14 Methods in Bimodal Bilingualism Research: Experimental Studies

Ronice Müller de Quadros, Deborah Chen Pichler, Diane Lillo-Martin, Carina Rebello Cruz, L. Viola Kozak, Jeffrey Levi Palmer, Aline Lemos Pizzio, and Wanette Reynolds

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Chapter Overview

This chapter presents experimental methods for investigating the bilingual development of signed and spoken language. We begin with an introduction to a research project for which these methods were developed. Next we describe

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the process of selection, adaptation, or development of parallel test batteries for target languages. These test target children between the ages of 4 to 7 years in the areas of general language, vocabulary, morphosyntax, phonology, and non-verbal intelligence. We describe each test, including information on how the test was developed and how it is administered, as well as suggestions for the set-up of camera(s) during filming. The chapter concludes with a discussion of the advantages of the data collection fair concept (an innovative technique for child data collection designed to improve on traditional piecemeal collection) and with a list of best practices for optimizing test effectiveness.

Introduction

This chapter will present an overview of methods in bilingualism and bimodal bilingualism research, focusing on experimental studies conducted by Lillo-Martin, Chen Pichler, and Quadros between 2009 and 2014 as part of a project called Development of Bimodal Bilingualism. In those studies we focused on the linguistic development of two groups of bilingual children exposed to one sign language and one spoken language: hearing children of Deaf[1] parents (Coda children or "kodas"); and signing Deaf children with a cochlear implant (CI) who have either Deaf or hearing parents. This chapter describes the use of experimental studies to investigate the simultaneous acquisition of sign language and speech by these children.

Important Considerations When Collecting Bimodal Bilingual Data

There are many challenges that must be approached carefully when setting out to collect bimodal bilingual data. Several of these challenges apply to the collection of unimodal bilingual data as well, and have been detailed in various publications regarding bilingual research (e.g. Moyer and Li Wei, 2008; Bhatia and Ritchie, 2004; Grosjean, 2008; Marian, 2008; de Houwer, 2009). In this section we will introduce general challenges related to collecting and evaluating bimodal bilingual data; a more detailed discussion of specific tests will follow in subsequent sections. Although our tests focus on American Sign Language (ASL), Brazilian Sign Language (Libras), and English and Brazilian Portuguese (BP), the practices we describe are applicable to other sign and spoken language combinations as well.

Studying bilinguals requires first and foremost the acceptance that bilingualism is not a static phenomenon. For instance, we have observed that the kodas in our longitudinal studies display very different developmental patterns as they grow out of toddlerhood and enter school, where they are immersed into a spoken language environment. We also noted a continual evolution of the roles played by the children's sign language and spoken language in their lives, and these changes impact children's use of these languages. It is important to identify the language experiences of the child, considering the persons with whom the child interacts during the period when the data are collected. Following Grosjean (2008), this includes gathering information on the child's language history and typical use (for instance, when the child was first exposed to each language, or the language(s) typically used with individuals in his/her everyday life); language stability (current skills in the languages currently being acquired and/or language attrition phenomena); language function (the typical context in which the child uses one language or the other); language proficiency; language mode (the amount of time spent in monolingual and bilingual modes); and general biographical data. In our project, we collect some of this information through a very detailed background form that we fill out together with the parent, in an informal interview format. Although time-consuming, this practice gives us the greatest assurance that parents (many of whom, in the US, are second-language users of ASL and English, having only learned them upon immigrating) understand the questions we are asking and answer them as accurately as possible. Other options include distributing the background form electronically, with an accompanying video that explains each section of the form in sign language. This material can be sent to parents to read/watch ahead of time, which reduces the amount of time needed to fill out paperwork on the day of testing.

Another consideration is that bilingual people must be evaluated in both languages. Marian (2008) points out that it is not always appropriate to use monolingual norms as the baseline for assessing bilingual development. This is especially clear in the case of vocabulary development (for discussion of this point with respect to speech bilinguals, see Pearson, Fernandez, and Ollder, 1993). A monolingual child with 20 words compared with a bilingual child with 10 words in each language should be considered as equivalent, although the bilingual has fewer words in the common language than her monolingual counterpart. Looking at only one language usually puts the bilingual child at a disadvantage, and this can lead to an inaccurate evaluation of his/her linguistic development.

Some researchers advocate for children's being tested by monolinguals for each of their languages (Grosjean, 2006; Cantone, 2007). In our specific case, since we are interested in bimodal bilingual production, to study how and when transfer and blending take place, we also encourage bimodal bilinguals to interact with the children. Our tests clearly target either the spoken language or the signed language, and they are administered by hearing or by Deaf/Coda researchers, respectively; but almost all of our experimenters are bilingual to varying extents. Thus the children are usually in bilingual mode (in the sense discussed by Grosjean, 2006, 2008). This favors normal access to both languages, even though there is a specific language target for each test.

