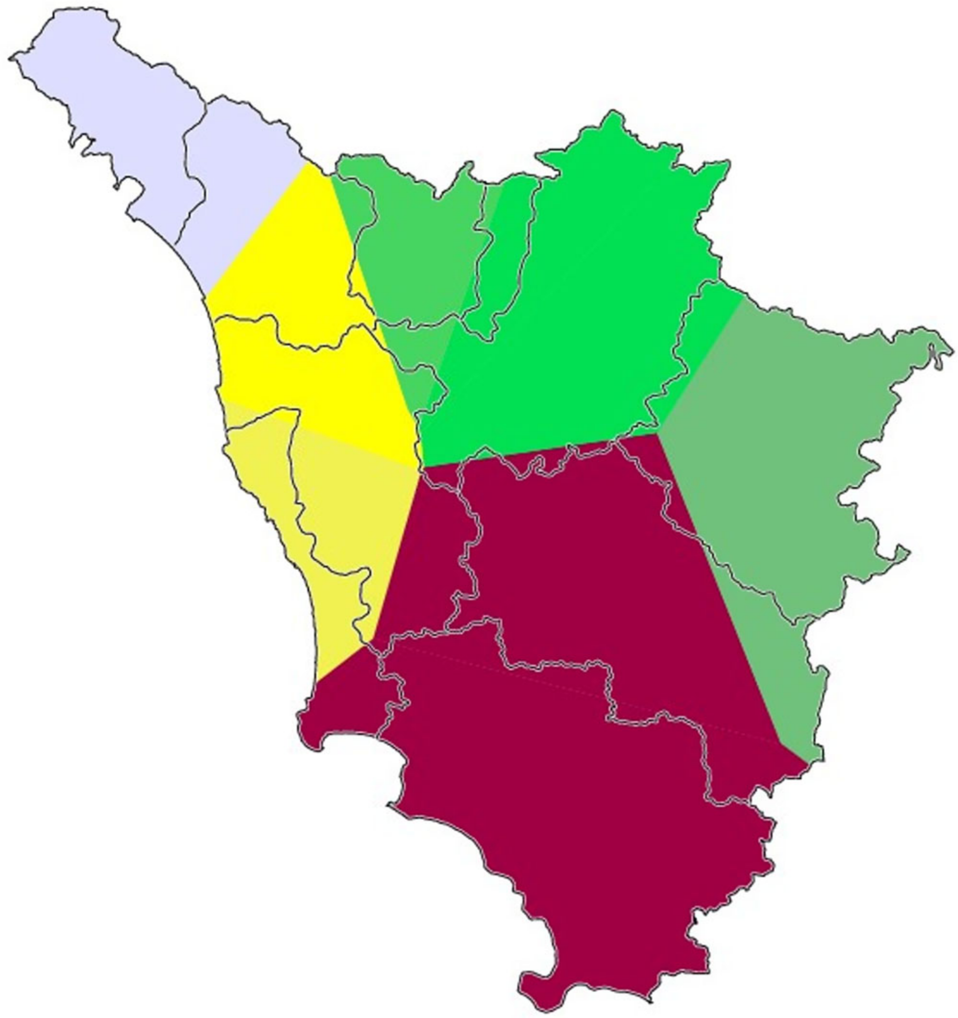
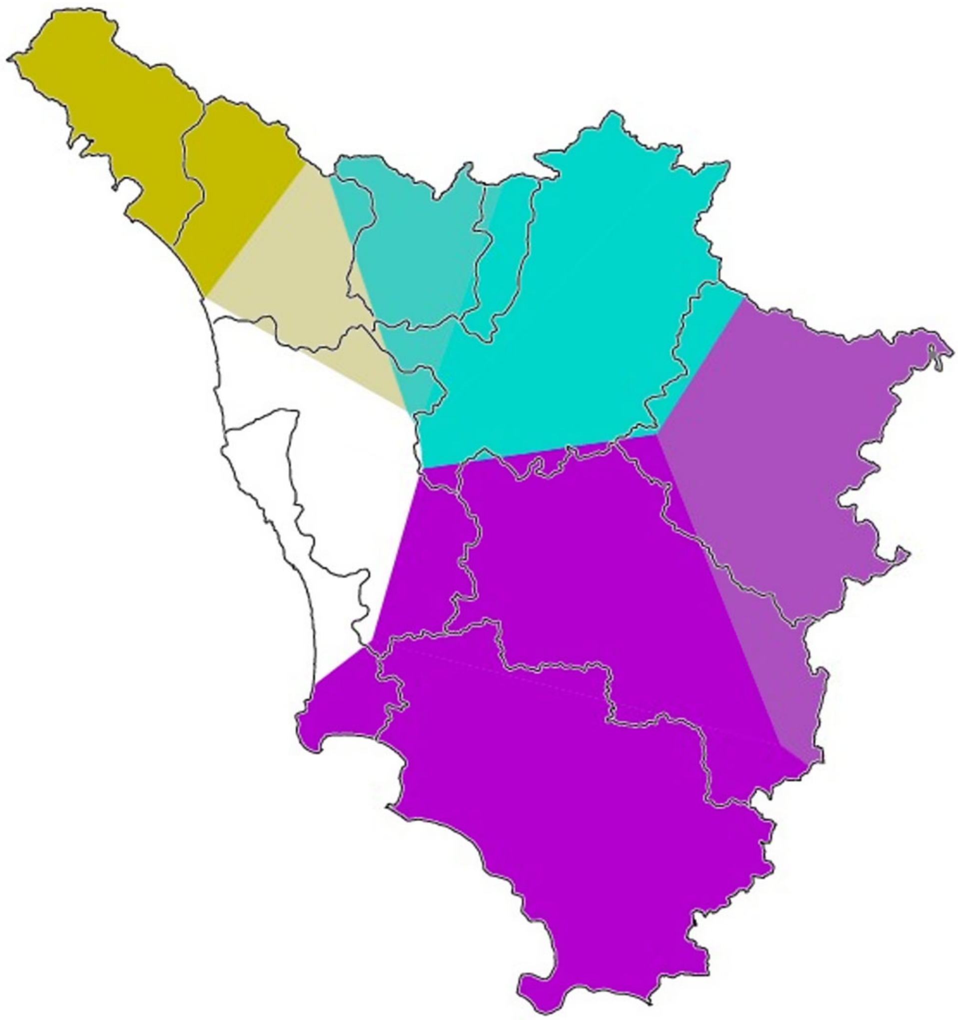


