8 Research Methods for Studying the Form of Signs

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Chapter Overview

This chapter discusses methodological considerations related to researching the form of a sign – research that can be subsumed to the phonology, phonetics, prosody and iconicity of sign languages. The research process, possible methods, and potential problems are considered in a step-by-step manner, which proceeds from finding a research question to collecting the data, finding signers, determining the equipment needed, and storing, annotating, and analyzing the data.

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Research Question

Sometimes the researcher begins from a research program or a directing theory; other times the researcher begins from nothing more than an observation of something unexpected. In either case, when the phonology, phonetics, iconicity, and prosody of sign languages are at stake, theories and questions are usually related to – or make use of – the notions, definitions, and tools presented below. The examples are from American Sign Language (ASL), unless otherwise specified.

Phonetics

Roughly speaking, the study of linguistic forms branches out into a physical part (phonetics) and a mental part (prosody and phonology). In-between lies iconicity, with characteristics of both.

Phonetics is responsible for the physical aspects of signs, and its primary task is to consider the non-contrastive constraints on phonology – those elements that are not part of the mental representation, but are a necessary part of the physical instantiation of a sign. These constraints are primarily articulatory (extending the ring finger alone is difficult) or perceptual (handshape details are harder to see than gross locations). However, some cognitive constraints would also appear to be phonetic. The obvious example is that different simultaneous movements on each hand are nearly impossible, yet such a constraint cannot be specifically linguistic or phonological, since it obviously applies to many non-linguistic events as well. Phonetics aims to discover these constraints and, in a sense, clear away everything that can be explained, until what is left is what must be included in the phonological/prosodic representations.

The sign FATHER (thumb of the spread hand taps the forehead a few times) shows how phonetic characteristics must be understood to represent a sign correctly. The location of the hand (at the forehead), the shape of the hand (spread, open), and the contact point (tip of thumb) need to be mentally represented in some manner. If phonetics were not considered, it would seem that the orientation of the hand must also be represented. But phonetics shows that there is no reason to include the orientation. Physically, certain orientations are either impossible or extremely awkward. All other orientations are acceptable: the hand may be oriented straight up and down, or the palm may face more or less downward (note that this is not evidence that the orientation of the hand is phonetically determined in every sign).

Iconicity

Iconicity, like phonetics, is rooted in the physical. But, whereas phonetics is concerned with the physical and cognitive characteristics of the signer and of the viewer, iconicity is connected with the physical reality of the world and with human culture. The mind renders iconically some aspect of reality: the shape of a tree, the type of dance performed in some cultures, the outward motion from the self that occurs in giving someone something, the fact that objects, when dropped, fall downward, the cultural belief that heaven is above us, the shape of written letters, and so on. Just as

what is phonetic need not be included in a mental representation, it seems likely that what is iconic may not need to be included in a specific representation. Unlike with phonetics, though, with iconicity it has to be the case that there is some mental representation of its content. Without the mental concept that heaven is above, or that, in the act of "giving," something passes from me to you, or that the letter "p" has a specific shape in written language, it would not be possible to use these concepts in the physical sign. Moreover, there are usually multiple ways to represent an object iconically, and there are different choices for different languages.

Additional issues raised by iconicity are:

- Iconic imitation allows substantive and geometric transformations (scaling, skewing, rotating), additions, and deletions. What are the limits?
- Iconicity appears to be optional and unpredictable. In some languages *dog* is iconic, in others arbitrary. Some verbs move in iconically predictable directions, but occurrence is unpredictable: de Beuzeville, Johnston, and Schembri (2009) show that, in two narrative types in Auslan, the occurrence of iconic verb motion is about a half of what is expected. Are there rules governing these processes?
- Why does some iconicity fade away over time, while some remains robust?
- How are grammatical categories related to iconicity?
- Is contrastiveness applicable? Iconicity can produce unsystematic outliers that do not participate in feature contrasts (van der Kooij, 2002).