Our discussion so far underlines a general but very important point raised by Grosjean with respect to bilingual status: we must remember that a bilingual person is not the equivalent of two monolinguals in one person. Having two languages in a single brain invariably leads to interaction, potentially of a kind not observed in monolinguals, so it follows that "bilinguals will not give exactly the same kinds of results as monolinguals" (Grosjean, 2008, p. 246). In our research we are seeing that this general rule also applies to bimodal bilinguals, whose patterns are similar to those of monolinguals in some areas, similar to those of unimodal bilinguals in other areas, and unique to them in yet other areas, with productions specific to bimodals, such as code-blending (Emmorey, Borinstein, Thompson, and Gollan, 2008).

The development of stimuli for bilingual projects is another area that deserves much careful consideration. Grosjean raises three potential issues related to stimuli: "differences in the stimuli used across studies, differences in stimuli used within studies, and factors that need to be controlled for in stimulus selection" (Grosjean, 2008, p. 259). In developing tests for a bimodal bilingual population, consideration must be given to how to compare children's development of phonotactic constraints and language-specific phonetics, since signed and spoken languages employ different articulators. It is crucial to take great care to ensure that the stimuli used would be as comparable as possible, despite differences in modality – as will be detailed in the following section.

Finally, it is very important to provide adequate training for experimenters (de Houwer, 2009). It is relevant to pay special attention to the sociolinguistic contexts of each setting for the experimental studies, especially with respect to each language. This is one of the reasons for prioritizing the presence of Deaf/Coda and hearing experimenters in our study, depending on the target language for each test.

Data Collection Fairs

The traditional model of experimental data collection involves testing children during the school day. To minimize disruption to the children's instructional time, data collection is typically spread over a prolonged period of weeks or months. Such an arrangement is acceptable if all the children to be tested attend the same school or live in the same general area. However, bimodal bilingual children are relatively difficult to find and are normally scattered across a broad geographical area, which requires extensive travel time for multiple visits to each child. We thus devised a new model for data collection: weekend "data collection fairs" held once or twice a year at various central locations with a particularly high density of children who meet our inclusion criteria.

Each fair targets either a sign language or a spoken language and consists of 5–8 hours of testing, interspersed with games, food, and free play with other signing children. At the start of each fair, we give the children "game cards" that list the tests they are scheduled to take on that day. Each test is represented on the card with an animal that matches an animal on one of the doors of the different testing rooms. The children's objective is to complete their game card by the end of the day – a task they take to with considerable enthusiasm.

The main advantage of the fair model is that it allows the collection of a large amount of data all at once, in conditions that are as consistent as possible across children and across tests. Because all the tests are administered on the same day, they offer us a useful snapshot of each child's total linguistic development at a single point in time, something that we could not achieve if data collection were drawn out over an extended period of time. Despite the long hours of testing, the children enjoy the fairs immensely. Another advantage is the chance to interact and exchange information with a large group of Deaf parents of bimodal bilingual children – for example, by including an informational program for parents to share project updates, answer questions, and discuss issues related to raising bimodal bilingual children. This interaction is very important, as families are critical long-term partners in such a research program.

General Principles of Test Development

Tests for a bimodal bilingual population need to target common areas of linguistic ability in both sign and spoken languages. Tests should give a good overview of the children's languages, and also go into some detail in areas of morphosyntax that are of particular interest for sign languages. Tests need to be as comparable as possible across target languages, especially in studies where different sign languages are compared. In cases where comparable tests are not available across the languages being studied, the focus should be on developing tests that are comparable within a single modality (e.g. across Libras and ASL, or across BP and English). In our study, when a test was available in one of the two sign languages only, we adapted a parallel version for the other sign language. For spoken languages, where standardized tests are more common, published, normed tests should be used whenever possible, adaptations should be developed as necessary, or completely new tests should be designed. Existing tests that have already been used with bimodal bilingual children, especially with CI children, should also be considered, so that results may be compared with those reported in the literature; for example our choice of the pseudo-word test developed by Dillon, Cleary, Pisoni, and Carter (2004) to study speech development in children with cochlear implants falls in this category.

Test adaptation begins with translation but also involves important language-specific modifications, which require careful work. For example, English morphology tests include the singular–plural distinction but no gender distinctions, whereas gender distinctions are included in Brazilian Portuguese tests. Similarly, in adapting the standardized Expressive Vocabulary test (EVT) of English vocabulary, we replaced several items that were culturally inappropriate or lacked a clear lexical equivalent in the target languages of BP, Libras, and ASL.

Also, some flexibility is needed where there is substantial regional linguistic variation. It is important to consult with local adults, especially the parents of the participant children, to ensure awareness of any local variants of the signs or words used.

