

Taking the Laboratory into the Field

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Abstract

We review the development of methodologies and technologies of empirical linguistic work done outside traditional academic laboratories. The integration of such results with contemporary language documentation and linguistic theory is an increasingly important component of language analysis. Taking linguistic inquiry out of the lab and away from well-described and familiar data brings challenges in logistics, ethics, and the definition of variability within language use. In an era when rapidly developing technologies offer new potential for collecting linguistic data, the role of empirical or experimental work in theoretical discussions continues to increase. Collecting linguistic data on understudied languages raises issues about its aim vis-à-vis the academy and the language communities, and about its integration into linguistic theory.

1. INTRODUCTION

Linguistic documentation and description of small and understudied languages and language communities have increased significantly in the past couple of decades. The reasons for this increased attention are diverse, but three stand out: (*a*) an awareness of the alarming rate of loss of linguistic diversity and what that entails culturally and intellectually; (*b*) the rapid development of adaptable technologies; and (*c*) the allotment of funding specifically for language documentation, resulting in the development of contemporary practices and technologies. In this article, we review methodologies and technologies as they relate to how current language documentation is understood and practiced—that is, what happens when we take linguistic inquiry out of the laboratory and away from well-described and familiar data in an era when rapidly developing technologies offer new potential for collecting linguistic data. At issue are the weight and role of empirical or experimental work in collecting linguistic data on understudied languages, its aim vis-à-vis the academy and the language communities, and its integration into linguistic theory.

A primary reason for this resurgent interest is the awareness of linguistic diversity and language loss. Language loss has been accelerating for many decades now (Bloomfield 1925, Hale et al. 1992, Whalen 2004); the rate of loss exceeds that of the extinction of birds and mammals (Sutherland 2003). In response, linguists have increased efforts at language documentation and data collection outside academic institutions, aided by funding sources both large [the National Science Foundation (United States), the Volkswagen Foundation (Germany), the Hans Rausing Endangered Languages Project (HRELP) of the School of Oriental and African Studies (SOAS; United Kingdom)] and small [the Endangered Language Fund (United States), the Foundation for Endangered Languages (United Kingdom), the Gesellschaft für bedrohte Sprachen (Germany)]. The funding agencies themselves often have different visions of what language documentation is, what happens to the data, and who is to benefit from them. Both Volkswagen's DoBeS (Documentation of Endangered Languages) project and SOAS's HRELP have developed explicit definitions of what language documentation entails, and stipulate what funding activities they expect to support, what happens to the data, and how they are archived and accessed. Together, these organizations have supported undertakings for approximately 1,000 language projects (somewhat fewer languages), far short of the 6,000 or so languages that are likely to be moribund by the end of this century (Whalen & Simons 2012). This loss of diversity means that the language faculty itself may be poorly understood because the smaller languages are more likely to have unusual properties (Whalen 2004). Even the process of collecting the relevant material from smaller language communities has been challenging to linguists' tools in terms of both organization and analysis.

Work on language documentation since the late 1990s has sought to separate itself from the notion of "language documentation" as grammar and dictionary writing, downplaying the role of "description." Himmelmann (1998) argued for a distinction between documentation and description, in which documentation can be done independently of the descriptive work, such as dictionary building, that arises out of data collected in documentation. Woodbury (2003), however, pointed out that the enterprise of language documentation is a more integrated project; all language documentation practices inherently involve a theoretical understanding and point of view. Description, organization, and analysis are essential aspects of the same enterprise. It is this later, integrated approach that informs current language documentation practices, has led to the development of empirical "lab" techniques in the field, and is the one that we assume in this review.

In this survey, we review current ways in which linguists take the methods and technologies developed in the laboratory into the field and the timeliness of this focus. Indeed, the theme of the Fourteenth Conference on Laboratory Phonology (held in 2014 in Tokyo) was "Laboratory Phonology Beyond the Laboratory: Quantitative Analyses of Speech Produced Outside the Phonetics Laboratory." For the purpose of this review, we define "taking the laboratory into the field" very broadly to be any situation in which a researcher travels with equipment and prepared stimuli to a community or population of speakers to collect linguistic data, rather than bringing the speakers into their academic research lab. We exclude traditional fieldwork with only a notebook or a recorder (audio and possibly video), although it is still of immense value. We discuss this definition and its implications more thoroughly in the following section.

1.1. Definition

Many issues arise in a discussion of the differences between an academic laboratory and a field setting that bear comment. We address them briefly here and discuss our working definition of what we include as "out of the lab" work.

First, the work from academic laboratories is the default standard for the study of many aspects of language; however, in the interplay between academic and field settings, the limitations of this default status are underscored. Most experimental studies in academic institutions run a very homogeneous population of compliant undergraduates. Outside the lab, this is not the case. The populations, especially but not exclusively for smaller languages, are quite heterogeneous and may be unexposed to the methods and technology of the study or to the conventions of reasoning that underlie the research. There is considerably more variability in the field at every level of interaction and analysis. How this variability plays out in comparisons between field data and laboratory data is a difficult and important topic, but is beyond the scope of this survey.

A second issue is the nature of experimental fieldwork itself. In the laboratory, experimental work is typically hypothesis driven, but often too little is known about a language under study in the field to generate meaningful hypotheses. Instead, the experimental work is often preceded by more broadly based documentation efforts with only general issues that could be helped with experimental evidence. The term experimental is thus used more loosely to mean elicitation with stimuli-using tasks, methods, and constructed stimuli, but not research that is basically data gathering through elicitation. This type of work is more exploratory than hypothesis testing and may thus seem less purely "scientific," but its value, especially for disappearing languages, can be immense.