Prosody

Prosody has two major functions: to group elements and to provide information about intentions and emotional states. Language is a near-continuous stream and prosody is vital to parsing it, to determining the beginnings and ends of signs, phrases, sentences, and larger units. Its second function is to indicate emotions and intentions (statements, questions, or emphasis). In sign languages, prosody is primarily expressed non-manually, by using gestures that typically spread over more than one sign, such as eye gaze direction; widening, narrowing or blinking the eyes; eyebrow raising and lowering; spreading, opening, closing, or pursing the lips; tongue protrusion; and body gestures such as head nods, shoulder shrugs, and turns or leans of body or head. Many non-manual gestures are relatively easy to maintain over periods of manual signing, and therefore they work well for the prosodic goal of pointing out boundaries.

There are a few exceptions to this neat separation of manual and non-manual gestures. Prosody may also be shown manually in the speed or tension of the hands, or in the size of the motion. Contrarily, some non-manual gestures related to a specific sign or to a spoken word are more properly considered part of the phonology. Examples are: (1) mouthing "actress" while signing ACT; (2) opening the mouth while signing OPEN-DOOR or OPEN-WINDOW; and (3) in some versions of the sign COMPARE, holding the hands up on either side of the head while the eyes move back and forth between them (comparing the hands). In these cases, the non-manual gesture adds to the phonologically carried denotational meaning, not to the prosodic intentional meaning. (For a more detailed discussions of sign language prosody than can be given here, see Brentari and Crossley, 2002; Sandler, 2010.)

Phonology

Phonology asks what characteristics must be remembered for a sign to be recognized or produced with all its phonetic variability. The phonological representation of signs is divided into features, hierarchy, and temporal order. In each case, the crucial issue is whether an element is contrastive.

Features

The existence of many current phonological models means that there is no agreed upon feature set, but most models include handshape, location, action, orientation, and global features such as number of hands and type of repetition. Models vary in the level of detail. Stokoe, Casterline, and Croneberg (1965) used broad locations (head, trunk, etc.); other models specify contralateral/ipsilateral, top/bottom, multiple places on the weak hand, and so on. Brentari's (1998) 48-feature system is reasonably representative; Uyechi (1996) and Hansen (2011) are more unusual.

In spite of the variety of models, phonologists agree that, for something to be considered a feature, it must be contrastive within the system. For example, in most models, FATHER and MOTHER (spread hand contacts location with thumb) show that forehead and chin are contrastive locations. Nevertheless, because contrastiveness only operates within a model, it is possible for contrast to occur in one model but not in another. For example, most systems consider repetition to be a feature; but it is not a feature in Liddell and Johnson (1989), and hence it is not contrastive for them.

Hierarchy

Hierarchical structure shows feature dependencies. There are three possible cases:

> Dependency If element *y* always occurs only when element *x* occurs but element *x* can occur without element *y*, then *y* depends on *x*. A hypothetical example: if the pinky extends, then the thumb always extends; but the converse is not true; so, if the thumb extends, sometimes the pinky does not extend. In this case, pinky extension depends on thumb extension. This would be a phonological structure constraint, since physically the pinky can extend without the thumb. Mak and Tang (2011) provide a non-hypothetical but more complex example: they argue that the features [repeat] and [return] depend on a movement feature node.
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> Non-dependency, single feature If element *y* always occurs only when element *x* occurs and element *x* always occurs only when element *y* occurs, then *y* and *x* are the same feature. Example: the relationship of the two smaller (distal) knuckles. Most people cannot flex one of these without the other. Either knuckle predicts the other, so a single feature [distal flexing] controls both.
>
> Non-dependency, two features If element *y* sometimes occurs when element *x* occurs and element *x* sometimes occurs when element *y* occurs, then

y and *x* are manifestations of two different and independent features. An example would be the extension of the index and thumb. Sometimes both the index and the thumb are extended, sometimes only the index is, and sometimes only the thumb is. Index and thumb extensions are independent.

Hierarchical structure may be more limited than in spoken languages. What appears to be structure may sometimes be phonetic constraints (Channon, 2004). Much remains to be understood in this area.

Temporal sequence

The notion of temporal order contrast and non-contrast is perhaps most easily understood with syntactic examples: (1) contrast: *Mary sees Jo* contrasts with *Jo sees Mary* because the meaning changes; (2) two kinds of non-contrastiveness: (2a) *Jo and Mary* is not-contrastive with *Mary and Jo* because the meaning does not change; and (2b) *the house* does not contrast with *house the* because only the first sequence is acceptable. Temporal order within a sign may be contrastive or non-contrastive. Examples of contrast and non-contrast are:

1 Contrast: IMPROVE and GET WORSE (the flat hand moves up the arm for IMPROVE and down the arm for GET WORSE).
2 Non-contrast:
   a DEAF can be signed by touching first the ear then the mouth or first the mouth then the ear. The order does not change the meaning;
   b WOMAN first touches the chin and then the chest with the thumb of the flat spread hand. Reversing the order is not acceptable and produces a non-sign.

