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Linguistic Visualizations as *objets d'art*?

Abstract This article undertakes a broad-ranging examination of the practice of data visualization in linguistic research, whether for elucidation and elaboration of theoretical models, analysis and interpretation of datasets, or summarization and presentation of research outcomes. Roman Jakobson's cube model for Russian case theory, and the concept of *objet d'art* (Chvany 1987) as a notional frame, are deployed to draw attention to a range of issues that must be considered in the use of linguistic visualizations. Following a survey of traditional and newer visualization techniques in linguistic research, the specific example of data analysis in historical sociolinguistics is used to make an argument for linguistic visualization practices that "use all the data", "view all the data", "view all the combinations", "view all the angles", and "use all the techniques".

1. Introduction

Jakobson's cube

The inspiration for the title of this article is a study by Catherine Chvany entitled "Jakobson's Cube as *Objet d'Art* and as Scientific Model" (Chvany 1987).[1] In her article Chvany discusses Roman Jakobson's "famous cube model for the interrelated meanings of the eight (= 2^3) cases encoded in the Russian language" (199) and the "three binary (+ or −) features (= 2^3): [± MARGINAL] (represented as the vertical dimension), [± QUANTIFYING] (the depth dimension), [± DIRECTIONAL] (the width dimension)" expressed by the eight Russian cases (200); and she reproduces a graphic representation of the Jakobson cube model, seen here in Figure 1.

1 Another version of the work appeared as Chvany 1984.

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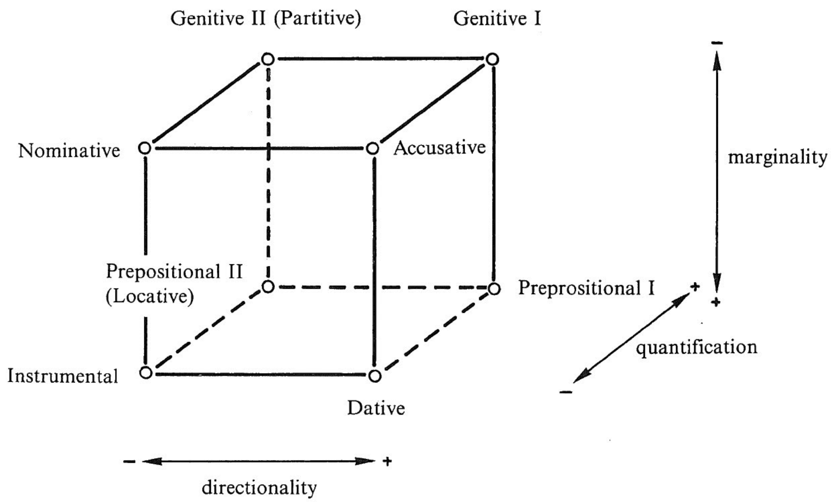

Figure 1: Mel'čuk's 1983 illustration of the Jakobson cube model, adapted from Jakobson 1958 (image from Chvany 1987, 199).

The purpose of Jakobson's cube is, of course, to provide a visual representation of a complex set of information.[2] Specifically it seeks to provide a maximally informative, and at the same time clearly interpretable, visualization of a theoretical model describing a set of features and the relationships between them in a morpho-syntactic system. The interpretive value of the cube visualization of this theoretical model becomes clearer when we consider it alongside an example (Figure 2) of one alternative way that these features and their interrelationships can be presented.

The intent here is not to say that the grid presentation in Figure 2 provides no meaningful access to the theoretical model and is of no assistance in the analysis of the information contained in the model, but when compared with the cube visualization in Figure 1, it is clear that we perceive the theoretical model and its information in a different way in each of the two visual representations.

This specific example of linguistic visualization – Roman Jakobson's Russian case theory represented as a cube – serves in the following discussion as our point of entry into a more broad-ranging examination of linguistic visualization under the general notion of *objet d'art.*

2 The practice of providing visual representations of complex information is certainly not unique to academic presentation of scientific research; it is also found quite readily in everyday use, with many types of visual illustrations employed to explain difficult concepts or rich information. The value of this everyday use of visualizations is clearly reflected in the common expression "a picture is worth a thousand words".

	Marginal	Quantifying	Ascriptive
Nominative	−	−	−
Accusative	−	−	+
Genitive$_1$	−	+	+
Genitive$_2$	−	+	−
Locative$_2$	+	+	−
Locative$_1$	+	+	+
Dative	+	−	+
Instrumental	+	−	−

Figure 2: Neidle's 1982 grid for the eight-case system in Russian. Note that Neidle uses "ascriptive" for "directional" (image from Chvany 1987, 218).

Jakobson's cube as *objet d'art*

In her discussion of graphic representations of linguistic systems, Chvany states: "[…] each geometric figure has its own semantics; it can be ambiguous (have homonyms), and it can have approximate synonyms, just as words do. The meanings of figures, governed by principles of visual perception, necessarily combine with the meanings assigned by the linguist" (1987, 208). Put another way, graphic representations themselves carry meaning – meaning that is correlated with other graphic representations, and that is sometimes ambiguous or interpretable in multiple ways, i.e., visual representations are embedded in systems of meaning, governed in part by "principles of visual perception". So, it can be argued that the cube itself, as a geometric figure, carries meaning and has the potential for variation and ambiguity in its meaning, as interpreted by individual observers – some might see one thing and others might see something else. Consider the illustrations in Figure 3 and Figure 4 by Joseph Jastrow (1899) of variant perceptions of the cube.[3]

3 For Figure 3, a version of the "Necker cube" (Necker 1832), Jastrow (1899) describes the multiple interpretations as follows: "Figs. 13a and 13b are added to make clearer the two methods of viewing Fig. 13. The heavier lines seem to represent the nearer surface. Fig. 13a more naturally suggests the nearer surface of the box in a position downward and to the left, and Fig. 13b makes the nearer side seem to be upward and to the right. But in spite of the heavier outlines of the one surface, it may be made to shift positions from foreground to background, although not so readily as in Fig. 13" (308). "The presence of the diagonal line makes the change more striking: in one position it runs from the left-hand rear upper corner to the right-hand front lower corner; while in the other it connects the left-hand front upper corner with the right-hand rear lower corner." (309). For the possible interpretations of the stacked cube illustration in Figure 4 he provides the following description: "If viewed in one way – the

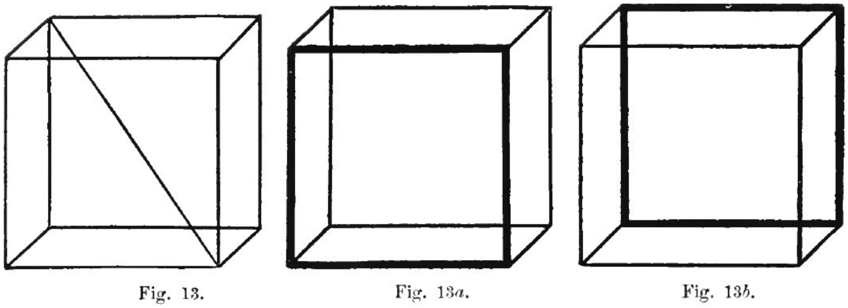

Figure 3: Jastrow's illustration of variation in perception of a cube (1899, 308).

This is not unlike our experiences when observing artistic designs and works of art. Each of us potentially sees something different first, or has a different interpretation of what is seen; and sometimes the longer you look at it, the more you see one thing instead of another or favor one interpretation over another; or the more often you look at it, the more you see different aspects of it that allow for different interpretations, or perhaps the less sure you are of what you actually see. As illustration of this effect, consider whether the artistic sketch in Figure 5 depicts the image of a rabbit or a duck.[4]

Jastrow, in summarizing his observations concerning the phenomenon of variant perceptions/interpretations of geometric shapes and artistic designs, including those illustrated in Figures 3, 4, and 5, notes:

> All these diagrams serve to illustrate the principle that when the objective features are ambiguous we see one thing or another according to the impression that is in the mind's eye; what the objective factors lack in definiteness the subjective ones supply, while *familiarity, prepossession, as well as other circumstances influence the result.* These illustrations show conclusively that seeing is not wholly an objective matter depending upon what there is to be seen, but is very considerably a

black surface forming the tops of the blocks – there seem to be six … ; but when the transformation has taken place and the black surfaces have become the overhanging bottoms of the boxes, there are seven …" (310).

4 This classic image was first published on page 147 of the 23 October 1892 issue (issue no. 2465) of the German magazine *Fliegende Blätter* (I. Schneider, ed. München: Braun & Schneider) with the wording "Welche Thiere gleichen einander am meisten? Kaninchen und Ente." (Which animals resemble each other the most? Rabbit and duck.) See http://digi.ub.uni-heidelberg.de/diglit/fb97/0147 for a digital facsimile edition of the issue containing the original image.