The adaptation of tests involving different languages and cultures is a complex task, and the task is even more challenging when the target languages are in different modalities, as mentioned earlier. This challenge is most notable in sign language adaptations of phonological awareness tests, because signed and spoken languages have very different sublexical units: there are sign parameters (handshapes, locations and movements) in sign languages versus phonemes in spoken languages. Even if we assume that spoken and sign languages share aspects of internal, abstract phonological organization, phonological awareness tests designed for spoken languages generally focus on the sequence of phonetic segments, and this leads to an experimental methodology that is not clearly appropriate for sign language. For instance, the experimenter typically produces a word, then asks the child to take out, insert, or substitute a phoneme or a syllable in different parts of the word. In sign languages, the handshape(s), location(s), and movement(s) that compose a sign primarily occur simultaneously (although many signs are organized sequentially as well, for example when there is a change from one handshape to another). This difference between spoken and signed languages makes phonological awareness evaluation very complex (see also Cruz and Lamprecht, 2011). Considering this fact, we have adopted strategies such as the use of pictures associated with parts of the handshapes.

After running the tests, we evaluated the test administration process and contrasted the results with those of various comparison groups: Coda adults, Deaf children of either Deaf or hearing parents but with very early exposure to sign language (as controls for sign language tests only), and hearing children (as controls for spoken language tests only).

The Test Battery in the Bibibi Project

The goals of the project Development of Bimodal Bilingualism, also known as the Binational Bimodal Bilingual (Bibibi) project, are to understand the nature of conditions for cross-language influence, the mechanisms by which two separate grammars interact, and the feasibility of accounting for bilingual phenomena without appealing to any special machinery. Readers interested in details of our theoretical motivations and findings that are not discussed here are referred to earlier publications (Lillo-Martin, Quadros, Koulidobrova, and Chen Pichler, 2010; Lillo-Martin, Koulidobrova, Quadros, and Chen Pichler, 2012; Quadros, Lillo-Martin, and Chen Pichler, 2010; Quadros, Lillo-Martin, and Chen Pichler, 2013; Quadros, Lillo-Martin, and Chen Pichler, forthcoming; Quadros and Karnopp, 2004). Our test battery is organized across four different linguistic areas, for both spoken and sign language. As previously mentioned, we test each language individually, at separate fairs. We summarize the tests below according to the area of language examined[2]:

general language tests:

- the Kendall Conversational Proficiency test;
- the Preschool Language Scales test;
- the Sign Language Receptive Skills test;
- narrative samples;

vocabulary tests:

- the Expressive Vocabulary test (EVT);

morphosyntax tests:

- verbal morphology;
- modifier noun order;
- wh-questions;

phonology tests:

- picture-naming;
- phonological discrimination (minimal pairs);

- phonological awareness;
- non-word repetition (pseudo-signs and pseudo-words);

additional tests:

- Leiter Non-verbal IQ (selected subtests);
- parent–child interaction sample.

All tests targeting BP and English are administered by hearing experimenters, while tests targeting Libras and ASL are administered by experimenters who are either Deaf or native hearing signers (Codas). Tests are recorded on video for subsequent coding and analysis. Some tests, particularly those targeting sign language, require specific camera angles to capture all the information necessary for coding; in our descriptions of individual tests below, we include several photos to illustrate these optimal camera angles.

General Language Tests

The Kendall Conversational Proficiency test (French, 1999)

This is a general communicative development instrument. It consists of a written checklist that defines levels of communicative competency with respect to various communicative features that may or may not be present in the child's language use. The checklist is completed by an evaluator who is a proficient signer and is also familiar with the child's current language use – typically, with the child's parents or teachers. It was developed in the US by French (1999) and adapted for use in Brazil (administered in written BP) for the purposes of this research. The advantage of this tool is that it gives a global sense of the child's communicative abilities in both sign and speech, which serves as context for interpreting children's scores on tests that target specific linguistic abilities.

The Preschool Language Scales (PLS4) test for English (Zimmerman, Steiner, and Pond, 2002) and BP

This test measures both comprehension and expression for a variety of language structures. Tasks vary according to the age of the subject at the time of testing, as subjects pass from one level to the next if they achieve a minimal score. An experimenter both administers this test and records the child's responses on a special answer sheet. A BP adaptation of the test was developed for the purposes of this project.

We selected this test because it has previously been used for children with cochlear implants, and it was also recommended by speech language therapists who work with kodas. The example below, from the BP version of the test, is designed to elicit specific verbal morphology.

67. *Usar formas verbais irregulares* [use of irregular verbal forms]
Prática: Vamos brincar de completer a frase seguindo a primeira frase apresentada [Let's play! I will present a phrase, and then you complete it.]
A primeira palavra é "fazer", eu começo a frase e você continua. [The first word is "to make." I will start a phrase and you continue it.]
Por exemplo, "Joana fez um bolo. A Maria … (fez um bolo)". [For example, "Joana made a cake. Mary …. (made a cake)".]
a. *Eu faço biscoitos. A Maria …* [I make cookies. Mary …]
b. *Eu fiz um desenho. Matias …* [I made a drawing. Matias …]

The disadvantage of the PLS is that it is a fairly long test, which may be difficult to administer to young children. However, its major advantage is the availability of standardized norms for monolingual English-speaking children. Additionally, the test items cover a number of grammatical domains, allowing the researcher to examine the child's performance in these areas.