Channon Crain (1996), Channon (2002a, 2002b), and Channon and van der Hulst (2011) have argued that, although sequences do occur within the sign/segment, they are non-contrastive. Either the meaning does not change because only one sequence is acceptable, or, if the meaning changes with an apparent feature permutation, the variation is not actually caused by feature permutation, but rather by a dynamic feature action (such as closing/opening, pronating/supinating, etc.). However, this viewpoint is controversial, and temporal sequence contrast remains an important question for both spoken language and sign language researchers. For example, some syllable onset sequences are not contrastive in English (*bl* and *str* are allowed, but not *lb* and *trs*). Feature sequence within a segment is not contrastive in spoken languages because even phonemes that appear to be ordered, such as affricates, actually have a fixed and therefore non-contrastive order (Lombardi, 1990).

Refining and clarifying the question

For most research projects, the researcher defines some relatively narrow question that can be answered at least tentatively. One might examine a particular articulatory constraint, or a repetition feature, or the prosodic use of eyebrows. As the project continues, the question may change somewhat, perhaps broadening or swerving aside

to some related question, but most likely narrowing to focus even more tightly on some part of the original question. Pilot studies are often useful as part of this process, to determine whether a particular research strategy is likely to be successful.

The researcher will often be working within the framework of some model. The primary test of a model is whether it over- or undergenerates. A desirable model does not undergenerate: it accounts for all observed signs, as well as for potential signs that signers agree are grammatical (accidental gaps). Nor does it overgenerate: it does not permit non-occurring signs that signers agree are impossible and ungrammatical (systematic gaps).

A hypothetical example of undergeneration would be a model that could only represent straight-line motion. If there were only a few signs with circular motion and many sign languages had only straight-line motion, then it might be possible to explain the apparent exceptions through some special stipulations, because one or a few counterexamples are not usually a sufficient counterargument. What is more important is a systematic inability to represent significant elements. In this example, because circular motion is both pervasive and contrastive, such a model would fail to represent reality.

Overgeneration can occur for either signs or representations. For example, a model that allows an unlimited number of location segments within a sign is overgenerating, because it predicts that simple signs with many locations should occur – for example a sign with locations at the forehead, ear, trunk, and hand. Yet sign languages appear to systematically avoid signs with three or more different and distinct locations (Channon, 2002a).

A model that requires that observed physical sequence must always be phonologically represented is overgenerating representations. As noted above, there are signs such as DEAF that can be performed in different sequences without change in the meaning of the sign. If the model requires that this phonetic sequence be represented, the model overgenerates and produces two representation for one sign.

Special rules or constraints can repair overgeneration. But, all other things being equal, a model with fewer added constraints is preferable, especially if the constraint has no clear natural explanation. A natural constraint usually appeals to physical necessity, efficiency, or comfort. Two examples of natural constraints are: (1) signs rarely have locations on the back of the body because the viewer needs to see the sign; and (2) repetition in a sign is usually instantiated as a single repetition, because this is more efficient. Examples of unnatural constraints would be: (1) the index finger must be extended in all signs; and (2) signs have only straight-line motion. These would be arbitrary limitations, with no basis in phonetic reality.

Data and Data Collection

When the researcher has a question and perhaps a model, it is time to collect data, which can be elicited or natural, isolated or connected forms.

Elicitation is more appropriate for type-based questions, such as how many signs in the language are made with a flat hand. Token counts (such as how many times a particular sign occurs) are normally not meaningful, because they would not generalize

to natural situations. Preparing prompts is more labor-intensive, but transcribing and analyzing the data is less labor-intensive. The researcher has more control over the output, so systematic sets of responses are possible. Additional information (including material and software) for elicitation can be found on the SIL web site (http://www.sil.org).