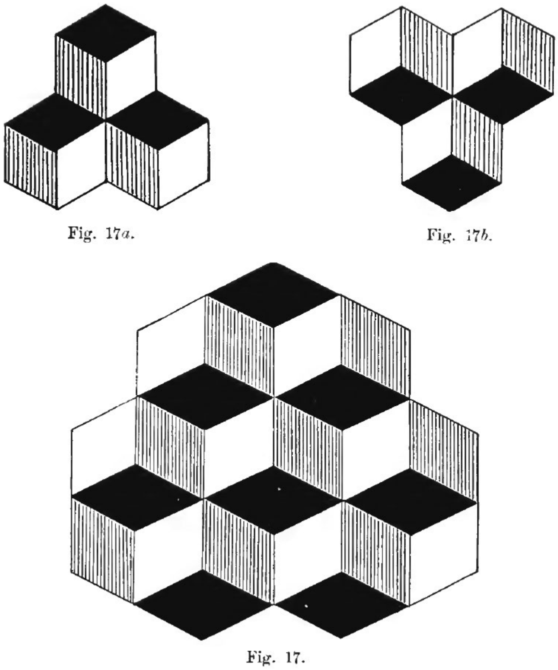

Figure 4: Jastrow's illustration of variation in perception of a stack of cubes (1899, 311).

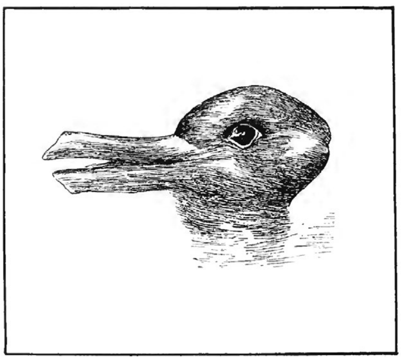

Figure 5: Jastrow's adaptation of the rabbit ~ duck illusion (1899, 312).

> subjective matter depending upon the eye that sees. *To the same observer a given arrangement of lines now appears as the representation of one object and now of another; and from the same objective experience, especially in instances that demand a somewhat complicated exercise of the senses, different observers derive very different impressions* [emphasis added, MRL] (1899, 310–311).

From the discussion above, the conclusion can be drawn that the cube itself (or any other visual illustration), like a work of art (an *objet d'art*), is open to potential variant perceptions that may *broaden* the possible range of observers' interpretations of the visualization (and the data it represents) well beyond any specific meaning assigned to it by the person using the cube (or other graphic illustration) as a visualization of their data and information.

Chvany in her continued discussion of visual representations of linguistic systems also points us in the opposite direction to the possible *constraining* influence of visualizations, describing the potential for a visualization to activate only a specific interpretation or range of interpretations of the data and thus ultimately influence the direction of the linguistic theory derived from the interpretation. "Moreover, the graphic representation, be it matrix, tree, box diagram or polyhedron, may, through its own semantics, influence the perception of the modeled system. As Stewart (1976) points out in her Introduction, 'the relationship of analogy between figure and datum, between design and meaning, is what enables graphic representation to influence linguistic theory'" (Chvany 1987, 208).

Thus, once again, as with *objets d'art*, where a specific artwork may become for many observers the standard interpretation (a sort of iconic representation) of the subject it is depicting, the specific form of a data visualization has the potential to narrow our perception and interpretation of the data. In our example of Jakobson's cube, the fact that he visualized his case theory with a cube could lead us to favor certain interpretations of the data, and it could ultimately become the primary, or even the only, way in which we see the data and conceptualize it theoretically, causing us to overlook, or even exclude, other possible theoretical interpretations.

Chvany highlights this potential constraining factor of a chosen visualization in the specific case of Roman Jakobson's cube representation of the Russian case system: "The 1958 model … expands the prism, closes the unfinished cube, answers its questions, *removes choice … the cube is a nonnegotiable model*" (1987, 215 – emphasis added MRL), adding further:

> Even those of us who disagree with one or another aspect of the cube model have used some of its component claims, whether as supporting argument, stipulation or axiom. For there are occasions where it is possible to use one or another part of the model, without regard – or need – for internal consistency of the whole. [...] The cube's unfalsifiable claims, while undesirable in a theory, do not interfere with these limited but useful applications, so *there is little motivation to change the model.* [...] In the area of applications, *it's 'love it or leave it'*. The system is so tight, it hangs together so well, that adjusting one opposition would entail changes in the rest, destroying the parts that one cannot disagree with (Chvany 1987, 216–217 – emphasis added MRL).[5]

In the end, a specific visualization could constrain the possible interpretations of a dataset or model to the point that we focus on the visualization rather than on the data or model that it represents, and we objectify the visualization thereby fixing (locking in) the form or type of that visualization, considering it immutable/unchangeable; and we then interpret all new data and arguments through that fixed form – the visualization becomes an *iconic* representation of the underlying information. This should cause us to wonder, with Chvany, "But the question remains, is the cube [or any other given visualization] the best possible icon of the system?" (1987, 218). We will return to this question of "best possible icon" in the discussion further below.

2. Tasks of linguistic visualizations

Elucidation and elaboration of theoretical models

The preceding discussion, of Roman Jakobson's cube visualization for his theory of the Russian case system, provides a good example of one of the common tasks for which linguistic visualizations are deployed – the elucidation and elaboration of theoretical models. A long-standing example of the use of visualizations to represent theoretical frameworks is the use of tree diagrams to illustrate the concept of genetic relatedness among languages (see Figure 6).

5 Chvany later adds to these thoughts a direct *objet d'art* reference, "The cube's take-it-or-leave-it, love-it-or-leave-it fate resembles the history of an art object more than the normal development of a scientific model" (1987: 222).

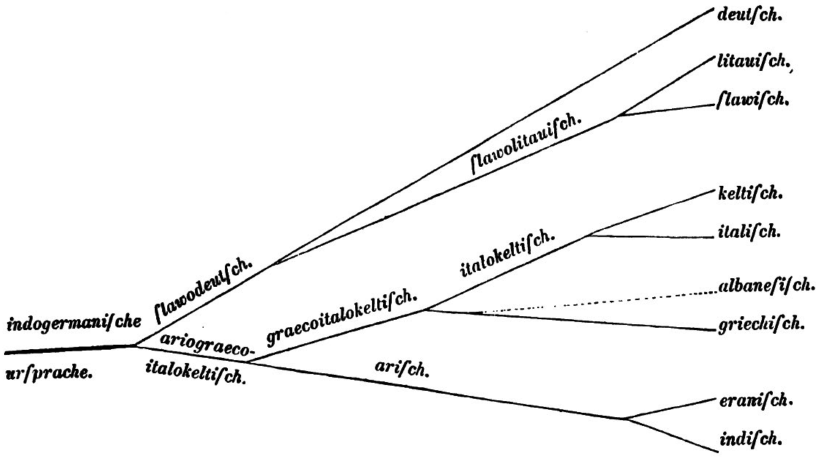

Figure 6: Schleicher's *Stammbaum* visualization of the genetic relatedness of the Indo-European languages (1861, 7).

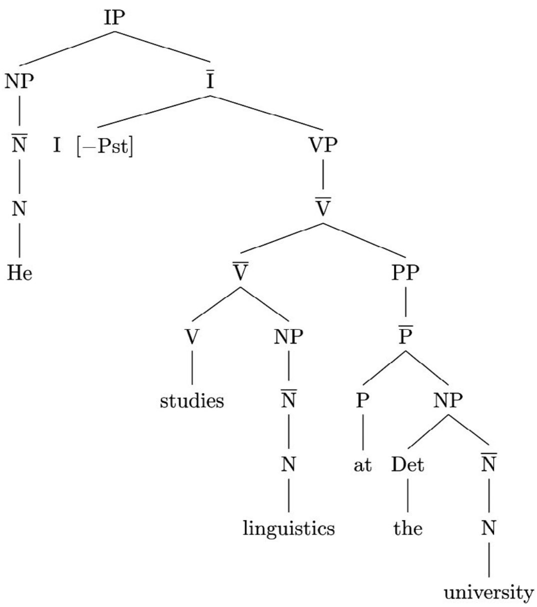

Figure 7: Syntax tree illustrating X-bar theory (https://commons.wikimedia.org/wiki/File:Xbarst1.svg – accessed 09 October 2016).