A third, related issue is the goal of the overall project. As mentioned above, the experimental component is seldom the main factor in research in the field, highlighting a common tension between a purely documentary linguistic, community-based approach and the interests of linguistic theory. Some of the methodologies used by linguists are tangential at best to documentary purposes, which can be problematic for linguists working closely with members of a community. A study addressing spatial reasoning is tremendously important in cognition (e.g., Bohnemeyer 2011) but may have only passing value to a community that may be working to revitalize its language and that requests more broadly descriptive materials. That said, the differences in cognition are ultimately part of what makes each language unique, which is exactly what most communities wish to maintain. Still, specialized studies are perhaps best done in larger, less endangered language communities, especially given that many larger, unendangered language communities are also understudied. Most field linguists attempt to navigate this issue with a mix of work, some designed for the community use (e.g., developing classroom materials or dictionaries) and some targeting broader linguistic questions. This issue also comes into play in obtaining permissions to work in a community, which usually entail addressing the benefits of the work to the community.

There is an intermediate domain between the lab in the field and an academic lab that has been used to great effect. This is the situation in which fluent speakers are brought to an academic or university setting. This type of work can be advertised as fieldwork, but it happens in a more controlled environment, where speakers are brought to a central area that is set up to handle the equipment necessary for particular types of research, such as eye tracking. Thus we separate two principal types of field situations. In the first, the fieldwork is performed in an institution outside the home institution. In this case, a researcher takes equipment, methods, and stimuli, prepared in advance at his or her home lab, to another institution to set up and run the experiments or elicitations with colleagues at that institution. Examples are Peter Ladefoged's work on West African languages in Nigeria (Ladefoged 1964); Joyce McDonough's work on Navajo with Martha Austin at Dine College in Shiprock, New Mexico (McDonough 2003); and Elisabeth Norcliffe's work on Yucatec Maya at Universidad de Oriente in Yucatan, Mexico (Norcliffe 2009). This type of fieldwork has been used with good results because institutions are natural gathering places for populations who would otherwise be difficult to reach.

The second type is fieldwork as it is more commonly understood, wherein a researcher travels to a community and works onsite without the infrastructural support of an institution. Examples are Ladefoged & Maddieson's (1996) fieldwork; Amanda Miller's work among the Khoesan speakers in Africa (Miller 2013); the portable field laboratory that Heriberto Avelino had set up at the Max Planck Institute in Leipzig, Germany; Volkswagen's DoBeS projects; and the projects supported by SOAS's HRELP grants.

Thus, the boundaries between experimental laboratory work and experimental work out of the laboratory are permeable. In this review, we consider "lab in the field" to mean a situation in which a researcher takes equipment out of her home lab and travels to another location to conduct research. Secondary distinctions are whether or not this takes advantage of infrastructure provided by an institution and the goals of the individual projects. Finally, we concern ourselves more narrowly with data collected to examine linguistic structures, rather than with broader cultural issues such as ethnobotany, ethnoastronomy, storytelling, or ethnomusicology; at the same time, we consider studies such as those on spatial reasoning or semantic classification, which are not an inherent part of the language documentation enterprise.

1.2. History

The laboratory study of linguistic structures itself goes back more than 100 years to the establishing of a lab in experimental phonetics in the College of France by L'Abbé Jean-Pierre Rousselot in 1896, and the publication of two volumes on experimental laboratory techniques titled Principes de phonétique expérimentale (Rousselot 1897-1908). Rousselot borrowed techniques, equipment, and methodologies from other disciplines, including the use of sound recordings and medical devices to measure air pressure and flow (i.e., kymographs) in the service of documenting and analyzing spoken language. This early experimental work focused on differences between living languages and dialects, but the research program was broadly construed; Rousselot also undertook work on lesser studied languages such as Mavan and Guarani and collected oral traditions and songs. He emphasized the collection of natural speech and language. His lab drew researchers from all over the world, and the lab techniques spread quickly throughout Europe and the United States. Additionally, anteceding contemporary practices, Rousselot worked with a French linguist and philologist, Ferdinand Brunot, to build an archive of recordings of the spoken word at the Sorbonne in 1911. Rousselot and his French colleagues pioneered the development of speech science and experimental phonetics and of current practices in language documentation, focusing on empirical data with concerns for documentation, diversity, and change, and the necessary involvement of new technologies and analyses in understanding human language.

1.3. Early Field Phonetics

Shortly after the publication of Rousselot's volumes, the newly formed Linguistics Department at the University of California, Berkeley, obtained a kymograph, a device for recording airflow and pressure and anatomical movements. P.E. Goddard, who was a student at Berkeley working among the Pacific Coast Dene communities, adopted Rousselot's instrumental techniques. Bringing his Dene consultants to Berkeley, Goddard collected empirical data using the kymograph and the technique of static palatography. Then, around 1905, Goddard took a field trip up to Dene Suliné (Chipewyan) communities in Alberta and northern Saskatchewan to create a description and illustration of the sounds of those Dene languages for comparison to the related Pacific Coast languages. He took the kymograph and Rousselot's experimental methodologies with him. Working with a Dene Suliné consultant, Jean-Baptiste Ennow,¹ he made a series of physiological recordings and transcribed collections of stories (see description in McDonough & Tucker 2012). Goddard published these in a series of articles and monographs between 1905 and 1929 (Goddard 1905, 1907, 1912, 1929). This empirical work on the Pacific Coast and Northern Dene communities is among the earliest instrumental field phonetics research performed in North America.