Natural data can range from completely natural data outside the researcher's control to semi-natural ones, where the researcher sets up the situation but does not try to control the output. Data of this type are more appropriate for token-based questions, such as what is the most common handshape in conversation. They are usually required when linking phonology/phonetics to syntactic, semantic, sociolinguistic, or discourse information. The type provides frequency data for sign languages, as in Morford and McFarlane (2003) for ASL and Johnston (2012) for Auslan. Naturally, there are gradations between natural and elicited, which are marked by more or less control over the signer's output. An example of intermediate control would be providing a map and asking the signer to describe a path on the map.

Citation forms are what a friendly, relatively equal-status stranger should get when asking a signer *how do you sign X*, or when providing a picture or videoclip and asking the signer to name the prompt. No special phonetic processes have been applied. However, signers' attitudes toward spoken and sign languages and toward the elicitor can create unpredictable *hypercorrections*. Signers might believe that forms influenced by a spoken language should be preferred or avoided. For example, signer A may give an initialized form of LUNCH (fingerspelled L at mouth), while signer B may give a compound (FOOD + NOON). Yet, if the same signers were observed in everyday conversation, signer A might use the compound, and signer B the initialized form.

A related problem is changing citation forms. The citation form for older signers might be a compound form for WOMAN (thumb of the fist–hand strokes side of cheek, then extended spread hand repeatedly contacts center chest). Younger signers may have a simpler citation form (thumb of extended spread hand contacts chin, then chest). Nevertheless, younger signers might still give the compound form if they have seen older, respected signers use it and they equate "citation" with formality and respect. These problems can be reduced (though probably not eliminated) through a non-threatening elicitation process that causes no serious power imbalance between elicitor and elicitee.

Prototypical connected forms occur in group conversations among familiar, fluent signers or when one is using picture book elicitation. Forms will vary both between and within signers. They are labor-intensive to annotate, because they must be identified within a sign stream. Finding enough examples for analysis can be difficult. A variant of connected discourse is the use of carrier phrases – fixed phrases or sentences with sign(s) of interest inserted in order for us to observe the effect of preceding or following material (see Grosvald and Corina, 2012; Emmorey, Gertsberg, Korpics, and Wright, 2009).

Citation and conversational forms are both important. Citation forms provide the benchmark to measure conversational forms against. Conversational forms provide information about the phonetic processes of the language, often replacing more marked with less marked features. For example, in Tyrone and Mauk's (2010) study, the citation form of WONDER occurs on the forehead, but often moves lower in faster signing. Both forms are needed if we want to discover these processes and constraints.

Exceptional data

In any corpus, there will be outliers that the researcher must decide how to handle. The most common types of sign outliers are non-core items (Brentari and Padden, 2001): (a) signs influenced by the spoken or written form of the language of the surrounding community; (b) compounds; and (c) iconic signs.

Spoken language influence adds complexity, as in word mouthing versus mouth gestures. Mouthing for multisyllabic words can include sequences of different mouth movements, which follow the mouth movements of the spoken language gloss (for further discussion of the relationship between mouthing and manual gestures, see Vinson, Thompson, Skinner, Fox, and Vigliocco, 2010). Mouth gestures, in contrast, are usually one (repeated) gesture, such as the mouth opening.

Signs can represent spoken language function words, such as forms of *to be*, articles, prepositions, and affixes. The most obvious effect of using function words is an increase in the number of signs per sentence. Therefore each sentence will probably take longer than usual overall, or each sign will be pronounced more rapidly than usual. In either case, there is likely to be some change in the prosody. The frequency of morphological groups of signs will probably be affected. For example, the use of articles is likely to decrease the use of pointing signs. Written language influence is most commonly seen in initialized signs, fingerspelling, and character signs. Such signs can demonstrate complex iconic handshapes and rare handshapes, as in Turkish fingerspelling (Kubus and Hohenberger, 2011), or Asian character signs (Fischer and Gong, 2011).

Handshape sequences may not follow Corina's (1993) constraint that handshape sequences are one handshape combined with a dynamic feature for opening or closing (see also Lee, 2008). An example of this violation is BACKGROUND: four extended fingers (B) followed by the index extended (G). Two-handed non-contacting signs may have different handshapes, as in TOTAL COMMUNICATION, which is realized with one hand curved (C) and the other in a fist, with thumb protruding between index and middle (T). Contacts may be unusual or difficult: in PERFECT two moving index fingers contact each other, in VERY the fingertips of the spread index and middle contact. More than two places may occur, as in OVERALLS (O at shoulders, then A at high chest, then L at low chest on both hands). This sign also shows that multiple handshapes may co-occur with multiple locations (or with other multiplied characteristic), whereas the core lexicon limits change to a maximum of two simultaneous changes (such as the hand opening while moving forward).