Map 12. Gabmap cartographic visualization of the probabilistic dendrogram shown in Figure 4 (Grosseto dataset).

pertinent dendrogram tags. Here, the colors do not have any peculiar dimensional meaning and are assigned randomly. Figure 1 show the probabilistic dendrogram and the map generated using Gabmap default settings (noise: 0.2; limit: 60%; exponent: 1.5; method: group average + weighted average) on the matrix representing the whole Tuscan dataset (Map 9). Results suggest that the varieties of Prato and Florence and of Pisa and Leghorn are consistently perceived as very similar by our Tuscan respondents. Arezzo and Siena are also grouped together; however, the correspondent node is quite high (= less similarity), and the clustering does not emerge with a 100% probability. Pistoia and Grosseto are clustered with Florence/Prato and Siena/Arezzo, respectively; the latter manifests a considerably higher node. Massa is clearly perceived as different from all the other Tuscan varieties.

Let us now have a look at the correspondent outputs of the noisy clustering algorithm run on geographically determined subsets of the dataset. Figures 2-9 and Maps 10-17 show the probabilistic dendrograms and maps of the matrices representing the responses of the participants from Arezzo, Florence, Grosseto, Lucca, Massa, Pisa, Prato, and Siena. Florence-Prato and Pisa-Leghorn appear to be the most common two-element clusters. Concerning the former, the only exception resides in the Pisan matrix, showing a first-order (but quite high) node between Florence and Arezzo, while Prato and Pistoia form a separate first-order group. The Pisa-Leghorn first order cluster is questioned by the respondents from Massa and Grosseto only. Both matrices manifest a preference toward a Pisa-Lucca first-order cluster, which is linked to Leghorn in a second level. Another recurrent element is the perceived singularity of the dialect of Massa. Only in the maps generated through the Florence and Arezzo datasets is Massa represented in a first-order cluster together with Lucca. Nevertheless, both clusters are quite high, and the latter emerges in just 66% of the algorithm iterations. Pistoia is usually clustered together with Prato-Florence through a second-order node; other than the Pisan exception, described above, the participants from Siena differed from the others in their perception of a first-order cluster including Pistoia and Lucca. Grosseto, Siena and Arezzo are variably bundled together (hence the high nodes in the general dendrogram, see Figure 1). Participants from Arezzo, Lucca, Prato, Siena, and Grosseto prefer to form a first-order cluster including Siena and Grosseto. In the Lucca and Prato dendrograms, Arezzo joins the two provinces through a second-order node. Arezzo is clustered together with Florence in the data from Grosseto and Siena through nonfirst-order nodes. However, in these cases, the node is very high (> 0.8) so that Arezzo is more or less considered an isolated variety. Lastly, Grosseto has a similar status in the dendrograms from Pisa and Florence.



Map 13. Gabmap cartographic visualization of the probabilistic dendrogram shown in Figure 5 (Lucca dataset).

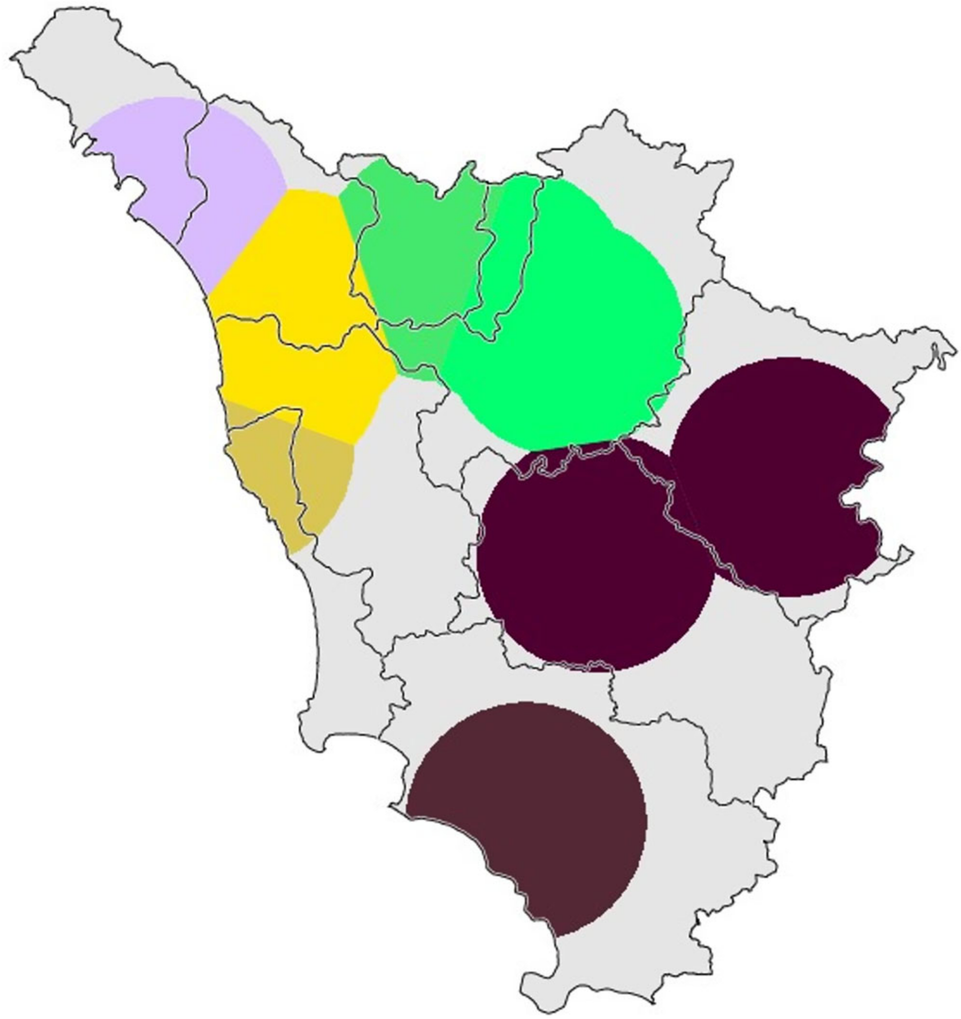
5.2 Effects of geographical distances

In order to answer question 2, we decided to compare different conceptualizations of distance (Gooskens, 2005), namely straight-line distance with a first basic level of spatial alternative, that is, road distances. As we saw in Section 5, Gabmap cartography is based on Google Earth data. For this reason, the platform allows the user to download a geographic distance table (km) including all the placemarks. Moreover, Gabmap automatically runs an R regression code predicting linguistic difference (dependent variable) from geographic distance data (independent variable). Gabmap relies on "as the crow flies" (from here on "crow") distances between localities, whereas road distances between Tuscan cities were computed through the pertinent Google Maps function. The shortest route was selected for each pairing.