Interestingly, although experimental phonetics continued, especially in Europe, this type of work outside the academic laboratory did not catch on. It lay dormant until the field phonetics tradition was revived by Peter Ladefoged in the 1950s and 1960s. In the early 1960s, Ladefoged, who was trained in acoustics and physiology, as well as traditional practical phonetics, collected sound recordings and made palatographic and aerodynamic studies of university students from West Africa while on a Ford Foundation grant at the University of Ibadan in Nigeria. This research was published as A Phonetic Study of West African Languages: An Auditory-Instrumental Survey (Ladefoged 1964). Ladefoged moved to the University of California, Los Angeles (UCLA), in 1962 and, working with his colleagues there, combined his interest in experimental phonetics with his interest in the description and documentation of the sounds of a wide variety of languages and dialects, culminating in the Sounds of the World's Languages grant with his most important collaborator, Ian Maddieson (Ladefoged & Maddieson 1996). Under Ladefoged's direction, the Phonetics Lab at UCLA became a training ground for field phoneticians and experimental fieldwork, continuing a tradition of taking a systematic approach to elicitations using prepared word lists and developing experimental field equipment and methodologies. Ladefoged wrote several fieldwork guides, often with Maddieson, adapting techniques and methodologies to new technologies as they arose, using the UCLA Working Papers in Phonetics volumes (all available online) as an important venue for getting this work into the linguistic domain.

Ladefoged approached phonetic fieldwork, data analysis, and theory as integrated aspects of the same enterprise. Throughout his career, he maintained an active engagement in theoretical discussion with phonologists. Ladefoged's fieldwork, for instance, led him to the construction of a linguistic phonetic feature system that challenged the Jacobsonian feature system of Chomsky & Halle's (1968) *The Sound Pattern of English*. Likewise, the later editions of his

¹The Dene Suliné retain a strong community memory of Goddard's visit. On a visit to Cold Lake in 2006, the grandson of Jean-Baptiste Ennow, Ernest Ennow, was introduced to the second author of this review by Sally Rice (University of Alberta) and Val Wood (Dene Suliné). The Dene Suliné community became aware of Goddard's publications only recently through Wood and Rice, who incorporated them into their documentation work, referring to them as the Ennow–Goddard texts.

textbook, A Course in Phonetics (Ladefoged 1975, and later editions), contained sections on stress and intonation informed by his discussion with phonologists at UCLA.

Ladefoged's and Maddieson's careers are interesting for the reasons discussed in this review and are relevant to current experimental work. Their fieldwork often took place in the language communities and at academic institutions other than their own, and involved the incorporation of new technology and the development of equipment and methods of data collection. They used elicitations as well as physiological and perceptual studies to collect data to test hypotheses and provide descriptions of sounds.

2. MODERN TECHNIQUES AND MATERIALS

Language is a multistratal biological system requiring many differing techniques to yield a full description, and there is a natural division between the techniques used to study sound and those used to study higher levels of language. The articulatory organization of speech can be measured with a great variety of techniques, many of which are now feasible for the field. Higher linguistic levels are more amenable to enhanced elicitation techniques or methods borrowed from psychology, discussed below.

For all aspects of language, of course, the brain plays a crucial role, and brain imaging has made great strides in recent decades. Although electroencephalography (EEG) is fairly portable, to our knowledge no linguistic fieldwork has been done with this technique. Other techniques, such as functional magnetic resonance imaging (fMRI), positron emission tomography (PET), magnetoencephalography (MEG), or near-infrared spectroscopy (NIRS), are firmly tied to the laboratory. Much interesting work suggests itself for such techniques with languages that are currently accessible only in the field; we discuss this further in Section 4.1.

2.1. Techniques

Here we discuss specialized techniques, even though much can be learned about the production of sounds in a language simply from the acoustics. Most modern documentation projects include audio (if not also video) recordings of the language. Despite some prominent skepticism about the utility of such recordings for phonetic analysis (Ladefoged 2003, p. 9), direct comparison shows that similar results can be obtained both from elicited data and from texts (DiCanio et al., forthcoming). Nonetheless, we take acoustic recordings using structured elicitations via word lists as a given in documentation and mention other techniques for the field here. We also take the qualitative use of video (e.g., Shosted 2011, Hargus 2012) as a given of certain kinds of documentation.

One of the techniques mentioned in Section 1 remains in use: Static palatography is employed to elucidate fine detail of coronal consonants (e.g., Sands et al. 2007, Anderson 2008, Yeou et al. 2011). Airflow and intraoral pressure can be measured with an airflow setup, portable mask, or tube connected to a laptop computer (e.g., Ladefoged et al. 1998).

Tracking movements of the articulators is accomplished in the field largely via ultrasound images of the tongue (**Figure 1**). This technique uses the same types of ultrasound equipment as in hospitals to look at the tongue surface during speech. Although many machines are too bulky for use in the field, many are truly portable (Gick 2002). The most recent models have only an ultrasound probe that plugs into a USB port on a computer, but they do not yet have the visual resolution that would make them appropriate for research on language. Ultrasound systems can be used in the field either without head stabilization (Whalen et al. 2011) or with one of several techniques for fixing the head relative to the probe (e.g., Miller & Finch 2011).



Figure 1

Several methods for correcting for head movement with ultrasound in the field. (*a*) The Probe Stabilization Headset, Articulate Systems (Scobbie et al. 2008). Reproduced courtesy of Alan Wrench. (*b*) The Palatron (Mielke et al. 2005). Reproduced courtesy of Jeff Mielke. (*c*) The laser-pointer method (Gick 2002). Reproduced courtesy of Cambridge University Press. (*d*) The Corrected High Frame Rate Anchored Ultrasound with Software Alignment (CHAUSA) (Miller & Finch 2011), a combination of the devices in panels *a* and *b*. Reproduced courtesy of ASHA.