Compounds join two simple signs (rarely three or more), so sequencing markedness increases. Simple signs allow combinations of features, but feature sequences cannot be longer than two (two places, two handshapes, etc.), and the domain of repetition must be the entire sign (Channon, 2002a, 2002b). In contrast, compounds can have a sequenced repetition of two types, such as repeated handshape change followed by repeated location change. They can have more than two distinct locations or handshapes, and so on.

Iconicity (other than that influenced by speech or writing) increases the number of marked but non-complex features (kidney location, contact at bottom of ring finger, etc.). Normally the number of repetitions is non-contrastive (Channon, 2002a), but iconicity allows contrastive repetition (demonstrating two versus four knocks on the door). Signs may be unusually long, and their beginning and ending points unclear. Both signers and viewers are more likely to gaze at the hands (Emmorey, Thompson, and Colvin, 2009).

Handshapes, though not complex, may vary from canonical handshapes. Space is used more systematically, as a three-dimensional map of entities in space (Liddell, 1996).

Exceptional data can be difficult to separate out, if (and when) this is necessary for the research goal. Compounds, for example, may start out as exceptional data, but over time they change sufficiently to become a part of the core lexicon (like DEAF, HOME, WOMAN, and many others), although they do often retain a somewhat unusual double location. Many initialized signs are well-behaved members of the core lexicon (like the days of the week or the names of colors in ASL). Determining what signs are exceptions and can reasonably be excluded from the data is, unfortunately, a judgment call and reasonable people may take different views. One solution is to find another person's data, when these have already been annotated for exception status. Another is to use a neutral referee to judge exceptionality. Alternatively signs can be excluded that meet certain criteria, for instance all the signs that last longer than a certain number of seconds, all the signs with two handshapes and two locations, or all the signs identified in the literature as initialized signs.

Signers

Signer characteristics can affect sign language production and/or perception in many overlapping and complex ways. Obvious characteristics to be considered include the signer's age, sex, and auditory and visual status. Other factors may also be important – for example:

- the signer's language models: auditory status, signers, sign language learners;
- language type: sign language of the deaf,[1] hearing group sign, manually coded sign, cued speech, tactile signing, oral (lip-reading), fingerspelling, gesture system, or spoken;

  Examples of hearing signing are Australian Aboriginal Sign Language (Kendon, 1990), and monastic signing (Umiker-Sebeok and Sebeok, 1987);

- modality:

  Is the signer using both speech and sign (bimodal communication)?

- number of languages known by the signer;
- length of use:

  How long has the signer used the language?

- nativeness:

  The clearest case of native language acquisition is a language acquired from birth. Languages acquired later are less fully native, with a severe decline in competence around puberty, after which few if any individuals acquire native competence (Lenneberg, 1967; Mayberry and Fischer, 1989). The age associated with this decline in competence may vary between speech and sign. Given normal linguistic capabilities, it is rare for a hearing child – but not uncommon for a deaf child born to non-signing hearing parents with subsequent delay in being provided with an accessible language model – to have no native competence from birth in any language;

- associations:

  Signer associations often indicate how much the language is used on a daily basis. A special and interesting case where association is significant is village signing, where an increased percentage of deafness in the population is associated with the development of a sign language used by both deaf and hearing community members;

- cognitive or physical characteristics: any conditions that might affect linguistic development, articulation or perception, such as cerebral palsy.

Number of signers

A final issue is how many signers are needed for the project. Here several questions are important: Is the goal of the project to obtain some representation of the diversity of signers within a particular language? Is the goal to look at cross-linguistic diversity? Is the goal to obtain something that is representative of the community as a whole?

It should be remembered that everyone has a slightly different lexicon, phonology, phonetics, prosody, and so on. This means that, if we collect 1,000 signs in a language, each from a different individual, we are actually collecting from 1,000 slightly different linguistic systems. Depending on the researcher's goals, this may or may not be desirable.