Correlation and regression analyses were performed in order to estimate the pertinence of different conceptualizations of distance to the participants' maps. The Gabmap regression plot of our whole Tuscan dataset is shown in Figure 10. Geographic distance significantly predicts perceived linguistic similarity; in other words, the spatially closest places are perceived more similarly from a linguistic point of view. Table 1 shows the correlation results between aggregate linguistic perceived differences and the different conceptualizations of geographic distance. Crow and road distances are substantially identical factors in terms of correlation coefficients. Indeed, the two conceptualizations are almost perfectly correlated ($r = 0.99$, $p < 0.001$) with one another. Additionally, the correlation between distance and perceived difference is rather strong ($r = 0.70/0.71$).

5.3 The proximity factor: Entropy as a measure of classification uncertainty

In order to investigate the role of the participants' homeplaces in determining different nuances of the general classification pattern (question 3), we decided to resort to an information-theory approach (Shannon, 1948; see the linguistic reviews in, among others, Blevins, 2013; Goldsmith, 2000; Kawahara, 2016:43–45) with the aim of providing a Tuscan test to the proximity factor in dialect folk categorization. Namely, we rephrase the proximity problem by shifting the focus to classification uncertainty using Shannon's (1948) information entropy.[13] In other words, we should expect that classification uncertainty about the potential dialect similarities (the 0 in our data format) or differences (the 1 in our data format) between two areas grows along the physical distance from the two areas to the participant's place of residence.



Map 14. Gabmap cartographic visualization of the probabilistic dendrogram shown in Figure 6 (Massa dataset).

Entropy estimates the uncertainty of a variable by looking at the distribution of its outcomes; in other words, it is a measure of response variability. In our case, the variable consists in a classification subgroup (e.g., the responses of the Florentine participants about the equivalence or discrepancy between the areas of Siena and Arezzo), and the outcomes in the 0 and 1 values that were explained in the previous sections. Entropy is computed as follows, where k stands for the number of outcomes and pi for the proportion of responses corresponding to each outcome: $\sum_{i=1}^{k} p_i \log_2(1/p_i)$. In our specific instance, the number of possible outcomes is set at two, that is, "two geographic areas are linguistically equivalent" and "two geographic areas are linguistically discrepant." For this reason, we relied on the following binary entropy formula, which requires only one outcome proportion in order to be computed: $-p \log_2(p) - (1-p) \log_2(1-p)$. The resulting entropy values range from 1 (the same number of 1 and 0 responses) to 0 (complete agreement).

Using the above reported formula, we computed the binary entropy of 360 classificatory variables (45 place combinations × 8 participants' homeplaces). Entropy values ranged from 0 to 0.99996, with a mean of 0.34739 and a standard deviation of 0.31232. Then, we tried to conceptualize a distance parameter to use as a predictor of entropy in a regression analysis. We decided to compute a simple mean of the distances separating the participant's place of residence from each of the two localities included in the classificatory combination. Again, both crow and road distances were computed following the methods explained in Section 5.2. However, given the results of Section 5.2, we report here only the analysis including road distances. For instance, in the above-mentioned example of the Florentine decisions about Siena and Arezzo, we obtained a mean of 80.25 road kilometers (Florence-Siena: 78.3 km.; Florence-Arezzo: 82.2 km.).

The 360 entropy and distance values corresponding to all the possible classificatory variables of our corpus were entered in a linear regression analysis. Figure 11 shows the regression plot. It should be noted that the regression line does not provide a good fitting of our data. Indeed, the curvilinearity of the distribution suggests that a nonlinear relationship exists between the two variables. In order to build an appropriate model, we opted for spline models, because they are usually considered to be a more refined approach to nonlinear regression (Sonderegger, Wagner & Torreira, 2018:§9.3). Splines connect polynomials together, smoothing the transitions between them through the so-called knots. The relationship between the number of knots and the bends of the curve is n knots = n−2 bends. Our data visualization suggests that the curve may be represented with a maximum of three bends