The Sign Language Receptive Skills test (Herman, Holmes, and Woll, 1999; Enns and Zimmer, 2009; Enns and Herman, 2011)

This test is based on the British Sign Language (BSL) Receptive Skills test (Herman et al., 1999). It was developed to monitor the sign language development of deaf children enrolled in bilingual programs. This tool offers a standardized measurement of sign language skills and represents a significant departure from sign language checklists and non-standardized experiments. The BSL version was carefully adapted for ASL by Enns and colleagues (Enns and Zimmer, 2009; Enns and Herman, 2011), who took into consideration linguistic differences between the two sign languages. Currently adaptations also exist for German Sign Language (Haug, 2011) and for Italian Sign Language (Surian and Tedoldi, 2005); there is also a pilot version for Australian Sign Language (Johnston, 2004). The ASL version is currently available on DVD, having been developed by Northern Signs Research as the Assessing ASL Development Receptive Skills test (see Enns and Zimmer, 2009; Enns and Herman, 2011). For our project, we made a further adaptation for Libras.[3] All versions contain 45 items and test number and distribution, negation, noun–verb distinctions, spatial verbs, size and shape classifiers, handling classifiers, role shift, and conditionals. For each item the child watches a signed sentence, then chooses one of four pictures that best corresponds to what was signed (an example is shown in Figure 14.1).

The Receptive Skills test is easy and straightforward to administer. In agreement with the pilot test results reported by Enns and Herman (2011), we found a high degree of variability in test scores among our participants.

Narrative samples

Co-constructed narrative samples between the child and either a parent or a researcher are elicited by using various wordless picture books (including *Good Dog, Carl* by Alexandra Day and *Tuesday* by David Wiesner). The same general

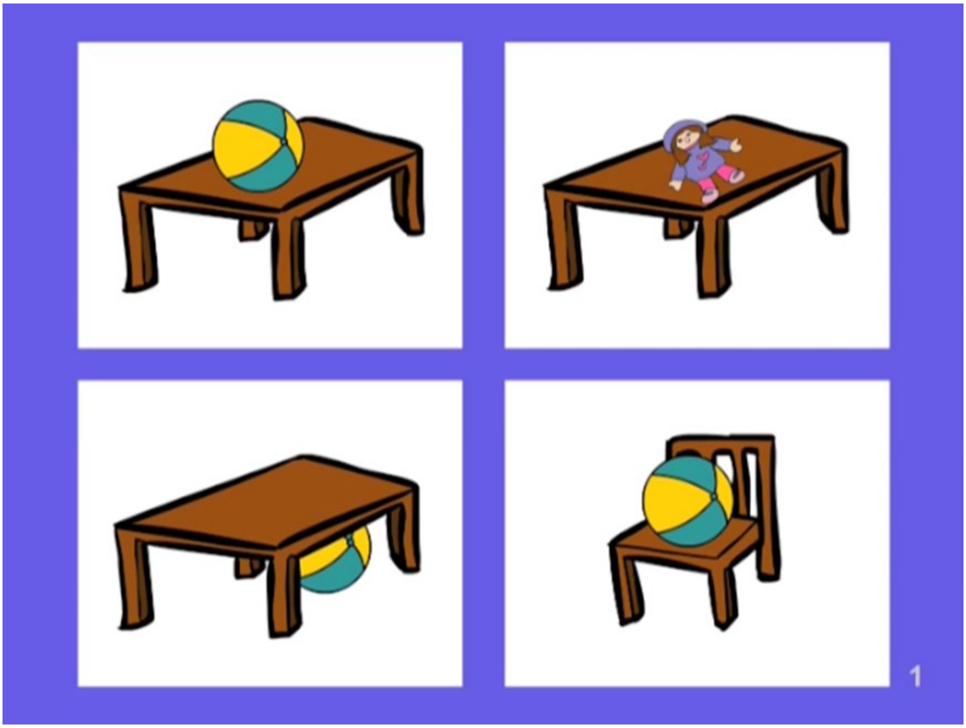

Figure 14.1 Card showing answer choices for the Sign Language Receptive Skills test.

approach is used for all four target languages during different sessions. One experimenter talks/signs with the child in the target language and reviews the book with the child. Then a second experimenter enters the room and interacts with the child, inviting him/her to retell (or at least comment on) the stories (s)he saw in the stimuli. The children interact with Deaf experimenters for the sign narratives and with hearing experimenters for the spoken language narratives. In a third and separate session, short film clips from wordless videos (including the *Minuscule* and the *Shaun the Sheep* series) are used in order to prompt short narratives in both languages during the same session. Narratives are filmed with the camera angled, so as to include both the child and the interlocutor's signing; the latter provides important additional context for analyzing the child's production (see Figure 14.2).

Precautions are necessary to ensure that comparable narratives are collected in both of the children's languages. For instance, to prevent effects of presentation order and practice, we provide multiple video stimuli and vary the order of the target language across children (Pavlenko, 2008). Our video elicitation task thus comprises four short video clips; the first two clips are elicited in the signed language first, then in the spoken language, while the second set of clips is presented in the reverse order. Furthermore, in order to encourage narratives that would be as comprehensive as possible, we wanted to emphasize to children that their interlocutors had not seen the stimulus pictures/videos. Thus we asked the

Figure 14.2 Camera angle for narrative task.

first experimenter to leave the room at the moment when the second (naïve) experimenter entered.