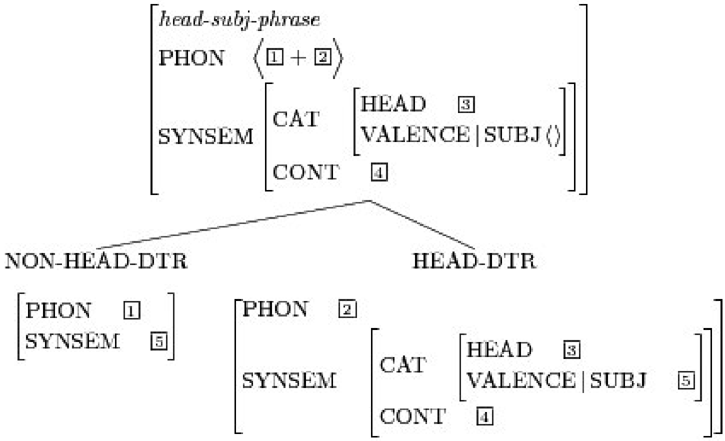

Figure 8: Tree visualizing HPSG theory (https://commons.wikimedia.org/wiki/File:Head-subj-tree.png – accessed 09 October 2016)

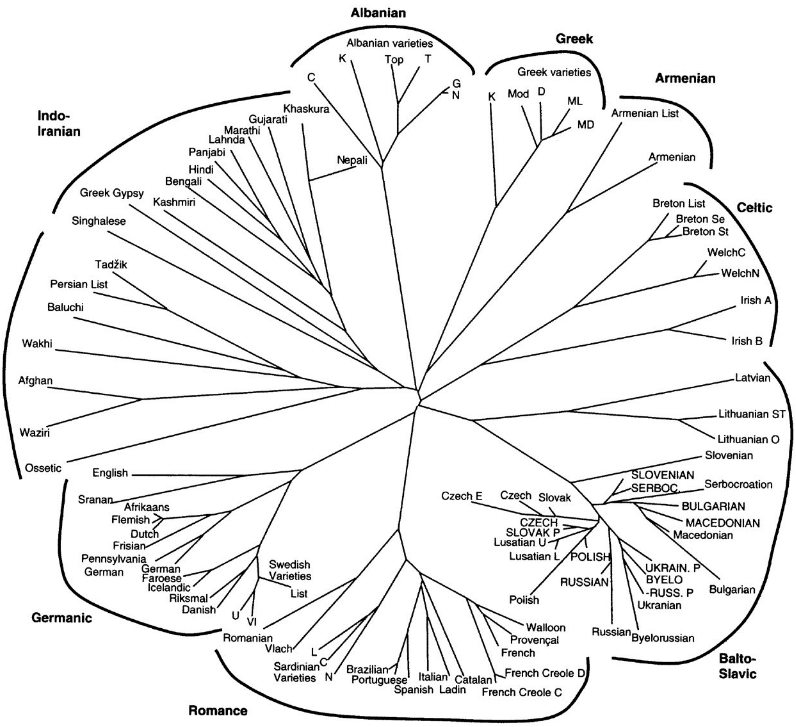

Figure 9: McMahon and McMahon's unrooted Indo-European tree generated on the basis of quantitative statistical analysis of relatedness data (2005, 101).

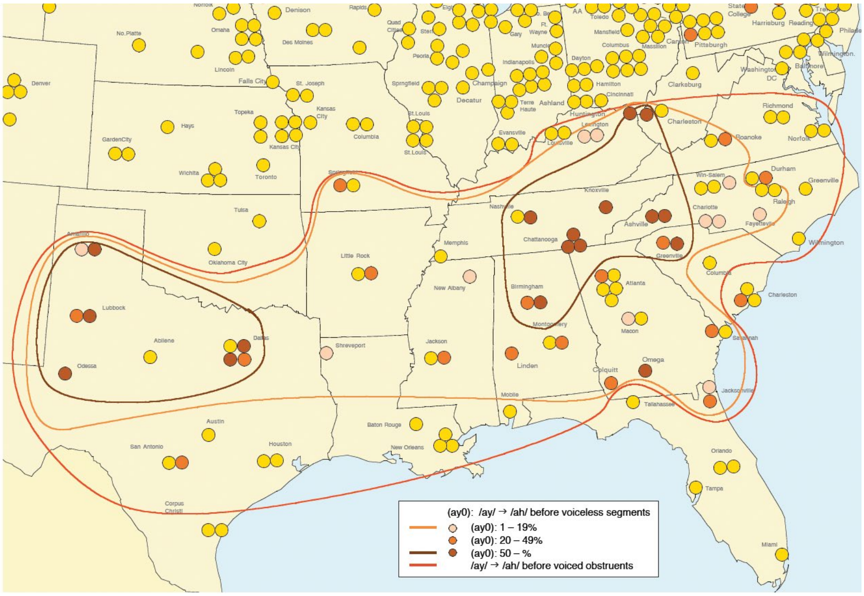

Figure 10: Labov, Ash, Boberg's map of monophthongization before voiceless consonants in North American English (2006, 129).

Of course, tree structures have also become a highly common visualization tool in other areas of linguistics as graphic representations of theoretical constructs as seen in Figure 7 and Figure 8.

Technological advances (most recently digital) in the tools and instruments available to us have allowed us to apply more sophisticated visualization techniques to existing theoretical models, checking those models and also refining and elaborating them in ways not before possible (or accomplished only with difficulty). Figure 9 provides an example of statistical and computational advances in tree diagrams for visualizing linguistic relatedness.

Analysis and interpretation of datasets

In addition to their use in elucidating and elaborating theoretical models, visualizations are commonly deployed on linguistic datasets with the hope of aiding the analysis of the data and the interpretation of the results of that analysis. One common example of this use of visualizations for data analysis and interpretation is the geospatial plotting of dialect data as seen in Figure 10.

Like tree diagrams to visualize linguistic relatedness, geospatial representation of dialect data has a long-standing tradition in linguistics (see Figure 11 and Figure 12).

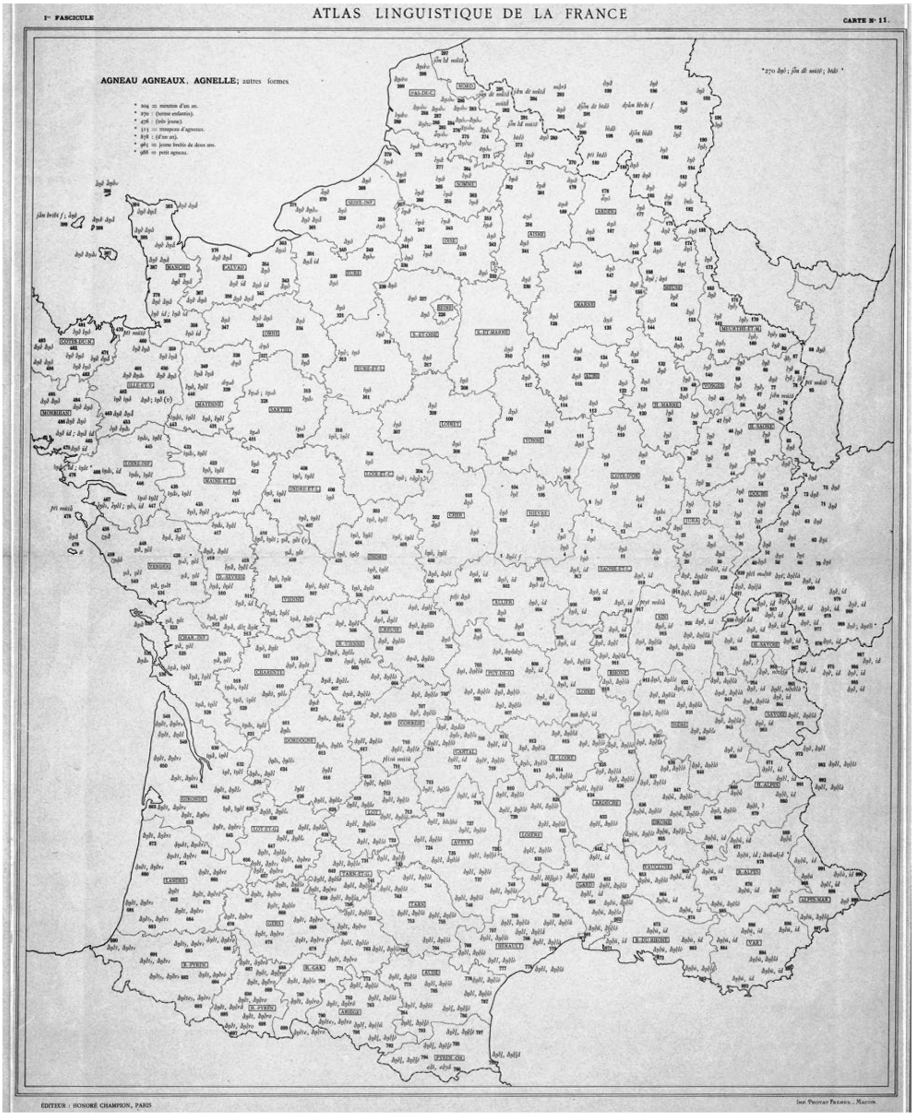

Figure 11: Gilliéron and Edmont's (1902–1910) *Atlas linguistique de la France*, fascicle 1, map no. 11 "AGNEAU, AGNEAUX, AGNELLE; autres formes" (http://cartodialect.imag.fr/cartoDialect/seadragon.jsp?carte=CarteALF0011&width=4852&height=5912 *or* http://cartodialect.imag.fr/cartoDialect/download/Carte-ALF0011.tif – both accessed 02 July 2017).