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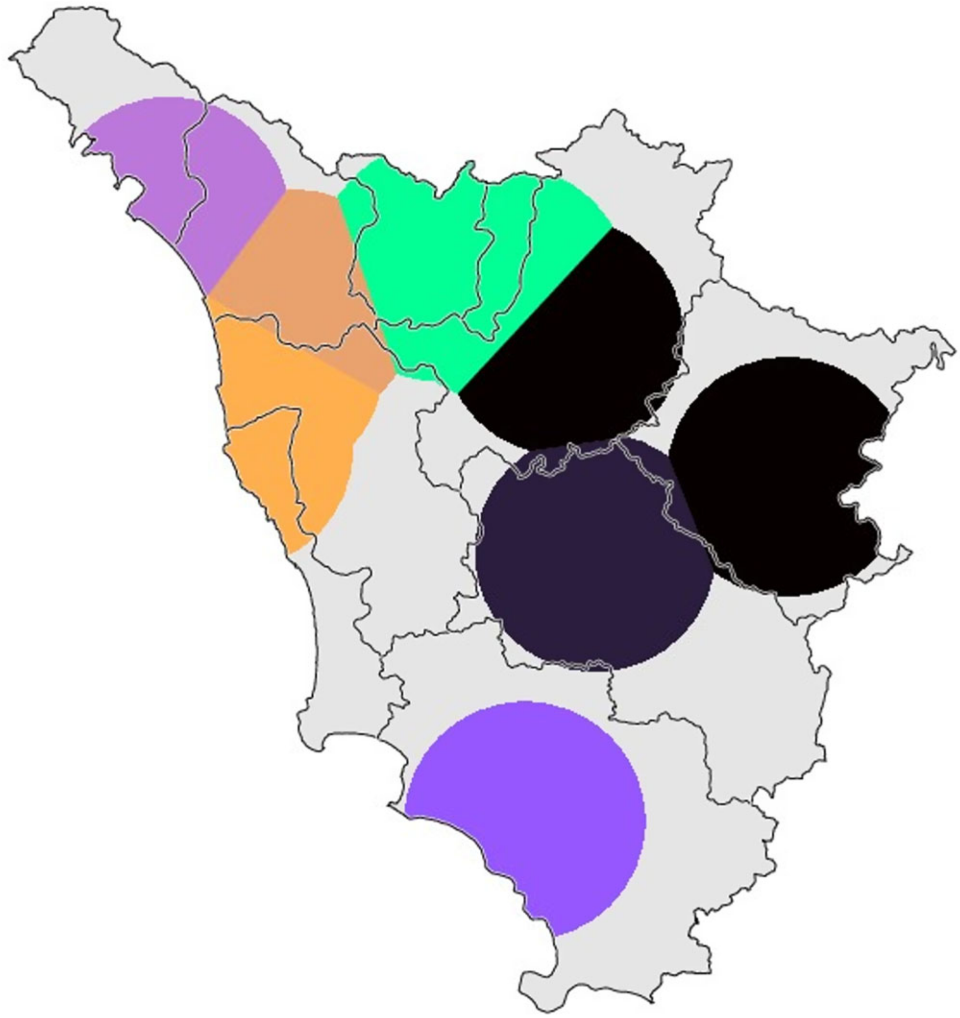
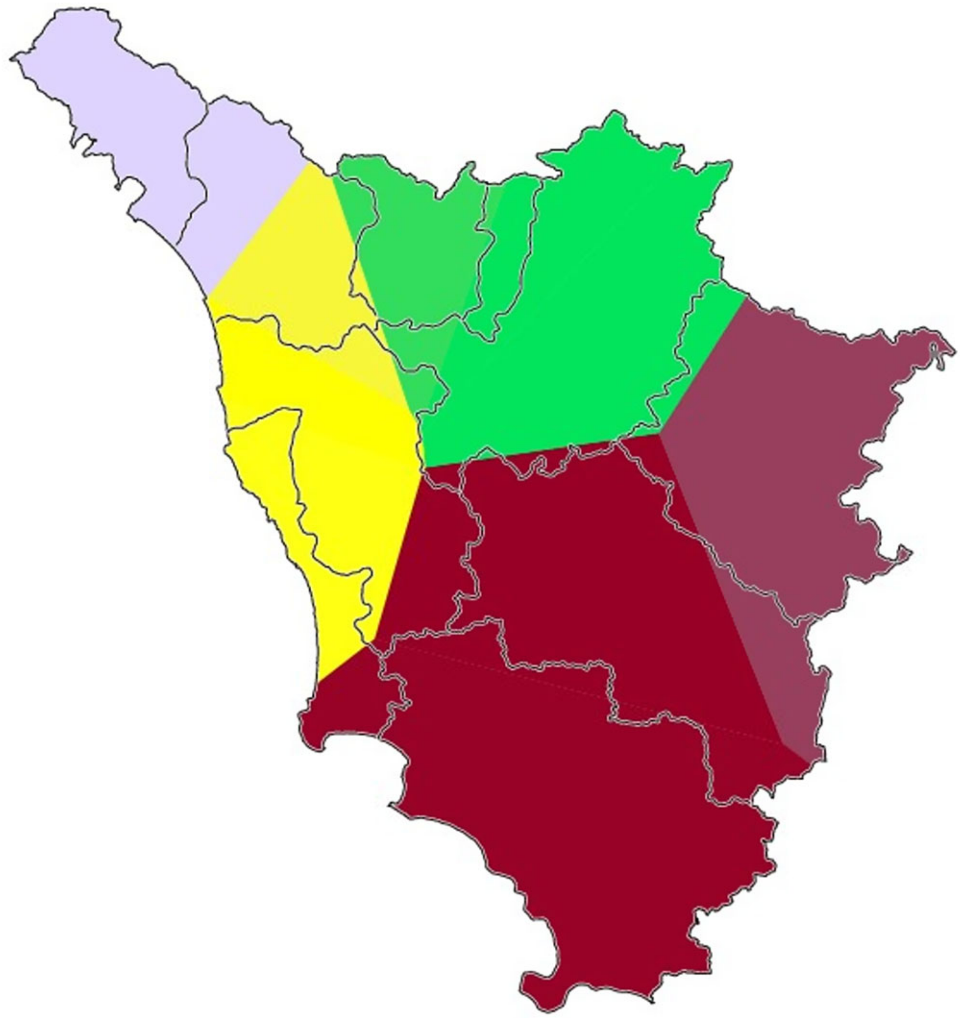


Map 15. Gabmap cartographic visualization of the probabilistic dendrogram shown in Figure 7 (Pisa dataset).

(a W structure). Starting from this observation, we built models of increasing complexity until we reached a six-knot spline model. Parallel models including 6, 5, 4, and 3 knots were built using the rms package (Harrell, 2020). Restricted cubic splines (rcs) are usually recommended, since they more accurately fit the extreme values of the predictor (Baayen, 2008:177). Table 2 summarizes the results of an ANOVA comparison between the models. Indeed, significant differences stop at the fifth knot, substantiating the W structure. However, not all the predictors may equally contribute to the model fit. In this circumstance, Bayesian Information Criterion (BIC) values can be used to perform model selection, since they penalize the addition of extra terms to the compared models. Let us take a look at the BIC values of the tested models (Table 2). Interestingly, the two-bend structure is here considered worse than both the single and the three-bend ones, and the single-bend model has the best BIC score. However, the BIC scores of the 3, 4, and 5 knot models are roughly equivalent ($\Delta BIC < 2$). With this due caveat, we interpreted the relationship between entropy and distance with reference to a simple curvilinear U-structure. In other words, response entropy is higher when the participants judge the dialect of two areas that are very close or very far from their place of residence. Conversely, the responses converge when the two localities under scrutiny are neither too close nor too far from the participant's place of residence. Table 3 summarizes the final three-knot model, and Figure 12 shows its marginal effects.