We score the narrative samples using the Index of Productive Syntax (IPSyn; Scarborough, 1990), which was developed for English and adapted by us for ASL, Libras, and BP. Analysis of narrative structure was conducted on the Brazilian data by Neves (2013). Naturally, other types of analyses can also be applied, as narrative data are an extremely rich resource for investigating the development of a broad range of syntactic and discourse structures.

Vocabulary Tests

The Expressive Vocabulary test (EVT) (Williams, 1997)

In this test vocabulary is elicited with the help of a set of pictures organized at different levels of difficulty, according to age. An experimenter shows the pictures to the child and asks him/her to produce the appropriate spoken or signed label. During administration of the EVT the camcorder should face the child and should include the elicitation picture, as shown below in Figure 14.3, so that coders may know which item is being tested.

We chose the EVT rather than a vocabulary comprehension test, reasoning that an expressive test would allow us to use essentially the same stimuli across all four target languages. This is a considerable advantage for research groups conducting cross-linguistic comparisons. On the other hand, the researchers must establish a list of acceptable responses for each item, and for this reason ensuring comparable scoring across languages can be challenging.

Figure 14.3 Camera angle for EVT.

Morphosyntax Tests

ASL and Libras verbal morphology

We designed this test of comprehension of ASL or Libras verbal morphology employing the truth-value judgment task methodology (Crain and McKee, 1986; Crain and Thornton, 1998). We have used this methodology in previous studies of both signed and spoken language, and we have modified it slightly from the original versions to make it more suitable for administration in ASL or Libras. Children watch a series of short video vignettes in which a cat, a pig, and a duck perform various actions to each other. After each vignette, the cat appears and signs a sentence summarizing what he thinks occurred in the vignette. The child must judge whether the verb agreement marking produced by the cat corresponds to the action presented in the preceding vignette.

The original version of this test included 32 items, but experimenters have reported that this number was too large for most children, who lost interest halfway through. As a result, the test has been shortened to roughly half of the original items.

English and BP verbal morphology

This test elicits production of verbal agreement – specifically, third-person agreement. For each item, the child sees a set of four pictures, one of which is highlighted by a bright red border. The child must describe the highlighted action to an experimenter, who then tries to pick out the same picture from a matching set of pictures in which the target picture is not highlighted. For each test item, the four pictures vary according to how many characters are depicted (one or two) and which of two actions is depicted (action A or action B).

The advantages of this test are that it is quite easy to administer and elicits common agreement forms for each target language. However, for researchers conducting an in-depth study of specific verbal forms, a more extensive study would be required.

Modifier noun order

We designed this elicitation test for English, BP, ASL, and Libras. It evaluates whether the child can produce sentences matching a situation shown in pictures, with an emphasis on the order of placement of adjective and noun within a subject or object noun phrase. An experimenter delivers instructions in sign or speech, depending on the test. The child and another experimenter each look at duplicate pairs of pictures, which are identical except for the fact that, in the child's pair, one of the pictures is highlighted (see Figure 14.4). The child must describe (in either sign or speech, depending on the target language) the highlighted picture to the experimenter, who in turn tries to determine which picture of the pair the child is describing. All the items in this test target adjective/noun word order. The target sentence in English for the highlighted picture in the sample below would be: "A fat cat and a fat dog are eating." The test is filmed capturing the child only, as shown in Figure 14.5; there is no need to film the experimenter in this test.

Because we use the same stimuli across all four languages for this test, each child sees the full set of pictures twice. However, the specific pictures that they are required to describe in the first testing differ from those in the second: on each card, the picture highlighted for the spoken language version of the test is the opposite of the one highlighted for the sign language version of the test. Additionally, since Libras and English are more restrictive than BP and ASL in terms of modifier–noun word order, we test children in the less restrictive language first, then in the more restrictive language after a month (or even later). This practice serves as a precaution against the possibility that test items in the first test would bias the children's word order choices in the second test.

Figure 14.4 Sample prompt from word order test.

Figure 14.5 Camera angle for word order test.

Wh-questions

We designed this production test targeting various types of wh-questions (see Lillo-Martin, 2000). It is administered by two experimenters: one storyteller and one "cat." The storyteller explains to the child that the cat is very knowledgeable about many things, but unfortunately very shy and afraid of interacting directly with adults. For this reason, the child is needed to ask questions on behalf of the storyteller and to relay the cat's answers back to her. The storyteller then uses toy props to tell a series of short stories, ending each one with a prompt for the child to ask the cat about some aspect of the story. An example is given below.

(Props: Woody, Buzz, Lotso, dog, cat)

STORYTELLER	Woody has a pet dog (Spot) and a pet cat (Fluffy). He's going on a trip and wants someone to help him out. Someone will have to feed Fluffy. Ask the cat who.
TARGET RESPONSE	Who will feed Fluffy?