2.2. Materials

Another issue that arises in the process of working with populations outside of academia is in the preparation and use of tools, stimuli, and materials for use in elicitation and behavioral studies. Because such populations are, of course, hugely diverse, researchers need materials and protocols that are easily adaptable to highly variable situations. Yet comparisons are easier when material is standardized; distinctions (some no doubt important) are lost in the process (Simons 2009). This tension is unlikely to be resolved.

Linguists have attempted to develop and provide standardized materials and stimuli for use in the field. In particular, the Language and Cognition Group of the Max Planck Institute for Psycholinguistics in Nijmegen, the Netherlands (MPI), has been developing field tools and protocols since the publication of their 1999 field manual. These materials may involve pictures and videos used to categorize responses for landscape terms or types of activities and protocols for types of data collection. Examples include a protocol and tool kit for using audio/video to examine interactions between children in different cultures (Schäfer & Haun 2010); questionnaires that address how languages encode or lexicalize features of movement such as agency or path (Wilkins 1999); and the storybook stimulus (Eisenbeiss et al. 1999), which is set up to elicit particular kinds of utterances, in this case to examine possessives and dative constructions. The Language Technology Laboratory of the University of Alberta's Linguistics Department is undertaking a similar project. This project, *21st Century Tools for Indigenous Languages* (Arppe et al. 2014) is a broad-based project, performed in close conjunction with two aboriginal tribes, that addresses the development of computational tools as a means of tool testing and as a research objective of its own; it is intended to be of mutual benefit to language communities and to linguistic research. An adaption of the map task (Anderson et al. 1991) called the toy game was constructed by McDonough & Lachler (2010) for use in collecting natural conversation using locally found objects and materials familiar to speakers; importantly, this task moved away from representations of routes on paper, which can be problematic, especially for populations who do not use text. This task limits the objects under discussion and elicits natural conversational exchanges about directions, placement, questions, clarification, and jokes.

Other examples of standardized field materials are those created by the Group of Prosodic Studies (GrEP) of Universitat Pompeu Fabra, Spain (http://prosodia.upf.edu/home/en/index. php), coordinated by Pilar Prieto. The GrEP developed materials for the collection of data on discourse prosody for use outside the lab and produced online intonational atlases of the languages and dialects in Catalonia and the Occitanian regions, as part of a comprehensive study of the dialectal diversity. These atlases provide interactive maps, with audio and video materials collected in the field.

Finally, it is becoming common practice for researchers to put in online archives the materials used in the collection of data outside the lab. They also use sharing programs such as Edinburgh DataShare (http://datashare.is.ed.ac.uk/handle/10283/154), where linguists such as Bert Remijsen archive fieldwork scripts, tools, and protocols.

2.3. Documentation Versus Description

Laboratory investigations are by definition limited in scope. Although they are not intended to replace documentation efforts and should be considered only as supplements, they are the foundation for further work on the various aspects of these languages and can influence our thinking about the structure of linguistic systems. Experimental work relies heavily on the understanding of documentary linguists in order to make informed choices about stimuli, methods, and interpretations. It is impossible for an experimentalist, working alone on a language for the first time, to arrive at a community without connections and without understanding the target language and then do any sensible work.

The targeted nature of experimental work makes it seem at odds with the needs of the language community. Abstruse questions that make sense only within a particular theoretical framework are unlikely to be adapted into teaching grammars. Nonetheless, there is ultimately great value in what is learned. Phonetic implementation of unusual sounds is highly desirable, if future generations are to be able to appreciate the differences between the heritage language and what is currently spoken. The nuances of grammatical categories can be very hard to tease apart, and often are not accessible to introspection. The difficult questions of how much language shapes our thoughts can be addressed only with sophisticated experiments (no matter how tempting it is to dismiss such differences out of hand). As with all basic research, the payoff can be years or decades in the future, but that does not compel us to give up the research. It simply requires that the benefits be more clearly defined as unpredictable and delayed.

3. LEVELS OF ANALYSIS

3.1. Phonetics and Phonology

The resurgence of interest in field phonetics accompanied the development of the research strategy of laboratory phonology, in which phonological generalizations arise from phonetic data. Laboratory phonology made it incumbent on linguists to provide phonetic data as evidence for phonological claims. Such data were not readily available for many of the languages of the world.

3.1.1. Speech perception. Speech perception studies in phonetics are relatively easily performed outside the lab because the equipment is readily available, but the technique is still not in wide use (Figure 2). The minimal requirements are computers, recorders, and headphones, and general methodologies used within the laboratory can certainly be informative. Nonetheless, there are well-known challenges that are often enough to deter research. The main one is the restriction to meaningful units. Cultural sensitivities, including those toward language, may affect the way forms are presented to speakers. These may further be limited to those that can be visually cued, given that most of the world's languages do not have a commonly used writing system. Literacy in a nontarget language can complicate the situation, because it may be that a speaker's first language becomes filtered through the writing system of the second. Finally, simply making arbitrary decisions as a choice of isolated words will often be considered a task not worth doing. When the experiments can overcome these challenges, they are quite valuable.