5.4 The role of "official" classification in explaining the perception of linguistic boundaries and the relationship between spatial distance and dialect grouping

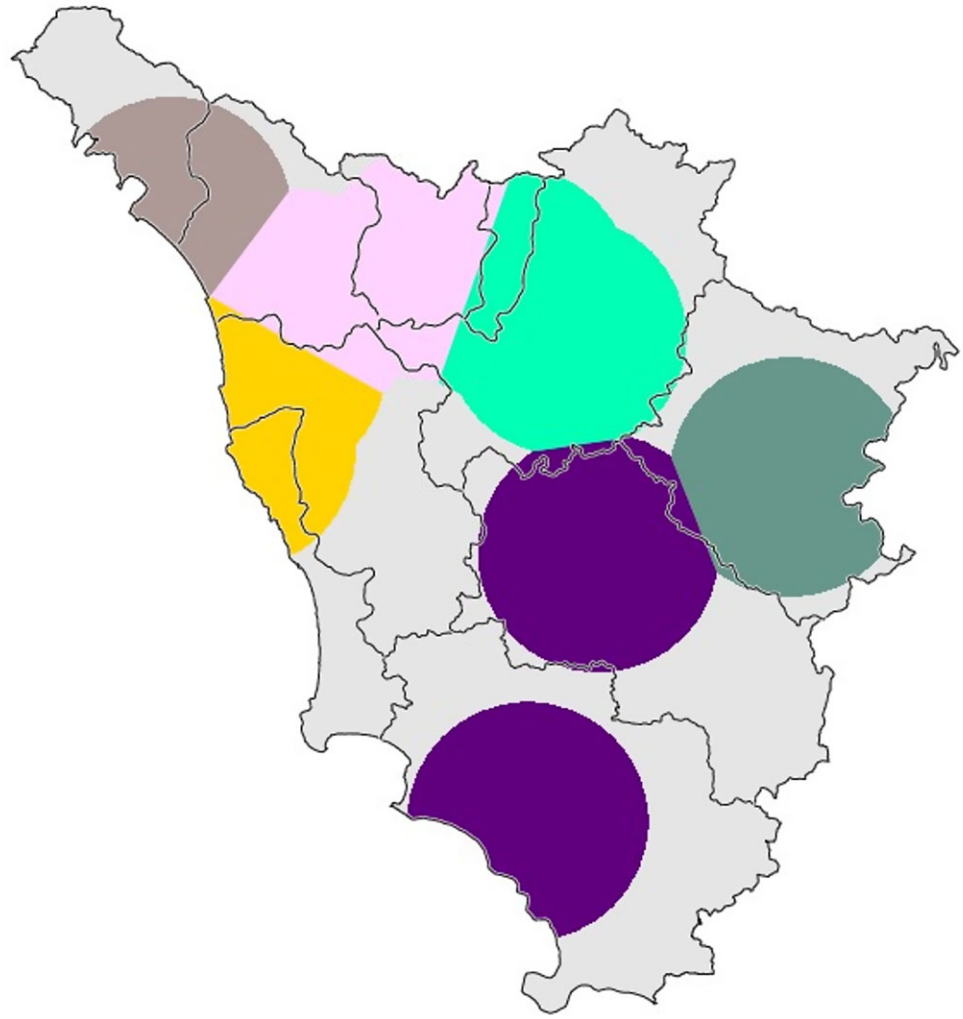
As we reviewed in Section 4.2, over the years many alternative groupings of the Tuscan dialects have been proposed by linguists. Here we focus on three of these solutions. The first is the *Carta dei Dialetti d'Italia* by Pellegrini (1977). The *Carta* was mainly based on the AIS materials, thus representing the Tuscan dialect landscape in the very first decades of the twentieth century. The second is the *Toscana* monography by Giannelli (1976), which was critically updated in the year 2000. Giannelli's work can be viewed as a classification model based on the contemporary "objective" differences between Tuscan varieties. Lastly, we consider Calamai's (2018) interpretation of the sociolinguistic grouping that was advanced in Agostiniani & Giannelli (1990). In this analysis, varieties are clustered by their areas of contemporary sociolinguistic influence while giving less importance to the historical processes leading to the "objective" differences. By comparing the correlation results between these three conceptualizations



Map 16. Gabmap cartographic visualization of the probabilistic dendrogram shown in Figure 8 (Prato dataset).

and the perceptions of our participants, we try to reach a better understanding of the type of knowledge that is activated during the draw-a-map task, whether it is historical (Pellegrini, 1977), synchronic (Giannelli, 2000), or sociolinguistic (Agostiniani & Giannelli, 1990). Additionally, we want to verify if these different types of knowledge are directly linked to spatial proximity and geographical distances. Correlation analyses were performed in order to estimate the pertinence of the individual parameters to the participants' maps. Then, generalized mixed models were built with the aim of investigating the joint effectiveness of distance and objective boundaries as explanatory factors of folk categorization. Our results (Table 1) show that Pellegrini's groupings lag behind ($r = 0.50$) both the synchronic solution of Giannelli ($r = 0.67$) and the sociolinguistic clusters of Agostiniani & Giannelli ($r = 0.80$). Thus, at first glance, the participant's mental maps seem to be mainly based on his/her sociolinguistic knowledge of the Tuscan region. However, Table 4 (point-biserial correlations) suggests that the Agostiniani & Giannelli grouping is more correlated to spatial distance than that of Giannelli. Therefore, there is the possibility that the portions of variance explained by the Agostiniani & Giannelli and distance variables manifest a higher degree of overlapping than the ones in the Giannelli/distance pairing. In order to substantiate this assumption, we ran six generalized linear mixed effect models in R (lme4 package: Bates et al., 2015: lmerTest package, Kuznetsova, Brockhoff & Christensen, 2017) trying to predict the 36,585 individual classificatory responses (see above, Section 5). Each model contained one of the possible distance/objective difference combinations along with random "Participant" (813) and "Combination" (45) terms. The six models were compared in terms of Akaike Information Criterion (AIC) scores. Table 5 summarizes the structure of the six models and reports their respective Variance Inflation Factor (VIF: car package, Fox & Weisberg, 2019), R^2 (marginal and conditional, as they were reported through the tab_model function of sjPlot: Lüdecke, 2021), and AIC.