The wh-test is filmed at an angle that captures the child head-on and both experimenters obliquely, as illustrated in Figure 14.6.

As is the case with the modifier noun order test, we use the same wh-test stimuli for the signed and the spoken languages. Thus we apply the precautions discussed above: we test children in the language with the less restrictive word order (in the case of wh-questions, these are Libras and ASL) before testing in those with the more restrictive word order, with sufficient time elapsed in between.

Figure 14.6 Camera angle for the wh-test.

Phonology Tests

BP picture naming (Andrade, Befi-Lopes, Fernandes, and Wertzner, 2004)

This is a phonological test for BP that includes a selection of the whole spectrum of phonological forms that are targeted in the analysis. The experimenter elicits words on the basis of 34 pictures, to determine the phonetic inventory of the child and to verify the occurrences of phonological processes that involve the types of syllabic structure used by the child and their distribution. An experimenter presents the child with pictures and asks him/her to name each one. If the child does not know a picture's name, the experimenter names it and continues through the next five items before returning to the unnamed picture and prompting the child again to name it. This test is simple and quick to administer.

English picture-naming (Goldman and Fristoe, 2000)

This is a very common, standardized test of English articulation that has been used in previous studies examining children with CIs. It is valid for individuals between the ages of 2 and 21 years. The experimenter shows children a series of pictures for which the child must provide English labels designed to cover a wide range of English phonemes. When scoring the Goldman–Fristoe test, it is recommended that researchers also use the Khan–Lewis Phonological Analysis (Pearson) for more comprehensive error analysis.

Figure 14.7 Camera angle for sign picture-naming test.

Libras and ASL picture-naming (Cruz, 2008)

These tests follow the same methodology as the BP picture-naming test described earlier. The ASL version was adapted from Cruz's original Libras test for the purposes of the Bibibi project. This test evaluates articulation of signs with various handshapes, locations, movements, and orientations. An experimenter presents a picture to the child and asks him/her to produce the corresponding sign. This test always precedes the tests of phonological awareness and phonological perception, since it introduces the items used in those tests, ensuring that the child knows the corresponding signs. If a child does not know the sign for a given picture, we follow the same technique as in the spoken BP test: the experimenter provides the sign, continues through the next five items, then returns to the picture that the child was unable to name and prompts him/her to try again. If the child still has problems, the experimenter will teach the child the sign, so that (s)he knows it for the phonological awareness test.

This test is filmed at an angle that captures the child head-on, as shown in Figure 14.7. In order to film each picture as it is being tested, the experimenter should turn each picture card toward the camera before presenting it to the child. There is a total of approximately 40 test items in the picture-naming test, but children in our target age range were able to name them easily and progressed fairly quickly through this task.

Phonological discrimination/minimal pairs (Pronovost and Dumbleton, 1953 for English; Carvalho, 2007 for BP)

This test uses minimal pairs to evaluate the child's perception of minimal phonological differences in English or BP. The experimenter produces a pair of words consisting of either the same word, repeated twice, or two words that differ by only a single

Figure 14.8 Sample prompt for English phonological discrimination.

phoneme (i.e., a minimal pair). The child must select from three possible picture pairs the correct pair that matches the words produced by the experimenter. For instance, if the experimenter says "coat" and "goat" (a minimal pair in English), the child should pick Pair 1 from the three pairs illustrated in Figure 14.8. If the experimenter says "goat" and "goat," the child should pick Pair 3.

Our phonological discrimination tests include 40 items that are generally quite straightforward to administer and easy for the children to answer.

ASL and Libras phonological discrimination/minimal pairs

For ASL and Libras, we designed tests parallel to the English and BP phonological discrimination tests described above. For each sign language, we collected minimal pairs that can be identified through picture pairs. The signs are presented by a Deaf signer on video (see Figure 14.9 for setup and camera angle). These minimal pairs differ in handshape only, in location only, in movement only, or in orientation only. The child watches a video in which an adult signer produces either the same sign twice or two signs that constitute a minimal pair. Then the child is instructed to pick from three pairs of pictures the one that matches the signs just produced. As for the English and BP phonological discrimination tests, the sign versions are simple to administer and produce dependable results.