Equipment: Prompts and Cameras

There are several types of equipment to consider: elicitation material or prompts, video cameras, and specialized equipment.

Setting up elicitation material can be a time-consuming process. If there are multiple languages, it can be helpful to be able to reuse material, as is done in the SignTyp2 project. However, using the same material for different languages poses its own problems, since cultures will vary in how they understand the prompt or in whether they will understand it at all. What one culture finds acceptable, another finds offensive. A picture of an American supermarket as an example of "shop/store" may not be appropriate for signers on other continents. At the completion of the SignTyp2 project in 2015, elicitation material will be available for 1,000 concepts, usable cross-linguistically by any interested researcher at SignTyp.uconn.edu.

The second common piece of equipment is one or more video cameras. Setups will range from the simple webcam to complex, expensive multi-camera setups, to capture multiple views of one or more signers. Budget and desired level of detail will dictate the choice. Researchers investigating phonetic or prosodic issues are more likely to need greater detail in the recordings and more elaborate setups, including frequent slow-motion replay. Specialized software will be required for synchronizing multiple cameras or for annotating overlap, synchronization, or disjunction of the sign stream. Bank, Crasborn, and van Hout (2011) use ELAN to annotate overlap variations between manual and mouth gestures in Sign Language of the Netherlands.

Particularly for research in phonetics and prosody, specialized equipment may be needed. Data gloves and other motion capture devices can measure a signer's actions in great detail. Eccarius, Bour, and Scheidt (2012) provide some calibration procedures and techniques for using data gloves to study signing. Special measuring callipers or software can be useful – as in Weast (2011), who used software callipers to measure the degree of eyebrow raising. Cheek (2001) used Vicon, a motion capture system to study handshape variation, and Mauk (2003) used it to look at how fast signing caused signers to undershoot (fail to reach) their target locations. Emmorey et al. (2009) used an Optotrak Certus system for their study of the effect of changing visual feedback for signers. Tyrone and Mauk's (2010) study of WONDER used the Optotrak Certus and Optotrak 3010 systems to capture signers' movement. Grosvald and Corina (2012) used the software package Presentation from Neurobehavioral Systems to display elicitation material and to record participants' responses. These examples are by no means exhaustive.

Although machine production and machine recognition of signs are still at the pilot project stage, they are likely to become useful in the future, for example if one uses sign recognition systems to assist in transcription. At present, however, no consumer system is available. In the absence of large corpora of sign languages, such problems as distinguishing where a sign begins and where it ends or recognizing a large vocabulary of signs are difficult to achieve; and this is only the first step in the far more complex process of recognizing discourse.

Sign production, like speech production, is a simpler task than recognition, and there are some systems approaching the goal of a marketable product; they use software such as Vcom3d, Poser, and Autodesk Maya. Parton (2006) and Lu (2011) provide surveys of the field. Wolfe, Cook, McDonald, and Schnepp (2011) provide a discussion of issues involved in the computer animation of signs and discuss how linguistic models can improve machine production.

Annotation: Transcription and Coding

Once video recordings or other materials have been collected or created, the information must be annotated in order to be organized in a corpus. A corpus has several essential characteristics: it is searchable, it is annotated, and it has a description of how/why/what: how and why it was collected and what is contained within it.

There are many hard-copy sign language dictionaries with pictures and descriptions of how the signs are made. These are annotated, but only in the most primitive sense can they be called searchable (there is usually an index listing the signs by glosses from a spoken language). They usually do include some description of how/why/what. These problems are more obvious for graphic collections of sign languages than for machine-readable text collections of spoken languages, which inherently have at least minimal annotation, are searchable, and usually include how/why/what.

Annotation can be divided into transcription and coding, which are distinct activities, as discussed in van der Hulst and Channon (2010) and summarized here. Transcription is the first step and coding is a second (automatic) step via a conversion

table. In transcription quick and easy production is most important, while in coding the researcher's quick and easy understanding of the coding system is most important.

Transcription

The three most important characteristics of transcription systems are bundling, memorability, and physical efficiency. Bundling means that, whatever details are included in the data collection process, they should be incorporated into as few symbols as possible. A common example is the bundling of handshape variables. In Stokoe's system, F is a bundled symbol that represents a handshape with the middle, ring, and pinky spread and extended (all knuckles straight), with the knuckles of the index finger flexed, and with the tip of the thumb contacting the tip of the index finger.