The two primary areas of speech perception in phonetic research are segments (consonants, vowels, and their alternations) and suprasegmental properties such as stress, tone, and voice quality (tone specification, interactions, and alignment) and intonation. Perception of segments has been less well studied than one might expect, given that every language has a realization that can be described as segmental. The techniques for the large literature on speech perception (e.g., Liberman & Whalen 2000, Samuel 2011), however, often depend on acoustic synthesis and mind-numbing repetition of nonsense items. As with nonwords, the willingness to perceive synthesis as speech is not universal, and further restricts what can be studied. The most direct use is often to play back a speaker's own productions of words that he or she claims are different to determine whether a distinction can in fact be heard. This playback technique can be used to check the linguist's



Figure 2

Site of work used by Abramson et al. (2013). (*a*) The monks' dining hall at the Buddhist monastery of Ban Nakhonchum, Ratchaburi Province, Thailand. (*b*) Perceptual testing at various stations inside the dining hall. Photographs reproduced courtesy of Arthur S. Abramson.

perception of an unusual or difficult sound contrast. Such techniques were often used by Ladefoged and his colleagues, and often operated in conjunction with the more extensive experience of a linguist working on the particular language.

The phonology of languages can be studied directly by experiments as well. The status of excrescent vowels in Scottish Gaelic was studied by Hammond et al. (2014). They found that vowels that were not supposed to be contributing to the phonology of the language did influence syllable counts but that these vowels differed from underlying vowels in the degree to which they attracted consonants to them. This test was facilitated by the ability to use a writing system that allowed for the representation of possibly noncontrastive vowels using accepted orthographic conventions.

Tone and voice quality have been studied somewhat more extensively, probably for two reasons. First, many lesser studied languages have much more complex and theoretically challenging tone systems compared with more widely spoken languages. Second, synthesis of fundamental frequency (F0) is more easily accomplished than some other aspects of speech, so the stimuli can be made to sound more natural. Resynthesis via PSOLA (Pitch Synchronous Overlap and Add) (Valbret et al. 1992) was successfully used in generating stimuli for speakers of various dialects of Kammu (Svantesson & House 2006). Using the same technique, both Gerfen & Baker (2005) and DiCanio (2012a) found that surprisingly small changes in F0 could signal tonal differences reliably (in Coatzospan Mixtec and Itunyoso Trique, respectively). DiCanio further found that nonnative speakers (of French, in this case) were more sensitive to the acoustic differences; they paid greater attention primarily to within-category differences compared with Trique speakers. Further studies are cited by Abramson (2013). Such results are important for demonstrating that reliable acoustic differences as small as 3 Hz, which might at first appear to be statistical flukes, can be perceptually relevant.

Synthesis of voice quality is more challenging, given its complex acoustic nature and the limitations of synthesis software (Klatt & Klatt 1990). Nonetheless, Abramson and colleagues (Abramson et al. 2004, 2007) have successfully examined register distinctions in Suai and Khmu', respectively. In both cases, a reported register distinction appears, from the perception, to be in the process of being replaced by a tonal distinction. Remijsen (2013) used perceptual studies testing listeners' reactions to tonal alignment to provide evidence for contrast in falling contours in Dinka.

3.1.2. Speech production. Collecting data on speech articulation requires specialized equipment (Stone 2010, Podesva & Zsiga 2014). Several techniques have been developed, including static and dynamic palatography, airflow and electroglottagraphy (EGG), ultrasound, and electromagnetography (EMA). Static palatography was introduced by Rousselot (1897-1908), and Ladefoged & Maddieson (1996) included it in their phonetic fieldwork, publishing palatography data along with airflow and EGG studies in the UCLA Phonetics Lab's Working Papers in Phonetics volumes. Collecting static palatography data involves painting the tongue or palate with a charcoal mixture and pronouncing a sequence of low vowel-consonant-low vowel (such as /ata/), followed by taking a picture of the tongue (when the palate has been painted) or palate (when the tongue is painted) to see the contact patterns, which show up in the transfer of the charcoal mixture to the articulator. This process can help determine the articulatory patterns of coronal, palatal, velar, and lateral segments in which the tongue and palate come into contact with each other (obstruents, nasals and laterals, and segments that use tongue bracing). The highly elaborated set of places of articulation in Dahalo was elucidated via static palatography (Maddieson et al. 1993), allowing for a much clearer description of the stops in terms of degree of contact and portion of the tongue (apical versus laminal) involved.

Airflow measures have recently become more portable as well (Figure 3) (Ladefoged 2003, Demolin 2011). The spread of nasality, the airstream mechanism for stops and clicks, and the control of pressure for fricatives can all be quantified with these instruments.

Measures of laryngeal function can be facilitated with EGG (Flemming et al. 2008, Avelino 2010, DiCanio 2012b, Abramson 2013). Studies using EGG have found that quite subtle changes in the glottal cycle can signal word differences in languages that have voice quality distinctions in their vowel systems. The interplay between tone and voice quality distinctions is more readily studied with a system such as EGG that can inform us about both quality and F0 simultaneously. Languages do, in fact, rely on bundles of such features, making it hard to decide which is the distinctive aspect (Abramson 2013).

The instrumental investigation of click sounds has led to a variety of experimental phonetic studies on their production. For instance, the way in which they are controlled aerodynamically, and how this differs from the aerodynamics at play in the articulation of more commonly found segments, was studied via a combination of palatography and airflow measurements (Traill 1991, Maddieson et al. 1999). The nonpulmonic nature of the clicks was more obvious in these measurements. Using static palatography, the researchers found that the amount of variability in the placement of the closure for clicks was comparable to that of pulmonic stops (Sands et al. 2007). This finding indicates that, although clicks are rather demanding articulations, they are not overly demanding. More recently, ultrasound has been used to study clicks (Miller et al. 2007, 2009; Miller 2013). These results have further refined our understanding of the implosive mechanism, suggesting that "lingual" is a better descriptor than "velaric." Patterns of coarticulation are also more easily understood with the ultrasound images of the tongue.