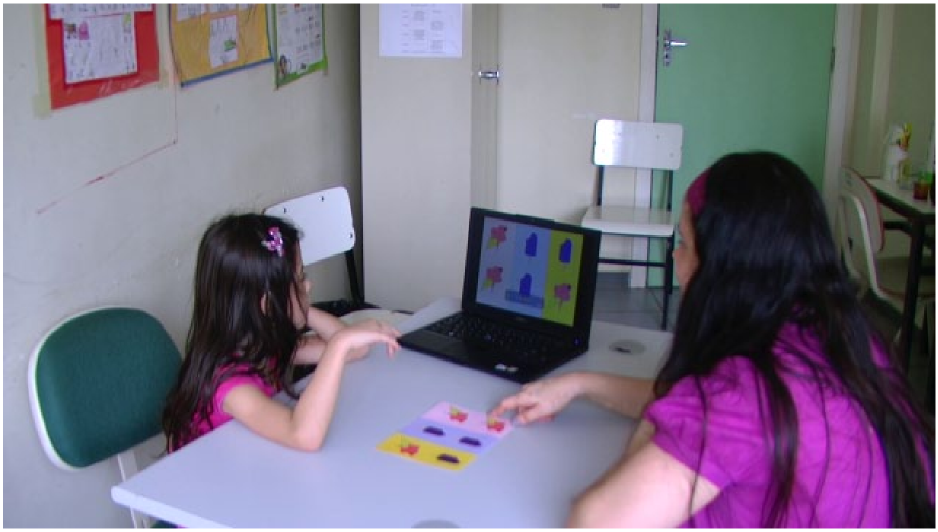

Figure 14.9 Camera angle for phonological discrimination/minimal pairs test.

ASL and Libras phonological awareness (Cruz and Lamprecht, 2008)

We use the Libras test developed by Cruz and Lamprecht and our own ASL adaptation to evaluate children's awareness of the handshape parameter; a similar test is currently under development for ASL (McQuarrie, 2012) as part of the VL2 sign assessment toolkit (cited below). The test is organized into sections on the basis of research on sign well-formedness (Quadros and Karnopp, 2004), sign language phonology, and sign language acquisition by Deaf children (Karnopp, 1999; Quadros, 1997). For each test item, the child sees one target picture plus three additional pictures below it. From these three pictures below the target, the child must pick the one whose sign matches the target in handshape. The three options include at least one foil, that is, an item whose sign has either the same location or the same movement as the target sign. The pictures selected are related to familiar contexts for children (family, toys, colors, animals, foods, etc.). For example given in Figures 14.10 and 14.11, the child sees a target picture of a snake and must think of the sign for SERPENTE (*snake*) in Libras (children are permitted to sign to themselves as a memory aid), then considers each of the three lower pictures, picking the one whose sign uses the same handshape (in this example, the "bent V" handshape). The correct answer in this case is CINCO (*five*). (Note that the child does not see a video of any signs, only pictures of each item. The signs are shown here solely for the purpose of illustrating these Libras signs for the reader.)

Although the child is not shown video for any of the signs represented by the pictures, all the signs that appear in this awareness test will have been previously elicited from the child in the earlier production test (see the description above for the Libras and ASL picture-naming test), ensuring that (s)he is familiar with all the relevant signs and can correctly associate them with the picture prompts.

For both phonological discrimination and awareness tests in Libras and ASL, the child selects answers by pointing to a computer screen, so the camera must be angled

Figure 14.10 Libras signs for SERPENTE (*snake*), PALHAÇO (*clown*), CINCO (*five*), and SORRIR (*smile*).

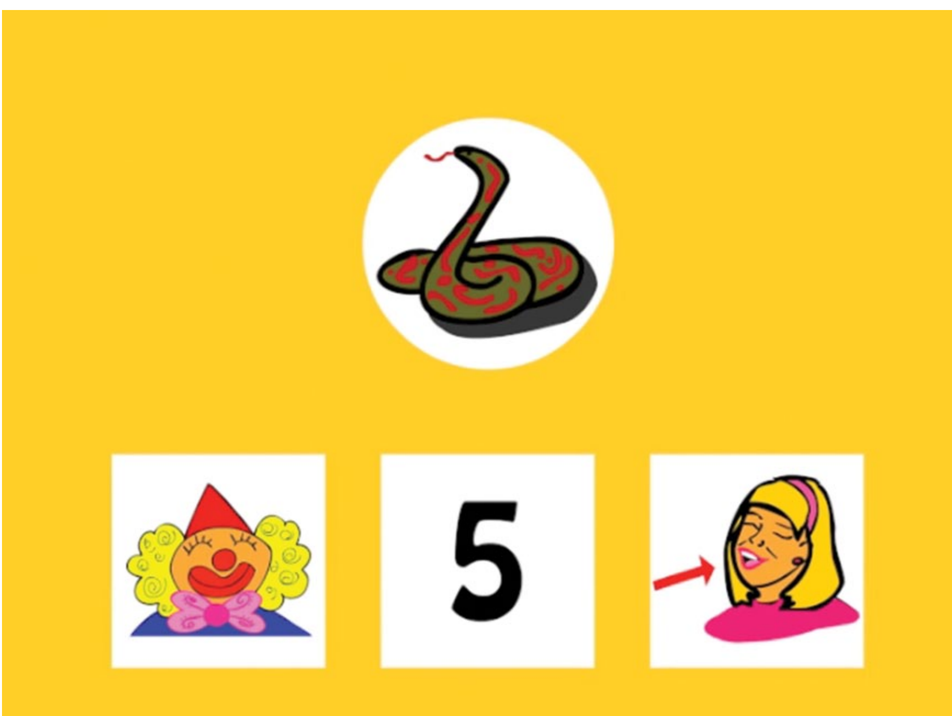

Figure 14.11 Sample prompt from Libras phonological awareness test.