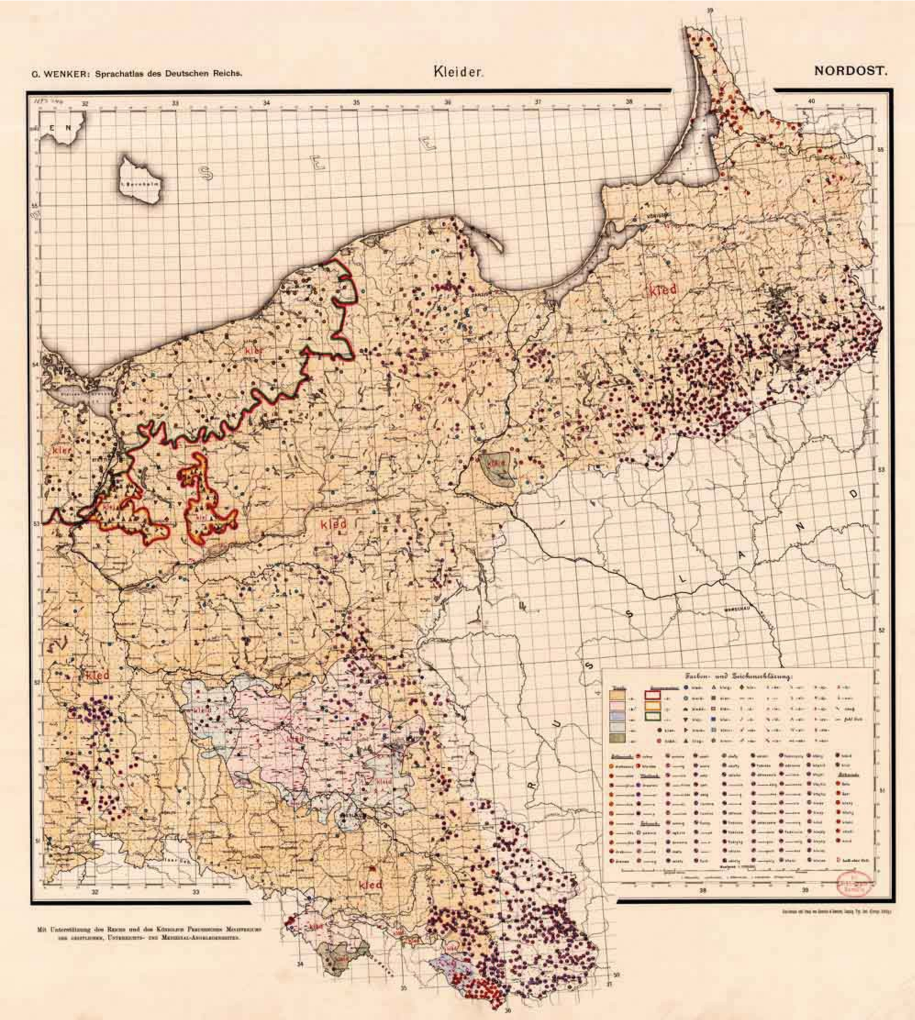

Figure 12: Wenker's (1888–1923) *Sprachatlas des Deutschen Reichs*, northeast sector map for "Kleider" (http://www.graphicscience.de/assets/images/DSA-Kleider_NO_udl-02-1000P.jpg – accessed 09 October 2016).

Just as theoretical models have benefited from advances in visualization tools and techniques, technological advances have provided ever more powerful tools for analysis and interpretation of data, illustrated in Figure 13, again on the example of geospatial mapping.

Technological advances have also made visualizations possible in areas where they were not possible before, where the visualizations themselves actually

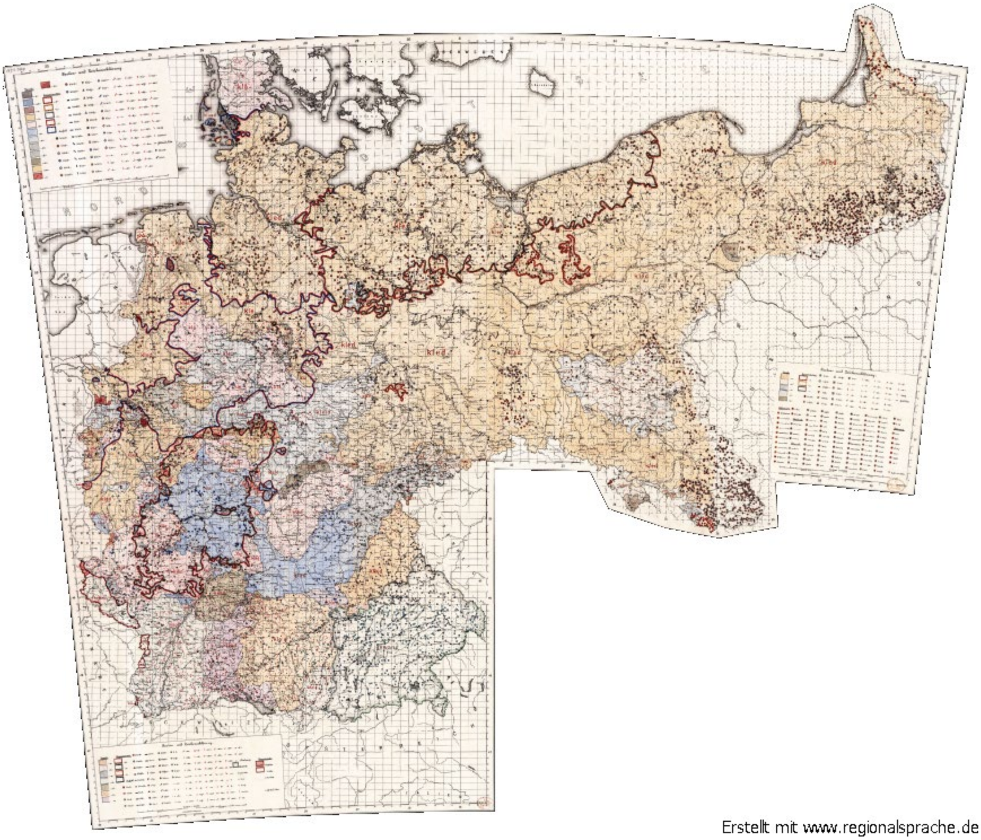

Figure 13: Full information for "Kleider" from Wenker's *Sprachatlas des Deutschen Reichs*, all sectors displayed "stitched together" in the REDE digital environment (www.regionalsprache.de – generated 18 September 2016).

provide for our analyses and interpretations new complementary and supplementary information previously not available (see Figure 14 for an example[6]).

6 As explained by Kevin McGowan (personal communication): "A common problem in phonetics and related fields is the need to visualize many vowel measurements together in a comprehensible way [the actual vowel measurement data also available due to technological advances – MRL]. Simply plotting these measurements as individual points can be uninformative or even misleading. Christian DiCanio of SUNY Buffalo proposes (2013) this novel method of using R (R Core Team 2016) with the ggplot package (Wickham 2009) to instead present the distribution of the vowel, using kernel density estimation to reveal patterns in the measurements that were previously difficult or impossible to discern. [In Figure 14] the distribution density plot reveals bimodal distributions for several vowel quality categories suggesting that a dimension other than simply the F1 (height) or F2 (backness) vowel formant measures

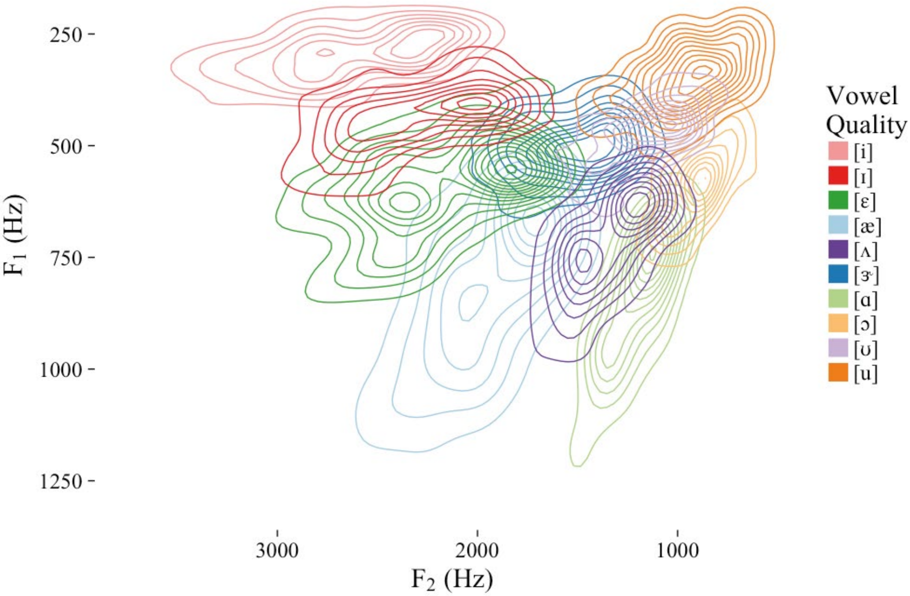

Figure 14: The classic vowel measurements of Peterson and Barney (1952), re-plotted using kernel density estimation to enhance clarity (image from Kevin McGowan, personal communication).