Ultrasound has been used to study another unusual sound type, interdental approximants, in this case, in Kagayanen (Mielke et al. 2011). The researchers found that only an interdental constriction is made; there was no further tongue raising. Using coronal sections (i.e., those



Figure 3

Airflow equipment being set up at the Flathead Cultural Center on the Flathead Reservation, Montana, in 1993 by Peter Ladefoged and Joyce McDonough. Photograph reproduced courtesy of Joyce McDonough.

perpendicular to the sagittal plane), Mielke et al. also showed that the sounds are somewhat lateralized, as transcription had suggested. Such subtle differences might be easier to teach to language learners with ultrasound feedback.

The "field" is not always terribly far from the laboratory. In a recent study in Dutch high schools, students were tracked with EMA to look for articulatory differences between dialects (Wieling et al. 2014). The authors found clear evidence of a fronter tongue position for the more southerly dialect, despite the fact that there was no clearly audible distinction. Such consistent differences in production pose a challenge, given that the speakers themselves are probably unaware of the differences (see Labov et al. 1991). It may be that ancillary effects on neighboring segments help maintain this difference, but that may not necessarily be the case, and this remains to be examined.

A final example is one that uses acoustic and perceptual analysis, but it is based on an elicitation paradigm designed to cause a linguistic reorganization (Chitoran & Tiede 2013). Biomechanical and structural constraints were examined by having speakers say a sequence of syllables to a metronome that increased in rate. Georgian allows consonant clusters and elisions that French does not; the results showed that Georgian speakers were much more likely than the French speakers to elide vowels at the fast rates, consistent with language-specific rather than universal constraints.

3.2. Semantics, Pragmatics, Syntax, and the Lexicon

One of the most active areas of new experimental research in the field is in semantics and pragmatics. In general, work in these areas uses elicitation techniques and methodologies designed to elicit judgments about meaning in the language under study in sessions conducted in a metalanguage (such as English or Spanish). The groundwork for doing contemporary fieldwork on meaning within truth-conditional semantics in formal semantics and pragmatics frameworks was laid out in an key article on methodology by Matthewson (2004, p. 370):

Semantic fieldwork aims to establish facts about the meaning of utterances, and parts of utterances, in the language under investigation. These semantic facts are often subtle, are usually context-dependent, and are almost never accessible by direct native-speaker intuitions....

Matthewson and those following this methodology move away from more traditional textdependent investigations favored by earlier linguists in the American tradition (e.g., Boas 1911). The current methodology calls for materials and stimuli designed to elicit semantic and pragmatic knowledge from speakers that do not involve direct questioning about meaning, but instead invoke truth conditions and felicity via clues provided by speakers' judgments and translations (Matthewson 1996). The task of building the stimuli for semantic and pragmatic elicitation is nontrivial and generally takes place in several steps. Importantly for the fieldworker, this work requires sufficient knowledge of the linguistic structures of the language under study—its syntax, phonology, and morphology-to construct grammatical utterances in that language. The first step is the linguist's: He or she must build enough knowledge of the semantic properties of a phenomenon under investigation to prepare a preliminary translation task in the language under study for an elicitation session. This stage of the task is necessarily open-ended and preliminary but must be broad enough to invoke data that may provide new insights and to answer questions about feasibility of the research questions and methodology. Data from an early elicitation session are essential in developing specific hypotheses on the phenomenon. The next step involves the design of judgment and feasibility tasks using target sentences based on the preliminary data. AnderBois (2012), for example, investigated focus and uninformativity in Yucatec Maya in interrogative utterances meant to elicit value judgments that address questions about the semantics of wh-, alternative, and polar questions. Murray (forthcoming) investigated the use of evidential in discourse in Cheyenne.

On the basis of her fieldwork, Matthewson (2013) describes the system of Gitksan modals with respect to a theory of modal typology, dividing up modal space according to three classic parameters: strength, epistemic type, and time orientation. The data were collected using the methods described in her earlier paper (Matthewson 2004), namely storyboards and structured contextualized elicitations. She presents evidence that Gitksan is a mixed system, encoding for type and strength lexically, but with two epistemic modals belonging to two distinct syntactic categories, and she argues for this system's position within the typology of modals. Contrast these techniques used, for instance, in the Holton & Lovick (2008) paper on evidentiality in Dena'ina, in which the authors argue for the form and function of evidential enclitics. In this thorough study, and working with a native speaker, the authors retranscribed all the texts on Dena'ina in the Alaska Native Language Archive and used any pedagogical data available as well as Lovick's field notes. We bring up this example to underscore the permeability of the distinction we draw in this review. Although both are contributions to modal typology and require working within current theory, under our definition, only Matthewson's work is an example of taking the laboratory into the field. However, note that the developing methodologies, such as those used by Holton & Lovick (2008), are likely to be relevant to moribund and endangered language communities, as are typological studies, in that they incorporate existing materials on the language by reannotating them and bringing them into contemporary discussion through the follow-up analysis.

Some of the widest and most fully articulated fieldwork programs on language and cognition have been created by researchers associated with the MPI. Dedicated to collecting linguistically diverse data from field sites in understudied language communities worldwide, groups within the MPI focus on issues in a broad range of topics around language and culture that encompass traditional fields such as ethnography, linguistic and cultural typology, and language documentation practices, but they have also introduced corpus linguistics and behavioral and experimental psychology, as well as new areas such as ethnosemantics and pragmatics. These areas are broadly construed as language sciences; the field research focus is concerned with the effects of the interplay between linguistic structures, culture, and cognition. To this end, the MPI has developed a series of field manuals and stimuli for the standardization of field data collection and methodology (e.g., Enfield et al. 2011).