Overall, despite the positive correlations between the predictors (see above), our models do not suffer from collinearity issues and can be safely interpreted. As expected from the correlation results, the models including the "Giannelli" variable along with spatial distance are the ones with lower VIF scores. In particular, the second model ("Giannelli" + crow distance) has the lowest VIF. This model is also the best in terms of AIC and amount of variance



Map 17. Gabmap cartographic visualization of the probabilistic dendrogram shown in Figure 9 (Siena dataset).

explained by the fixed factors. The fifth model ("Giannelli" + road distance) shows almost the same AIC score ($\Delta < 2$) and those including the "Agostiniani & Giannelli" variable also have moderate support ($\Delta < 4$). Lastly, the third and sixth models, those including Pellegrini's division of the Tuscan dialects, have no support ($\Delta > 10$; Burnham & Anderson, 2004:271). Indeed, in these models, the "Pellegrini" predictor does not reach statistical significance. From these results we may infer that the best explanatory model is the one with the most conceptually separate predictors. Social rationales are partially overlapped with the relative proximity between locations, thus performing worse in explaining the participant's responses. Table 6 summarizes the best model (n. 2).

6. Discussion

Our research questions found partial answers in the analyses we ran. Here we will report the main findings and discuss them in detail.

As far as the participants' clustering proposals are concerned (question 1), visual inspection of the difference map of our whole Tuscan dataset revealed that geographical proximity enhanced the perception of dialect similarity between, in particular, the areas of Pistoia-Prato-Florence and Leghorn-Pisa-Lucca. Additionally, a multidimensional scaling analysis suggested that the most evident fracture in the perception of dialect continua lies between the areas of Leghorn-Pisa and Siena-Grosseto. Cluster analyses show that, for all the respondents, the provinces listed as showing linguistic similarities in first-order nodes are (1) Prato and Florence; (2) Pisa and Leghorn; and (3) Arezzo and Siena. As we saw in Section 4.2, the latter pairing does not correspond to any objective linguistic cluster. Other provinces, conversely, appear to be opaquer. Pistoia is sometimes clustered with Florence and Prato, Grosseto sometimes clusters both with Siena and Arezzo, Lucca is sometimes associated with the Pisa-Leghorn cluster, whereas Massa is almost always considered in isolation. When looking in detail at the respondents' place of birth, we noted some idiosyncrasies in the individual cluster formation processes. However, we could not discern an area that manifests significant deviations from the results of the mean regional perceptions. In general, it appears that the most common perceptual areas in the region are the Florence-Prato cluster and the Pisa-Leghorn one. Unsurprisingly, Florence seems to be the most recognized area,

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Table 1. Coefficients of the correlations between perceived dialect difference and geographic distance/objective difference. *** = $p < 0.001$

	Crow distance	Road distance	Pellegrini	Giannelli	Agostiniani & Giannelli
Perceived difference	0.70***	0.71***	0.50***	0.67***	0.80***

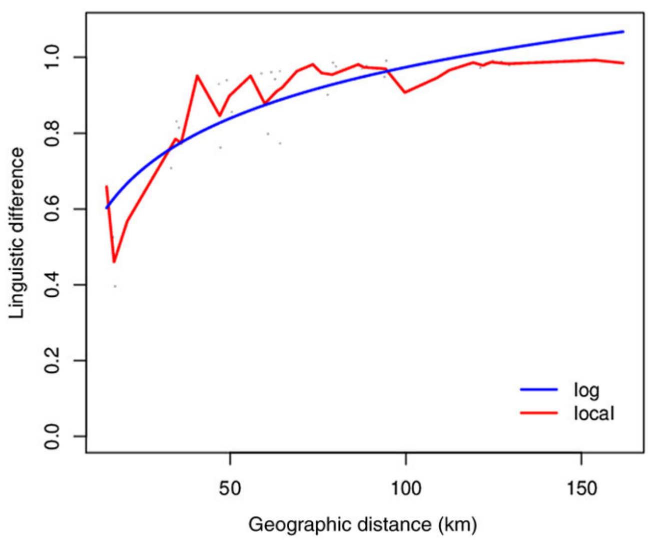

Figure 10. Gabmap regression plot concerning our whole Tuscan dataset.

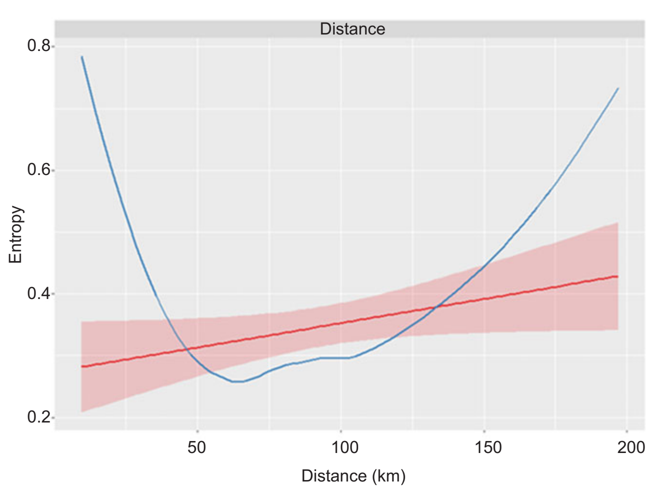

Figure 11. Regression plot of a linear model struggling to fit the entropy data. Data distribution is clearly nonlinear.

together with Prato. The linguistic affiliation of Prato with Florence is longstanding; by virtue of its sociolinguistic prestige, the Florentine dialect spread its area of influence westward, and this was already observed in Agostiniani & Giannelli (1990). Conversely, as already mentioned in Section 4.2, the expanding features of the Leghorn variety have come to light in the last two centuries. Despite its recent sociolinguistic prestige, the perceptual saliency of a west coast cluster (Pisa-Leghorn) appears to be quite robust. Such prominence might be correlated with the high visibility that characterizes the Leghornese variety. Popular satirical magazines such as *Il Vernacoliere* are indeed distributed throughout and outside Tuscany and show a widespread use of the Leghornese dialect in juxtaposition with the Pisan variety (Calamai, 2005). It should also be noted that analyses with Gabmap did not allow for the verification of the statistical significance in the differences between the ways of perceiving spatiality. In the future, more effort will be made in order to verify how perceived spatiality varies according to the area of origin of the respondents and how different processes of clustering are distributed through the region.