Summarization and presentation of research outcomes

A third general area in which visualizations have become commonplace in linguistic research is as a means of summarizing for presentation the outcomes of data analysis and interpretation, illustrating the results of an investigation. Similar to visualizations of theoretical models, these visualizations generally serve to render tables of numbers, lists of linguistic data, or extended prose into a visually digestible form (see Figure 15 and Figure 16).

A different, but familiar, example of the use of visualizations to summarize research results can be seen in Figure 17.

can be expected to explain much of the observed variation. Indeed, replotting these data separately by speaker gender results in largely unimodal vowel distributions with much less overlap across vowel quality categories".

morphological unit	region	pattern*	no pattern	insufficient data
1) 1st sg. n-p. thematic verbs I, II, III	MSlk		X	
	WSlk	X		
	CSlk		*(X)***	X
	ESlk		X	
2) instr. sg. masc. & neut. nouns	MSlk	X		
	WSlk		X	
	CSlk		X	
	ESlk	X		
3) dat. pl. masc. & neut. nouns	MSlk		X	
	WSlk	X		
	CSlk	X		
	ESlk	X		
4) instr. pl. masc. & neut. nouns	MSlk	*(X)***		X
	WSlk		X	
	CSlk	X		
	ESlk	X†		
5) loc. pl. masc. & neut. nouns	MSlk			X
	WSlk			X
	CSlk			X
	ESlk			X
6) gen./dat./loc. sg. fem. hard-stem adjs.	MSlk		X	
	WSlk	*(X)*††	X	
	CSlk	X		
	ESlk	X		
7) loc. sg. masc. & neut. hard-stem adjs.	MSlk	X†		
	WSlk		X†	
	CSlk	X		
	ESlk	*(X)***		X
8) dat./loc. 2nd sg. & refl. pronouns	MSlk	*(X)***		X
	WSlk	X†		
	CSlk	X		
	ESlk	*(X)***		X
9) 1st sg. pres. of **byti*	MSlk	*(X)***		X
	WSlk	X		
	CSlk	X		
	ESlk		X	

**Throughout this table, a parenthetical "(X)" indicates a possible alternative to "X". An explanatory note describes the nature of the alternative. **This is an extrapolated interpretation. The data set is too small to mark the result as certain. †This result would benefit from verification with additional data. ††Possible tendency toward region-wide patterning of* -ej *ending.*

Figure 15: Summary table showing the distribution of patterns of morphological variants across geographical space with measures of certainty and type of patterning (Lauersdorf 2010, 160–161).

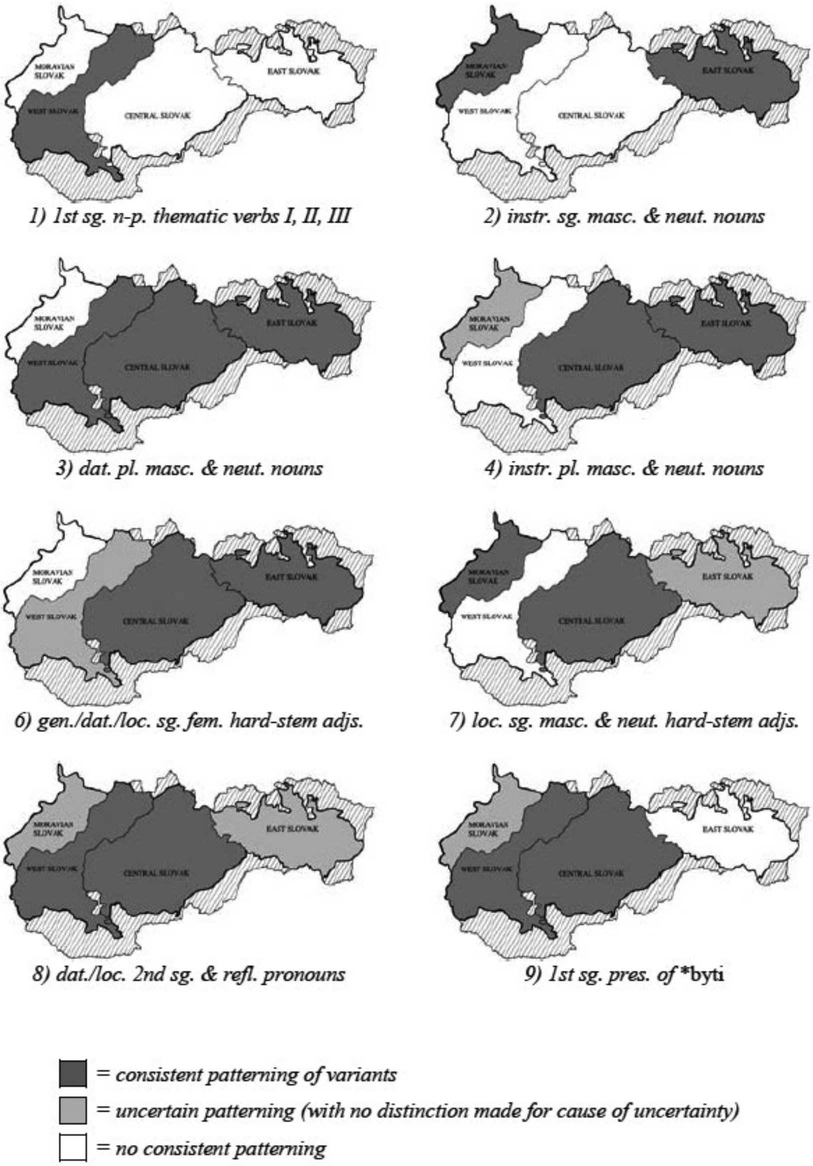

Figure 16: Geospatial visualization of the information in Figure 15 (Lauersdorf 2010, 163).

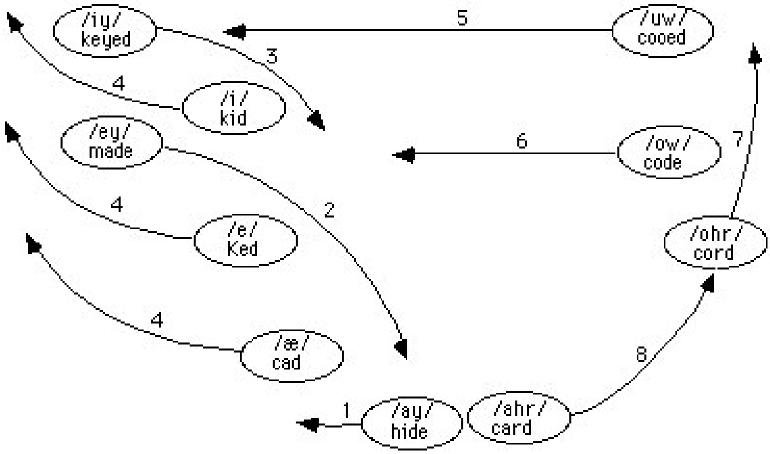

Figure 17: William Labov's schematic overview of the Southern vowel shift in North American English (http://www.ling.upenn.edu/phono_atlas/ICSLP4.html – accessed 09 October 2016).

Figure 18 and Figure 19 provide examples of visualizations that present research outcomes in geospatial and tree form once again.

Figure 18: Labov, Ash, Boberg's overview of the major dialect divisions in North American English (2006, 148).