A rich area of research that has emerged from the MPI's Language and Cognition Group investigates the constraints on the cross-linguistic representation of cognitive categories, called semantic typology (Levinson 2008, O'Meara & Bohnemeyer 2008). Early examples include Berlin & Kay's (1969) study of basic color terms and Lounsbury's (1956) study of kinship terminology. In the Nijmegen types of studies, participants may be shown pictures (Hamilton et al. 2013) or asked to identify features of a landscape, sort objects into groups, or name colors or numerals. Stimuli are prepared ahead of time to answer questions about the semantic representation of concepts, as in a study of the verbs *put* and *take* in Yélî Dnye (Papuan) (Levinson & Brown 2012), a study of the classification of ideophones (Dingemanse 2011, 2012), and studies on spatial relations (places and directions) in Tseltal (Li et al. 2011) and in Dutch and Namibian (Haun et al. 2011). These studies investigate the relationship between cognitive and linguistic constraints on representations in semantic domains (Haun et al. 2006).

Research using eye tracking has shown that sentence formation in Tagalog reveals a very early effect of grammar on lexical selection (Sauppe et al. 2013). If a noun was marked with a morpheme

as a "privileged syntactic argument," it was fixated on more frequently than if it was not marked that way. Because the verb comes first in Tagalog sentences, this finding indicates that the entirety of the sentence was being taken into account from the beginning, which would not be necessary in languages with other structures.

More common in the field are lexical naming studies. These are elicitation studies in which systematic materials are prepared and shown to speakers to test groupings that fall under areas such as ethnosemantics and ethnophysiography, which investigate cross-linguistic categories of semantics and of landscape classification, respectively (Levinson 2008, O'Meara & Bohnemeyer 2008).

Such studies are not set up to test specific hypotheses. However, they conflate two steps in the process of building hypothesis testing: First, they are crucial to the understanding of the structures of a language under study, a necessary preliminary stage, and second, the annotated data can provide textual analysis of morphological and lexical properties to investigate lexical and morphological structures. For instance, Borchardt-Grimm's work on number systems on Ikaan in Africa on a DoBeS project has served as a basis for a morphosyntactic analysis (Borchardt 2011). Holton (2011), in his study of landscape terminology in Western Pantar (Papuan), points out that these geomorphological studies reflect the unique "discretization" of landscape, not merely as lexical specialization (i.e., lots of names for important aspects of landscape), but as closely tied to the individual cultural classification systems at work in the area.

3.3. Morphological Processing

Experimental work on morphological knowledge is somewhat rare. In one study on Spanish and Russian versus Inuttitut, Sherkina-Lieber and colleagues (Sherkina-Lieber 2011, Sherkina-Lieber et al. 2011) used a forced-choice algorithm to determine the acquisition and comprehension of aspectual morphemes in bilingual speakers versus heritage speakers (those learning their ancestral language as a second language). The study found that semantic complexity has an effect on language learning and change: Listeners interpreted the meaning of lower-complexity aspectual morphemes with more accuracy than they did higher-complexity morphemes. For instance, when aspect is bundled with tense, higher-complexity aspectual morphemes are more vulnerable to attrition and reconstruction than are lower-complexity morphemes. In a preliminary study on Navajo verbal morpheme ordering, McDonough & Willie (2000), also using a forced-choice paradigm, gave fluent speakers and second-language speakers two forms and asked them to identify the more correct one. The "incorrect" forms were designed to reflect five distinct types of ordering mismatches in the verb, identified by Willie as systematic errors made by less fluent speakers. The study found that fluent speakers and second-language speakers tolerated different types of ordering and agreement mismatches. Fluent speakers were tolerant of morpheme misorderings and positional reversals if they occurred peripherally, at the left edge of the word, but were sensitive to highly complex morphemes of the core verb at the right edge of the word, which carry rich morphosyntactic specification. Less fluent speakers made mistakes in all five areas.

4. ETHICAL ISSUES

The ethical issues of obtaining documentation from community members (Dwyer 2006) are present in experimental situations but are increased by the differences between the demands of the experiments and the expectations of the participants. Foremost is the approval of ethics boards with appropriate oversight, usually institutional review boards at universities, but approval from

the communities is also essential (Bird 2011). Many communities are reluctant to work with linguists because of unequal relationships with previous researchers; it can take some (or a great deal of) negotiating to overcome such past impediments.

Experiments typically require repetition of identical or nearly identical stimuli to overcome the natural variability in judgments or production. In word list recitations, for instance, speakers may refuse to say a word more than once or may react strongly to the repetition or the structure of an experiment, being much less tolerant than undergraduates to the needs of the experimenter. Perception experiments in the field can be construed as a community, rather than an individual, event. Sometimes participants may stop when they are bored or annoyed by the seemingly meaningless content of an experiment. Seasoned fieldworkers develop sensitivity to a community's willingness to tolerate the linguist's tasks. There is also the issue of how the linguist interacts culturally. Situations with a community may exist in which speakers give a linguist high status as a visitor or as a westerner (that is, someone from a privileged economic and social status in the global economy) and therefore provide information that the speakers think the linguist wants to hear.

Questions also arise regarding the interactions and role of western linguists, especially in small language communities, where the needs of the community are quite different from those of the linguist. Western linguists often occupy a position of considerable power; they travel freely, they have equipment and funds, and they can leave. It is for this reason that affiliations with local academic institutions can be beneficial—they provide a bridge between a language community and institutional resources.

Another issue arises with community approval: the size of the community. If a community is large, no one person can speak for the language or the community. If a community is small and coextensive with the language, there are more likely to be individual representatives of the local community or local authorities in the village whom researchers must address. The difficulty of extrapolating from a small number of speakers, of course, is a scientific corollary of this ethical issue (Bird 2011).