Memorable systems can be created by using either systematic or iconic relationships between symbols. Imagine a transcription system using a numeric keypad for entering letters. Letters randomly assigned to numbers (as in B = 2, C = 24, D = 14, and A = 17) would be non-memorable, while A = 1, B = 2 and so on are systematically memorable. Although each equation is arbitrary, the set of equations is related, and knowing one equation means that others are predictable. Under certain conditions, memorability conflicts with physical efficiency. When this happens, efficiency is often more important for transcription. In the example of the keypad, it might be worthwhile to assign single-digit codes to the ten most commonly used letters and two-digit codes to the rest, in sequence, even though this would partially destroy memorability. If the amount transcribed is small, memorability is more important, while for large amounts efficiency becomes more important.

Another way to make symbols memorable is to use iconicity, as is done in SignWriting and, to a lesser extent, in HamNoSys. Iconic memorability seems especially appropriate for sign languages, because iconicity itself is naturally memorable as well as systematic, and therefore memorable in that way as well. Iconicity does have the drawback of making the transcription system less ergonomic and less computer-friendly, but a well-designed system with appropriate software should reduce these problems to manageable levels.

Ergonomics or physical efficiency depends on the input device. For example, on an ordinary keyboard, assigning the most common symbols to the keys struck by the index or middle fingers is more efficient because these fingers are the strongest. Using the space bar or the enter key as symbols could be efficient, since these are large keys and easier to strike correctly. If one is using a mouse and screen, clickable symbols should be placed fairly close together, to reduce mouse travel time. The keyboard is usually more efficient than the mouse for a given stroke, because the hands are already on the keyboard and a stroke is a single action. In contrast, using the mouse requires three actions: moving the hand to the mouse, moving the mouse to the right place, and then clicking. In addition, for most mice clicking requires more energy than a key click.

Coding

Coding is a separate activity. Unlike a transcription system, which should be bundled and memorable, the coding system should be unbundled and understandable. Where a transcription system ideally has a one-to-many relationship with the data points

(one bundled symbol for many variables), a coding system should have an unbundled one-to-one relationship with the data (as well as a many-to-one relationship with the transcription symbols). In a transcription system, "F" can be used to represent a handshape similar in form to the American fingerspelled letter "f." In a coding system, the symbol F would be separated into multiple symbols such as *knuckle bending*, *thumb contact*, *extended fingers*, and so on.

The second important characteristic distinguishing transcription and coding is the difference between *memorable* and *understandable*. A memorable symbol is distinct from all other symbols in the system and is systematically or iconically linked to related symbols. Although it takes some time for the transcriber to remember the symbols associated with each variable group, the systematic relationship between the symbols means that, once the transcriber remembers a few of them and what they are linked to, the association of the others are easily derived. An understandable symbol does not necessarily have these kinds of links to related symbols and is usually less distinct. An understandable, but not memorable, coding symbol might be *hand opens*. It is not memorable or distinct, because it is easy to confuse the actual symbol with other potential symbols such as *hand opening*, *the hand opens*, *hands open*, and so on.

The different importance of understandability and memorability arises from their different uses in coding and transcription. The transcriber has time to learn and memorize symbols, because (s)he will be repeatedly entering them. Since a transcriber will be presumably transcribing relatively large amounts of data, the effort involved in memorizing symbols that are not immediately obvious but have some kind of internal coherence and are distinct (not confusing) is a reasonable trade-off. The coding system, however, should be transparent and understandable for someone looking at it for the first time. The individuals examining the coded results (i.e., researchers) will usually not be looking at the symbols often enough to memorize them. Their acquaintance with the symbols will be briefer, and will generally not involve the action of creating the symbols. Instead they will be manipulating – counting, sorting, analyzing – already created data, often in aggregate form. Finally, in a coding system physical ease or ergonomics is much less important than in a transcription system. This means that, where a keyboard solution often works better than a mouse for transcription, the reverse is true for a coding system. A mouse-based system is more intuitively obvious because it presents the user with choices instead of requiring the user to remember codes or keys. The more the coding system is skewed to understandability at the expense of memorability, the more important it is to use a mouse-based system with preset choices.