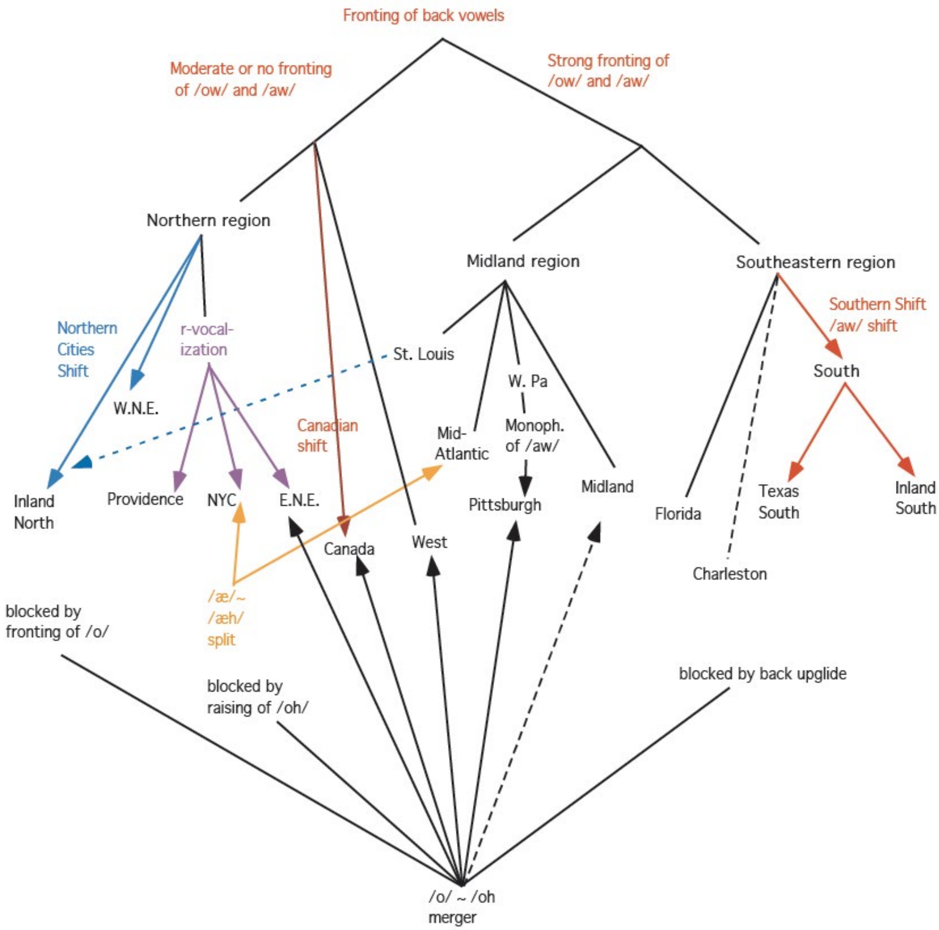

Figure 19: Labov, Ash, Boberg's schematic tree illustrating their "hierarchical structure of North American dialects" (2006, 147).

What visualization accomplishes in these tasks

In each of the three general tasks outlined above, the end goal of the use of linguistic visualization is the same: to gain insight and to facilitate/improve results.

- theoretical models → gain insight into and provide better comprehension and testing of the model
- data analysis → gain insight into and provide better analysis and interpretation of the data

- research outcomes → gain insight into and provide better comprehension and testing of the outcomes

If there is no additional insight provided by a given visualization, or if there is no facilitation or improvement of the theoretical model, the data analysis, or the research results, then we might question the use of the visualization. We might also question the use of a given visualization in the context discussed earlier where we have perhaps locked in a specific form or type of visualization, considering it immutable/unchangeable, and we then interpret all new data and arguments through that fixed form whereby the visualization becomes an *iconic* representation of the underlying information. Repeating Chvany's cautionary statement, "But the question remains, is the cube [or any other given visualization] the best possible icon of the system?" (1987, 218).

Jakobson's cube as cautionary tale

In the same way that the cube has become *the* visualization of Jakobson's Russian case theory, the different classic visualizations presented above to illustrate theoretical models, data analyses, and research outcomes have become *iconic* for the information that they represent. We all recognize, without any explanation or clarification, how we are to interpret tree diagrams, dialect maps, syntax trees, and vowel shift diagrams because they have become standard visualizations for the information that they illustrate. Chvany states about Jakobson's cube: "The controversies surrounding the cube seem strangely out of proportion to its importance as a theoretical construct. [...] *There is nothing sacred about the cube*" (1987, 218 – emphasis added, MRL). In the same way, we would be wise to question ourselves regarding some of the standard visualizations that have become iconic in our areas of study. Have we objectified these visualizations thereby fixing (locking in) their form and rendering them immutable/unchangeable (iconic)? And do we interpret all new information and arguments through these fixed forms, potentially focusing, in our subsequent analyses, more on the visualization than on the information behind it? And what are we missing if we are, in fact, doing this?

In the iconicity of accepted, standard visualizations:

- we are potentially missing some of the data or some of the relations between the data;
- we are potentially not allowing for all the possible data combinations;
- we are potentially not seeing all the angles;
- we are potentially missing opportunities to try different techniques.

Chvany provides discussion and illustration of several of these points in regards to the Jakobson cube visualization (1987, 218–219), exemplified here in Figure 20 and Figure 21.

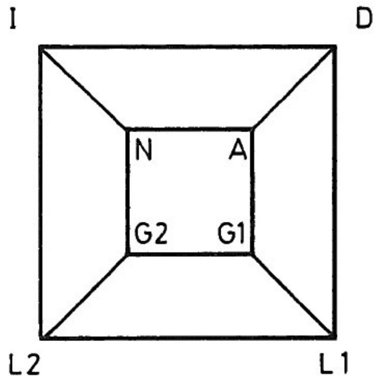

Figure 20: Chvany's alternative visualization of Jakobson's cube (illustrating our notion of viewing *from a different angle*) giving more emphasis to the "central-peripheral distinction" of the theory (1987, 218).

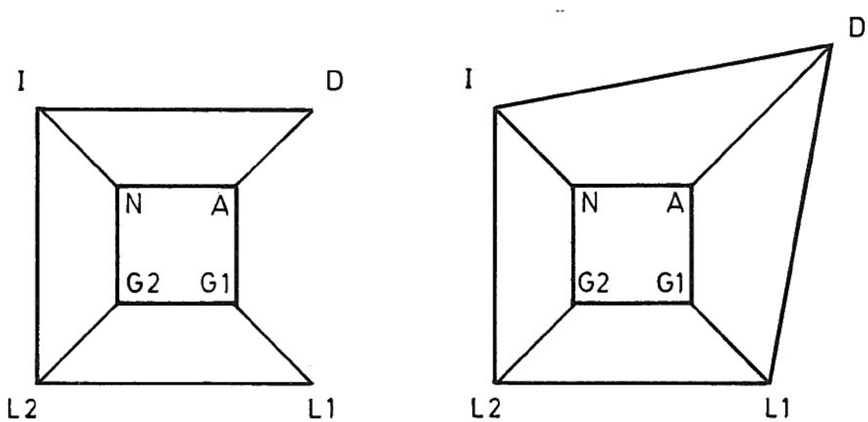

Figure 21: Chvany's further alternatives to Jakobson's cube (illustrating our notions of viewing *from a different angle and showing different relations* between the structures) (1987, 219).

In discussing alternative visualizations of the Russian case system (from different angles or showing different relationships) Chvany states: "The drawing is two-dimensional, and the three-dimensional illusion is not needed to represent the system …" (1987, 218), and "Jakobson actually refers to hierarchization (1958, 175) … . One weakness of the cube figure as an icon of the Russian case meanings is that its dominant reading is ahierarchical. A hierarchy is better represented, and tested, in a tree-shaped model" (1987, 219). This again speaks directly to one of our cautions above that, in locking in one iconic visualization, there is the potential for missing some of the relations between the data.

3. Applying visualizations to linguistics

A contextualization from historical sociolinguistics

Much of the work that I do in the field of historical sociolinguistics involves complex situations of historical language contact with:

- a high number of language varieties in contact;
- no identified standard language or prestige variety;
- a multitude of geographical and political borders;
- quickly changing socio-cultural, socio-political, socio-economic contexts.

What I seek to investigate about those situations is:

- what is the impact of the language contact on the structures of the language varieties in contact?
- what patterning of structural features can be seen across the varieties in contact (is there dialect leveling, koinéization, etc.)?
- if patterning is detected, what type, degree, location, domain, etc. does it demonstrate?
- can specific socio-historical factors be correlated to the structural patterning?