Turning to geographic distance (question 2), our data show that there is no difference between crow and road distance in the perceptual identification of similar areas. This means that contiguous areas that are divided by geographical obstacles such as mountain ranges or rivers (as for Monte Pisano) are, anyway, in spatial relationship. Even if improvements are still planned today, such as the highway from Grosseto to the Leghorn province, Tuscany is, indeed, a rather well-developed region in terms of its highway system. This result clearly resembles similar tests based on Dutch data (e.g., Nerbonne, van Gemert & Heeringa, 2005) or the Norwegian "modern" travel distances in Gooskens (2005). The structure of the Tuscan highway system dampens the potential explanatory benefit of such refinements in the conceptualization of geographic distance. It is also thanks to the efficiency of the infrastructures that varieties such as the Florentine dialect have spread throughout the region. In any case, other studies are needed in order to understand the role of road distance in determining the perception of linguistic clusters. Dialectological data have shown that sociolinguistic centers of prestige, such as Florence, can, in some cases, spread their linguistic influence, prevailing over nearer geographic centers (such as in the case of the Casentino area, which tends to receive its prestige forms from Florence rather than from Arezzo; see Cravens & Giannelli, 1995). Other studies are needed in order to understand, from a perceptual perspective, the relationship between geographical distance, road distance, and commuting. Clusters of interaction determined by frequent commuting flows between localities with many opportunities for contacts can indeed explain the spreading of linguistic varieties and the subsequent increasing in recognition of particular varieties (Montgomery, 2017).

Our tests on the proximity effect (question 3) revealed that the participants' classification uncertainty does not simply grow linearly along with the distance between their homeplaces and the regional subareas. The participants' uncertainty is positively affected by both the distance and closeness to the objects of their classifications. Conversely, the participants' responses converge when the areas are neither too distant nor too close to their homeplaces. Thus, it appears that the two peaks of uncertainty can be put in relationship to different processes. When participants were asked to classify places, cultural aspects play a role. Folk classifications appear to reflect an *esprit de clocher*, postulating that the strongest distinction is between "us" and "them," where "them" are our closest neighbors. As observed in other perceptual studies (e.g., D'Agostino et al., 2002), "closest places" are the ones that are usually judged as the most linguistically different and recognizable. This behavior could have interfered with a rational acknowledgment of equivalence between spatially contiguous areas (see Section 2.1), creating classification uncertainty. Conversely, when asked to judge on more distant places, the spatial aspect is more prominent. People may indeed have no idea on how some dialects sound, so their classifications will be more uncertain. In the future, other relevant variables will be tested, and estimates will be made to test for the complexity of the objects to be classified. It is indeed

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Table 2. ANOVA table of the comparisons between the spline models of increasing complexity. BIC values of each model are also displayed on the right. *** = p < 0.001, * = p < 0.05

Model	Res. Df	RSS	Df	Sum Sq	F	Pr (> F)	BIC
Linear	358	34.745					197.5891
3 knots	357	31.990	1	2.75468	31.7694	3.55e-08 ***	173.7384
4 knots	356	31.567	1	0.42376	4.8871	0.02770 *	174.8239
5 knots	355	30.997	1	0.56908	6.5632	0.01082 *	174.1607
6 knots	354	30.695	1	0.30261	3.4900	0.06257	176.5151

Table 3. Summary of the best spline model (3 knots) in terms of BIC values. *** = p < 0.001

	Estimate	Std. Error	*t* value	*Pr(>|t|)*
(Intercept)	0.549867	0.063363	8.678	< 2e-16 ***
rcs(Distance, 3), Distance	0.004012	0.000947	4.237	2.89e-05 ***
rcs(Distance, 3), Distance'	0.006628	0.001195	5.544	5.74e-08 ***

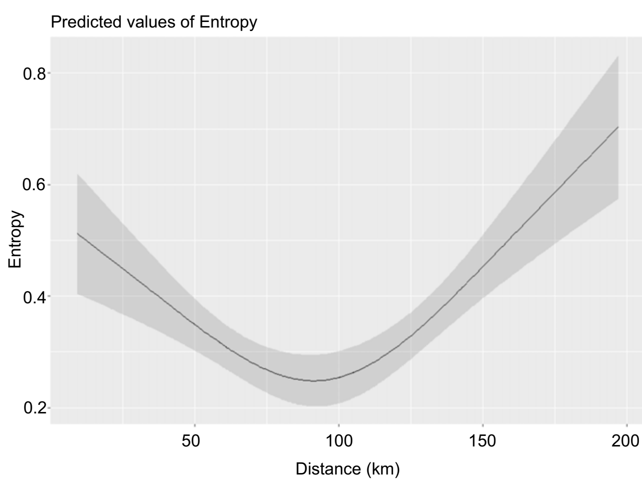

Figure 12. Marginal effect plot from the 3-knot spline model (Table 3).

possible that linguistically complex areas will lead to greater uncertainty about classifications.

The comparison with the dialectological data (question 4) shows that the classification by Pellegrini (1977) does not reflect folks' perception of the region. When looking at the other two partitions, we observed through correlation analyses that respondents' classifications resemble the partition proposed by Agostiniani & Giannelli (1990). Respondents, as already observed in other studies (Evans, 2011), sometimes happen to detect "subtle differences in specific linguistic markers of variety" (Preston, 2018:200). However, when testing for the combined effects of geographical distance and objective linguistic differences, the sociolinguistic partition by Agostiniani & Giannelli (1990) lags behind Giannelli's (2000) synchronic solution. This is explained by the mixed nature of the sociolinguistic partition, which contains noticeable portions of shared variance with the distance variable.

Table 4. Coefficients of the correlations between the different conceptualizations of distance and objective differences. *** = p < 0.001, ** = p < 0.01

	Pellegrini	Giannelli	Agostiniani & Giannelli
Crow distance	0.50***	0.38**	0.46**
Road distance	0.50***	0.41**	0.47**

Table 5. Comparison of the six generalized linear mixed effect models evaluating the best explanatory combination between the different conceptualizations of spatial distance and objective linguistic difference

Model	Structure	VIF	R^2(Marginal/ Conditional)	AIC
1	Response ~ Crow distance + Agostiniani&Giannelli + (1|Participant) + (1|Combination)	1.27492	0.275/0.594	16185.748
2	Response ~ Crow distance + Giannelli + (1|Participant) + (1|Combination)	1.173155	0.281/0.595	16183.251
3	Response ~ Crow distance + Pellegrini + (1|Participant) + (1|Combination)	1.336226	0.255/0.596	16196.054
4	Response ~ Road distance + Agostiniani&Giannelli + (1|Participant) + (1|Combination)	1.289848	0.275/0.594	16185.579
5	Response ~ Road distance + Giannelli + (1|Participant) + (1|Combination)	1.200069	0.279/0.595	16184.356
6	Response ~ Road distance + Pellegrini + (1|Participant) + (1|Combination)	1.334757	0.257/0.596	16194.982