Examples of transcription and coding systems

These examples are from the SignTyp project. Figure 8.1 shows a SignWriting transcription that has only three iconic symbols. These symbols are converted via a table to SignTyp codes. Table 8.1 shows a simplified version of a few of the 20 SignTyp records (=codes) that represent the three SignWriting symbols. SignWriting symbols are bundled and memorable; SignTyp symbols are understandable and unbundled, which means that they are easily sorted, counted, and analyzed.

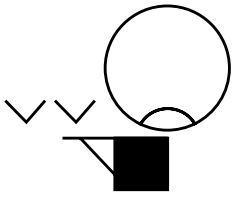

Figure 8.1 SignWriting of BIRD.

Table 8.1 Some SignTyp records (simplified) for BIRD.

Major Category	*Subhead1*	*Subhead2*	*Value*
action	handshape change		closing
action	Repetition		handshape change
hand posture	spreading		unspread
hand posture	finger group	closed fingers	middle–ring–pinky
hand posture	finger group	most extended	index
hand posture	finger group posture	most extended	bent
hand posture	fingers contacted by thumb		index
hand posture	thumb posture		opposed
Location	vertical	head	lower face

Data Storage: Database and Spreadsheet Software

The two most common choices for storage are the spreadsheet and the relational database.

A spreadsheet is appropriate for a small amount of data, perhaps under 10,000 records. Pivot tables (a table that summarizes the data for variables that the researcher selects) are easy to create and access and are an easy way to understand the aggregated data while the non-aggregate data are also quickly accessible. Formulae to manipulate the data can be quickly written and can easily refer to previous and next record – which is important, since most signs are likely to require at least two records (rows). The alternative to a spreadsheet is a *relational database*. Databases are generally faster than spreadsheets and more secure. They allow multiple researchers to access the same data at the same time. However, it is usually not necessary to make a choice between the advantages of spreadsheets and databases. Data can be stored in a relational database and then accessed when one links to them through a spreadsheet. The spreadsheet pivot tables then allow for further manipulation of the data.

Analysis

The final stage in a research project is analysis. Most phonological data are not quantitative but rather qualitative (categorical). They are usually not ordinal – a location on the nose is not greater or smaller than a location on the ear. For categorical

non-ordinal data, we can obtain frequencies that include the mode (the most common value). For categorical ordinal data, the median (the middle value) is also obtainable. But, for any categorical data, means (or averages) are meaningless.

Phonetic and prosodic data are more likely to be quantitative. For example, the height of a raised eyebrow can be ordered and measured (as in Weast, 2011). Many characteristics are usefully measured quantitatively, even though the characteristic is actually categorical. For example, categories for finger spreading could be unspread, neutral (neither spread nor unspread), spread, and extremely spread. A possible research project might treat spreading quantitatively and might measure the amount of spreading in various tokens of a handshape. The quantitative information might then help determine how many categories there are, if the researcher can show clustering around multiple modes that can be equated to spreading categories.

A first analysis of data probably uses frequency tables, which provide information about common and rare values, as well as missing values. For example, suppose that the question is what sets of fingers could be extended in a sign. Impossible forms are found by listing all 24 (4 x 3 x 2) logical possibilities and by comparing them with the actually occurring forms. Cross-tabulation examines the relationships between two or more variables and whether certain sets of data are significantly different from a norm – for example, whether the set of the extended fingers influences the type of flexion involved. Some projects will need more complex statistical analyses. Brentari and Eccarius (2011) used ANOVAs to determine whether there were significant differences in responses to different handshape groups, and de Beuzeville et al. (2009) used Varbrul to analyze factors that influence when verbs are inflected in Auslan.

Conclusion

This chapter has looked at the variables that need to be considered in setting up a research project for the forms of signs. The considerations mentioned here are intended to provide a starting point only, since every research project is different. At a minimum, however, the points mentioned here should serve as an initial checklist.

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Note

1 In this chapter I use the lowercase form *deaf* throughout.

Keywords

citation form; coding; contrastiveness; features; iconicity; phonetics; phonological hierarchy; phonology; sign internal sequence; transcription

See Also

Chapter 4; Chapter 5; Chapter 7; Chapter 11

Suggested Readings

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