Given that this work is being performed for historical language periods, there is the issue of the so-called "bad data problem", made famous by Labov in his statement that "… [h]istorical linguistics can … be thought of as the art of making the best use of bad data" (1994, 11). Importantly for our discussion here, this is often re-cast by historical linguists as a problem of "imperfect" data (Joseph and Janda 2003, 14), or "making the best use of the data available" (Nevalainen and Raumolin-Brunberg 2003, 26). Given that the available data is "imperfect" (i.e., limited, fragmentary, or incomplete), it is imperative to gather as much of it as possible for a given investigation, from all interrelated sources, linguistic and socio-historical – in other words, it is imperative to use all the data! This is especially true for the type of investigation that I described at the beginning of this section involving historical language analysis through data-driven pattern identification and correlation with socio-historical factors. At this point it is important to note that, while the discussion in the remainder of this section derives from a specific application in historical sociolinguistics (as described above), I believe that the arguments presented are applicable to any context of visualization in linguistic analysis.

Use all the data!

As stated, historical data (linguistic or otherwise) tends to be "imperfect" data (i.e., limited, fragmentary, incomplete), and generally speaking, the earlier the time period under investigation, the "more imperfect" the data. Thus, if we hope to achieve generalizable results from historical sociolinguistic investigations, it becomes necessary to gather as much of the data as possible from all interrelated sources. Even when dealing with contemporary linguistic data, gathered in the field, in the lab, or in a corpus, it can perhaps never be guaranteed that we are working with "perfect" data, i.e., data that is *not* limited, fragmentary, or incomplete in some respect. In this way, the call to "use all the data" certainly has broader application beyond historical sociolinguistics.

Logically, if you use all the data, you have to process all the data in your analysis. And if you have to process all the data, you will very likely need to use statistics and visualization for data analysis. The need for statistical and visual assistance in analysis can be driven by the size of the dataset, wishing, for example to isolate relevant information in a large dataset or to determine viability and significance in a small dataset. It can be driven by the multifactored nature of the dataset with the interaction of many different data types. It can be driven by the type of information that we wish to extract from the dataset (e.g. correlational information about multiple variables).

In all of this I believe that there is an implied, and very important, set of corollaries regarding data visualization:

⟶ Use all the data.
⟶ If you use all the data, *view* all the data.
⟶ If you view all the data, view all the *combinations*.
⟶ If you view all the data, view all the *angles*.
⟶ If you view all the data, use all the *techniques*.

It should be mentioned that I am working through the rationale and the arguments here on the basis of the visualization task of data analysis and interpretation, but the basic tenets of these propositions are also easily transferable to visualization for the elucidation and elaboration of theoretical models and to visualization for the summarization and presentation of research outcomes.

View all the data

Often we decide directly, or the visualization technique that we choose decides indirectly for us, which subsets of the data we end up viewing; and in both cases, the power of the visualization is limited by the decisions made about which data subsets to view. If, in performing our linguistic visualizations, we make *a priori* decisions, for whatever reasons, concerning the subset(s) of the data that should be visualized, we run the risk of potentially missing patterns in the overall dataset. Even in very large datasets, where an initial visualization of the entire dataset could be as dense and opaque to interpretation and analysis as the raw dataset itself, the use of visualization could have the potential to show subdivisions in the dataset that *a priori* pre-visualization decisions would miss. It is necessary to *view all the data.*

A first reaction to Figure 22 might be that, in viewing all the data, the overall amount of data, and the various parameters ascribed to it, create a visualization that is difficult to parse for the purposes of data analysis. However, within the specific framework of the investigation, the authors of the study note, on the contrary, that "At first sight it is apparent that the structure of the city does not only reflect the political dimension discussed earlier: Figure 7 [Figure 22 here] clearly reveals the segregation into different social classes. Some actors only appear in combination with very few events whereas others are highly integrated in the center of the structure. In the center of events we find the craftsmen, the clerks, the merchants, and the educated bourgeoisie, whereas the vintners and the workers are basically linked to the periphery of the system." (Krempel and Schnegg 1999). This conclusion would likely not have been possible without viewing all the data, and it allows for potential subdivision of the dataset for deeper analysis on the basis of having specifically viewed all the data.

Relatedly, if, in performing our linguistic visualizations, we use only the iconic standard visualizations commonly employed for the specific type of data we are analyzing, we might potentially miss some of the data or some of the relations between the data, either through our preconceived notions of what the visualization should show, or through actual restrictions on the data that the visualization can accept, or the type of relations it can show. (We will return to

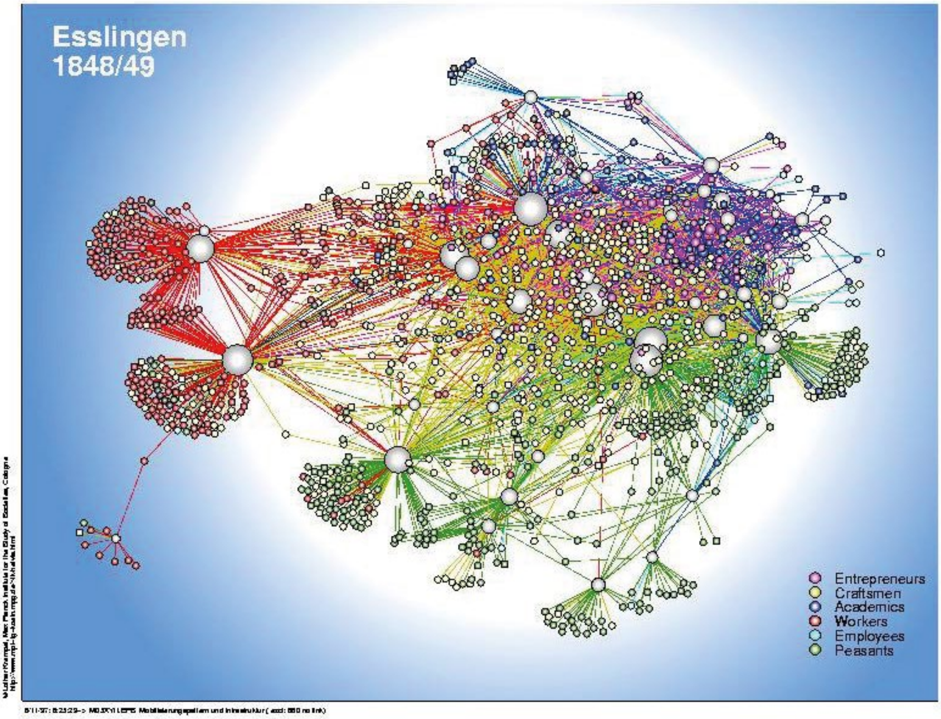

Figure 22: Krempel and Schnegg's (1999) visualization of the social landscape of Esslingen, Germany, 1848/49.

this notion of chosen visualization techniques disallowing a view of all the data in the section on "using all the techniques".)

View all the combinations

As mentioned above, very large datasets have the potential, if viewed with all data points and parameters, to produce highly complex visualizations that may be largely impenetrable to interpretation, so "viewing all the data" at once may not be of much assistance in data analysis – the visual density may be too great, or there may be mixed types of data that are difficult to bring together in a single visualization. On the other hand, in breaking the data down into subsets to assist in visual analysis, *a priori* assumptions about the parts of the data that should be combined and the parts that should be excluded in any given visualization will potentially cause us to miss patterns in our analysis because we perhaps did not bring the appropriate parts of the data together, in our *a priori* selection, to adequately reveal the correlations that might exist. In cases where it becomes procedurally/methodologically necessary to view the data in subsets, it becomes necessary to *view all the combinations*.

The risk of not viewing all the combinations, and thereby potentially missing patterns in the analysis, also arises if we rely exclusively on the use of iconic standard visualizations. If we always apply only the same standard visualizations to the data we are working with, we are potentially missing some of the combinations of the data either through our preconceived notions of what combinations these visualizations should show, or through actual restrictions on the data combinations the visualization technique can accept, or the types of combinations it can show.

View all the angles

A simple graphic illustration will demonstrate the importance of considering multiple views or angles of the relationship between data points in a visualization. Consider a representation of the connections between data points plotted in a two dimensional square. It is a square when viewed head-on, and a different square (but still a square) from behind (Figure 23).

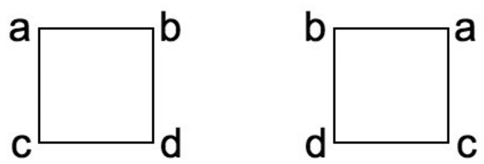

Figure 23: Data points "a", "b", "c", "d" plotted as a square, *viewed from front and back.*

From the top it is a horizontal line, and from the bottom it is a different horizontal line (Figure 24).

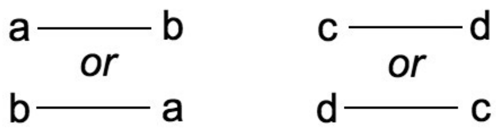

Figure 24: Data points "a", "b", "c", "d" plotted as a square, *viewed from top and bottom.*

From one side it is a vertical line, from the other side a different vertical line (Figure 25).