Table 6. Summary of the best model explaining the participant's responses to the draw-a-map task. Random effects include Participant (813: variance 1.8971, standard deviation 1.3774) and Combination (45: variance 0.6523, standard deviation 0.8077). *** = p < 0.001

	Estimate	Std. Error	*z* value	*Pr(>|z|)*
Intercept	-0.157907	0.349230	-0.452	0.651
Crow distance	0.032819	0.003679	8.921	< 2e-16 ***
Giannelli	1.450731	0.365137	3.973	7.09e-05 ***

To sum up, the model that best explains the results of our draw-a-map task suggests that our participants made their decisions looking at (1) a keen sense of spatial contiguity; and (2) the synchronic presence of linguistic differences between the Tuscan subregions. However, the role played by geographical distance in explaining our model is probably related to the bidimensional nature of the task itself. Other tasks that do not involve spatial representations are needed in order to understand the processes underlying the perception of language variation.

7. Conclusion

The question of spatial delimitation of languages and dialects has for a long time been the main object of study of dialectologists. We considered the notion of linguistic space itself in the perception that respondents (high school students) have of it, and we investigated the differences between linguistic borders and perceived language borders. Although it is sometimes difficult to determine whether it is actually dialect areas that the informants are identifying or simply administrative districts, we found that the results of the present survey of perceptual dialectology connect in many ways with other dimensions of linguistic research. The 813 maps we investigated show a detailed, lively, and dynamic "common folk knowledge" with respect to linguistic variation. They represented the perceived space not only according to landscape or geographical borders, or according to traffic and economic flows, but also according to concrete linguistic variation.

From the methodological viewpoint, we sketched a fast and accessible workflow based on the publicly available web software Gabmap. Gabmap can contribute to the ongoing discussion on the procedures for the quantitative processing of draw-a-map data. Among the other statistical techniques that were selected to answer our research question, the nonlinear spline models provide a first assessment of the role of information entropy in the analysis of dialect perceptual distances (Heeringa & Prokić, 2018).

The next step would be to expand the analysis to different areas with different sociolinguistic scenarios throughout the Italian peninsula and to find differences according to sex/gender, age, social class, and education of the respondents. The vast majority of perceptual dialectology studies have been conducted among university or high school students, thus implicitly focusing on a majority of white, middle-class speakers (Mitchel, Lesho & Walker, 2017). Hence, a broadening of the sample appears to be opportune and can no longer be postponed. From a different perspective, the processes of indexicality and stereotyping (Campbell-Kibler, 2012) need to be better investigated, too. Once an in-depth analysis of the perceptual salience of Tuscan varieties has been done, it can be put into relationship with the collected perceptual maps. It is precisely this cross-fertilization of different perspectives and methods that makes the linguistic picture of a given region more complete and thorough.

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Notes

1 This "proximity factor" was also discussed by Diercks (2003), who dubbed it as "Place of residence factor."

2 The English translation of every single variety is given only where there are official translations of their Italian equivalents (e.g., Florentine, Sienese, etc.), whereas others such as *Lucchese* and *Pistoiese* are kept in Italian.

3 Therefore, if we look carefully, Tuscany does not have one language or one single accent, but it shows different languages and accents according to the variety of cities and villages. In accents and in words, the Arezzo residents are different from the Volterranians, the Sienese from the Florentines, the Pisans from the inhabitants of Pistoia, the people from Lucca from the people from Cortona [. . .] and for every place there is a variety of pronunciations and words. [. . .] If we want to refine it with the hammer of truth, we will notice that such differences are so minuscule that those who were born outside Tuscany will not find any difference between the Florentine, Sienese, Pisan, Lucchese or other similar varieties, or they will notice them only with great difficulty (our translation).

4 The Tuscan branch, located in the northern part of the region, is divided properly into four distinct groups, which we have called Florentine, Sienese, Tiberin, and Corsican. The Florentine group embraces the entire Arno basin as well as the Serchio and Cecina valleys. This is divided into several dialects, the main one being the Florentine. [. . .] Its most distinct varieties are: Lucchese, the Pisan variety, which is spoken alongside the Era and Cecina valleys, and Leghornese, which is the most deviant variety (our translation).

5 A cartographic representation of Giannelli's (1988) partition can be found at the following URL: http://www.treccani.it/enciclopedia/dialettitoscani_%28Enciclopedia_dell%27Italiano%29/ (accessed October 2021).

6 The "La Spezia-Rimini Line" represents the (approximate) boundary of some fundamental features of northern dialects, such as the voicing of intervocalic voiceless consonants; the deletion of posttonic [e] after [l]; the syncope of pretonic vowels; the shortening of long consonants; the vowel nasalization and the loss of final nasals (Savoia, 1997).

7 See Bounds and Southerland (2018) for a detailed discussion on this methodological issue with data from the American PD landscape. Since it is not plausible to infer a perfect correspondence between the American and Italian national level on the one hand, or an American State and an Italian Regional level on the other, we opted for a cautious approach and limited the information written on the base maps to the bare minimum.

8 For privacy reasons, the type and the name of the school are retained.

9 In the Montevarchi area the Florentine variety is spoken, although the town belongs to the Arezzo district; see Giannelli (2000).

10 https://www.google.it/earth/ (accessed October 22, 2021).

11 Coding errors resulting in matrix asymmetries were spotted through a semi-automated procedure. First, the suspect matrix was imported in R (R Core Team, 2020) and its transposition was generated through the t() function. Then, the two matrices were inserted in a subtraction. As symmetric matrices should be equal to their transposition, nonzero results indicated the loci of the coding errors.

12 In the statistical jargon, dimensionality refers to the number of attributes of a dataset. High dimensionality usually causes data sparseness and represents a computational obstacle to statistical testing. For this reason, dimensionality reduction techniques, such as multidimensional scaling, are a common procedure to obtain simple data representations (i.e., with few but meaningful attributes) while retaining the essential properties of the original space.

13 In the dialectometric tradition, information entropy has found its place as a validation procedure for clustering algorithms (Prokić & Nerbonne, 2008) and is still considered a promising parameter for the development of new analytical strategies (Heeringa & Prokić, 2018:343).

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