4.1. The Field in the Laboratory

This review focuses on doing experimental work with communities, either where the speakers live or nearby, but certainly outside the typical domain of the laboratory. It is also worth examining the symmetrical situation of bringing the field into the laboratory. If the participants in an experiment can be brought into a laboratory exclusively for the experiment, then the range of techniques expands (e.g., Stone 2010), but some of the other issues remain.

The ethical issues of dealing with community members (see the previous section) are heightened by the difficulties that are typically involved in bringing participants to the laboratory. Travel may be unfamiliar, and the experimental situation is sure to be novel. A difficult challenge for the researcher is allowing the participants to change their minds without penalty. This is an essential component of the ethical treatment of participants, but it can be especially difficult to abide by when great expense and planning have gone into a trip. The reward for participation cannot be allowed to become too large, either, or the payment can become coercive. These issues arise in the field as well, of course, but the rigidity with which on-campus standards are often enforced may make the situation more difficult than might be expected when dealing with community-based or even diaspora speakers.

Bringing the field into the laboratory, of course, opens up an array of techniques that would otherwise be unavailable. For example, Proctor et al. (2010) have been able to better understand the four-way coronal stop distinction in Wubuy via electromagnetic articulometry, available only in a university laboratory. Our own work with Navajo, although it used ultrasound, took

advantage of a speaker's availability in Connecticut (Iskarous et al. 2012). The measurement of muscles with electromyography (EMG) requires a fixed, somewhat clinical setting (e.g., Bell-Berti & Harris 1981), although some recent work on speech processing has employed promising (and portable) surface EMG (e.g., Schultz & Wand 2010). The exciting possibilities of real-time MRI (e.g., Narayanan et al. 2004) will not be portable in the foreseeable future. A fuller description of these techniques is beyond the scope of this article, but we note that they allow the study of features that are impractical to assess in the field.

Often, the issue is simply one of finding enough native speakers who the researcher can afford to access, rather than any more profound issue. Thus, the speaking task used by Crowhurst & Trechter (2014) could have been done in the field, but the expense of getting there was not justified, given that a large diaspora community was available.

The various brain-imaging methods mentioned above (Section 2.1) offer some of the greatest rewards for bringing the field into the laboratory, but in addition to the considerations already raised, they impose a large burden on stimulus and experiment design. Most of the world's languages do not have a written form in wide use, so the means of presenting stimuli generally must be acoustic. Participants from remote areas are unlikely to be inured to the tedium of making meaningless decisions about isolated words for hours on end. As valuable as it is to learn how cognition differs with extreme differences in language structure, such experiments need to be adapted to the needs of participants and the specifics of the language influences cognition, the experiments are going to be difficult, given that they depend on a sophisticated understanding of the target language. The languages under study in the field are essentially never well known to scientists, so greater collaboration with native speakers seems necessary in order for us to take this last chance of studying these issues.

4.2. Archiving

Because experimental work outside the lab is closely aligned with language documentation, we briefly mention archival practices. Access to the data collected in the field has become an important issue in community work, especially in endangered language communities. Although language and sound archives have existed for more than 100 years, the emphasis of the new archives is on online access, which often addresses the ability of small communities to both access and limit access to their own data via access protocols. We list some of these archives in Related Resources, below.

In general, these archives are geared toward acoustic (and possibly video) recordings of texts. Very few experimental results are included or even envisioned. We hope that future archives, and changes to existing archives, will allow for easier inclusion of the types of results surveyed here so that the usefulness of the archives can increase and our understanding of these languages can be as full as possible.

5. CONCLUSIONS

Language documentation, as well as its methodologies, its adaptation of laboratory techniques for use in the field, and its involvement in issues in linguistic theory and cognitive science, is a vital and increasingly important aspect of contemporary linguistics and cognitive science. The technology and methodologies for investigating language in the field continue to develop. The need for documentation is uncontestable, as languages are an oddly human part of the "Sixth Extinction" (Kolbert 2014). The assumptions we make about what can and cannot be part of language or expressed by language are constantly confounded by new discoveries in underresourced languages. Even our understanding of what counts as variability versus language differences is under revision. The discoveries from experimental methods not only inform us about the newly described languages but also modify our thinking about previously described languages. Taking the laboratory into the field is an essential part of the effort to understand our most human trait, language.

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RELATED RESOURCES

- Archive of the Indigenous Languages of Latin America (AILLA), University of Texas, Austin. http://www.ailla. utexas.org
- Atles interactiu de l'entonació del català, Universitat Pompeu Fabra, Barcelona, Spain. http://prosodia.upf.edu/atlesentonacio/

California Language Archive, University of California, Berkeley. http://cla.berkeley.edu

- DoBeS Programme, Hannover, Germany. http://www.volkswagenstiftung.de/en/funding/completed-initiatives/ documentation-of-endangered-languages.html
- Endangered Languages Archive (ELAR), School of Oriental and African Studies, United Kingdom. http:// www.hrelp.org/archive/

Langues et civilisations à tradition orale (LACITO), CNRS, France. http://lacito.vjf.cnrs.fr/archivage/

- Max Planck Institute of Psycholinguistics, Nijmegen, Netherlands. http://www.mpi.nl/departments/languageand-cognition/linguistic-diversity-and-processing
- Native American Languages at the Sam Noble Oklahoma Museum of Natural History, University of Oklahoma. http://www.snomnh.ou.edu/collections-research/nal.htm
- Working Papers in Phonetics, Department of Linguistics, UCLA. http://www.linguistics.ucla.edu/faciliti/ workpapph/wpp.htm