Figure 25: Data points “a”, “b”, “c”, “d” plotted as a square, *viewed from left and right sides.*

From a front angle it is a quadrilateral with two different types of relations between the points, depending on the angle (Figure 26).

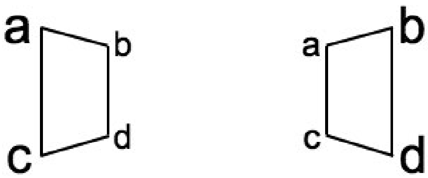

Figure 26: Data points “a”, “b”, “c”, “d” plotted as a square, *viewed from left and right front angles.*

We can appreciate already from this simple demonstration (that does not nearly exhaust the possible angles of view on a square) that the interpretation and analysis of data in any given visualization could be considerably affected by the angle of view on the visualization. It thus becomes necessary to *view all the angles*, or at the very least, it is necessary to view more than one angle, in order to be aware of the effect that the angle of view might have on our understanding of the data. An even greater appreciation for this notion of viewing all the angles can be achieved by adding just one additional dimension to the square and considering the cube from multiple angles (Figure 27 – rotated here *only* 90 degrees, *only* on its central vertical axis).

The question must then be posed: what are we missing in the visualizations of our data, (especially in our iconic standard visualizations) if they are static, with no interactive or dynamic component that allows for different views on the data?

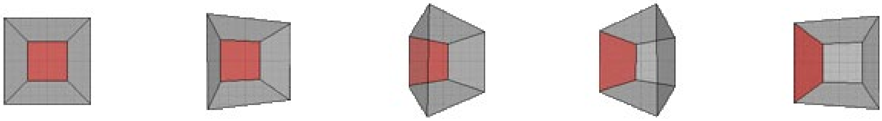

Figure 27: Cube visualization rotated 90 degrees on its central vertical axis (http://www.traipse.com/hypercube/ – accessed 09 October 2016).

Use all the techniques

Earlier in this text, and particularly in each of the last three sections, part of the discussion has revolved around the limitations of using only the visualization techniques that have become commonplace and common practice ("iconic") in the field in which any individual investigation is anchored. One way to escape this *iconicity* problem, where our reliance on iconic standard visualization tools and techniques causes us to potentially not use all the data, not view all the data, not view all the combinations, or not view all the angles, is to *use all the techniques* (or at least *consider more of* the techniques). Of course, there are certain limitations, both methodological and practical, that often prevent us from truly testing *all* of the visualization techniques available. Specific data types match with specific statistical models, and other data types match with other statistical models; and some data types match better with certain visual representations than with others. But trying something out of the ordinary (i.e., a non-iconic or non-typical visualization) may yield extraordinary results.

It should be kept in mind here that the call to *use all the techniques* does not exclude the iconic standard visualizations, but rather begins with them and then goes beyond them. The argument here is that employing non-typical visualizations, in addition to the iconic standard visualizations, provides the potential for additional scientific gains. Bubenhofer (2018) echoes this, stating: "In order, however, to allow for innovation in the area of scientific visualization, this canon of disciplinary visualization practices must constantly be called into question"[7] (S. 45). As just one example of the insights to be gained from using innovative techniques beyond the iconic standard visualizations in a given field, Montgomery (2012) convincingly demonstrates that the visualization of geospatial data in

7 "Um aber Innovation im Bereich wissenschaftlicher Visualisierung zu ermöglichen, muss dieser Kanon disziplinärer Visualisierungspraktiken immer wieder hintergangen werden."

a graph form allows for analysis and interpretation beyond what is possible with the original geospatial representation of the data (see Figure 28 and Figure 29).[8]

Linguistic visualizations as *objets d'art*?

Interestingly, the deliberate use of non-typical visualization tools and techniques to allow the observer to see something not ordinarily seen, or not otherwise perceptible, is a feature of *objets d'art* as well. Different works of art allow us to perceive the world in different ways by presenting the "information" of the world in different combinations, from different angles, using different media and techniques (i.e., different types of "visualizations"), and thus works of art often give us new appreciation, understanding, and insight into the information that they are portraying, even if we have already seen the same information represented in other works of art (i.e., other "visualizations") or in its original form in the world (as "raw data").

Of course, it was *not* the intent of this discussion to examine the viability of a direct equation between linguistic visualizations and artworks, nor was the intent to determine whether linguistic visualizations demonstrate some sort of creative, interpretive, esthetic, or other equivalency with artworks. As stated at the outset, the concept of *objet d'art* served here as a notional category, deployed to draw attention to a range of issues that must be considered in the use of visualizations in linguistic research. The use of visualization tools and techniques has the potential to provide new insights and to facilitate/improve outcomes in linguistic theories, analyses, and results. As we view all the data, all the combinations, and all the angles, using all the techniques, we must simply remain

8 Montgomery's explanation of the maps in Figure 28: "The data gathered for the North-South divide question for each location in Study 1. Each line drawn by respondents is included on the three maps: (a) respondents from Carlisle (67 lines drawn); (b) respondents from Crewe (61 lines drawn); (c) respondents from Hull (72 lines drawn)" (2012, 652). This geospatial data was then converted to graph form (Figure 29): "Consequently, ImageJ (Rasband 2011 [now 2016 – MRL]) was used to interrogate the data more closely. The programme includes a tool that permits analysis of image luminance, which is well suited to investigating the placement of North-South lines as a greater density of lines reduces luminance. ImageJ creates a 3D graph for each map with luminance interpreted on the z-axis of the graph. The luminance value is inverted (so lesser luminance appears as a spike on the graph) and a smoothing technique applied to the data which removes some of the individual variance and permits the investigation of greatest agreement. The 3D image is then rotated in order that a 2D 'slice' of the image viewed from north to south can be captured. This 2D 'slice' allows a user to examine how far north or south North-South lines have been placed by respondents in conjunction with the composite line maps" (2012, 653).

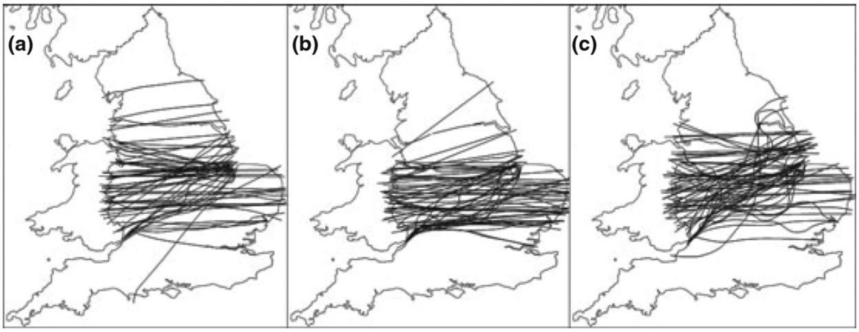

Figure 28: Montgomery's maps showing geospatial locations of north/south dividing lines drawn for a perceptual dialectology study of England (2012, 652).

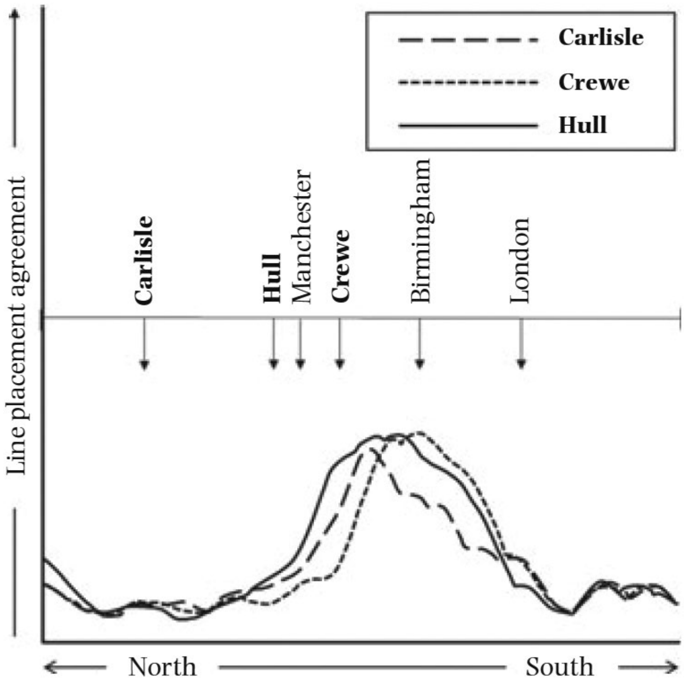

Figure 29: Montgomery's graph showing relative locations and density of geospatial bundling of north/south dividing lines drawn for a perceptual dialectology study of England (2012, 653).

mindful of the different ways in which visualizations have the potential to not only show us more, but also influence what we see.

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