Figure 14.12 Camera angle for sign phonological awareness test.

so as to capture clearly the direction of the child's pointing, as illustrated in Figure 14.12. It is also important to include the experimenter, who can reconfirm children's selections, if these are not clearly articulated.

The ability of children to complete this test is especially dependent on the ability of experimenters to explain the test instructions. In particular, those administering the test require additional training in order to learn how to guide the children in retrieving the relevant signs from their mental lexicon without demonstrating the signs.

Phonological awareness (Carvalho, Alvarez, and Caetano, 1998 for BP; Kaminski and Good, 1996 for English)

This BP phonological awareness test (Perfil de Habilidades Fonológicas) targets phonological processing. It evaluates phonological skills such as the ability to isolate single syllables or phonemes in a word, to detect and repeat rhymes, to rearrange syllables in a nonsense word to produce a real word, and to match the initial phoneme of a word to a picture of a human mouth forming that phoneme. This test is very comprehensive; it contains 56 items distributed over nine subsections, and it is consequently very lengthy. For younger children especially, it is sometimes necessary to break the testing into two sessions, with a rest between the sessions.

For English, we use the Initial Sound Fluency test (ISF), a phonemic awareness measure for children from 4 to 6 years of age. The ISF is a component of the Dynamic Indicators of Basic Early Literacy Skills (DIBELS; Sopris West Educational Services), and assesses children's ability to recognize and produce the initial sound in an orally presented word.

For all BP/English phonological tests, we film the child's face closely, and optionally we also include the experimenter and the stimulus picture as illustrated in Figure 14.13.

Figure 14.13 Camera angle for speech phonological awareness test.

We also film with an additional microphone and in a quiet room. If the child speaks very softly, experimenters should ask the child to repeat his/her answer more loudly, or the experimenter may repeat the child's answer, to help with later coding.

English non-word repetition/pseudo-words (Carter, Killon, and Pisoni, 2002; Dillon et al., 2004) and BP non-word repetition/ pseudo-words (Santos and Bueno, 2003)

The English pseudo-word repetition task developed by Carter et al. (2002) was designed to investigate the ability of English-speaking children with CIs to reproduce novel sound patterns that nevertheless display phonological patterns typical of English; we use this test with both hearing and deaf participants. Pseudo-words are grouped according to number of syllables; they range from two to five syllables. Upon hearing a pseudo-word, children must be able to hold it in their phonological memory in order to reproduce it accurately. Their reproduced forms are scored with respect to overall correctness/incorrectness, number of syllables, and stress placement, with the option of more detailed phonetic coding.

The BP pseudo-word task was developed on the basis of studies of word frequency in Brazilian TV shows and analysis of recurring phonological patterns across the most frequently occurring words. Items in this test have the following stress and syllable properties: a basic strong/weak stress pattern in two-syllable words; a weak/strong/weak stress pattern in three-syllable words; a weak/weak/strong/weak stress pattern in four-syllable words; and a weak/weak/weak/strong/weak stress pattern in five-syllable words. As in the English pseudo-word test, BP pseudo-words can be scored for overall (in)correctness, number of syllables, and word-likeness, with the option of coding for more detailed phonetic information as needed.

To ensure consistency in presentation, the pseudo-word stimuli are pre-recorded. Children generally find this repetition task entertaining and easy to do. While their overall reproduction is good, the finer-grained analyses of segmental accuracy reveal interesting errors (Quadros, Cruz, and Pizzio, 2012). Many children also volunteer their intuitions about real words that sound like the pseudo-words, and we noted these intuitions for future reference.

ASL and Libras non-word repetition/Pseudo-signs (Mann, Marshall, Mason, and Morgan, 2010)

We designed the pseudo-sign tests with the same goals as the pseudo-word described above, following a procedure similar to that reported in Mann et al. (2010) for pseudo-signs in BSL. The sign versions include pseudo-signs that resemble real ASL and Libras signs in that they display common patterns of internal sign structure. They vary across several parameters – such as the number of hands involved in articulation, whether there is handshape change during the sign, the type of sign movement, and whether or not the sign is a compound. The signs are presented by a Deaf signer on video, and the child is instructed to repeat each item after it is presented. Figure 14.14 illustrates an example of a non-sign item from the first category (one hand, one handshape, no path movement):

The pseudo-sign test can be filmed at the angle shown in Figure 14.15, capturing both the stimulus video and the child's production.

Figure 14.14 Sample prompt from the ASL pseudo-sign test.

Figure 14.15 Camera angle for pseudo-sign test.

The ASL (39 items) and Libras (33 items) versions of the pseudo-sign test are rather lengthy, and some younger subjects have difficulty staying on task for the entire test. Generally, however, children appear to find this task easy and enjoyable, and they volunteer phonologically similar real signs, as described above for the pseudo-word task. The only notable challenge encountered during administration was that, because stimuli were pre-recorded and played automatically (alternating with a brief blank screen during which the child reproduces the sign), children sometimes missed seeing stimuli. For this reason it was very important to remind experimenters to pay close attention to the task, so that they could stop the video and repeat a stimulus if the child failed to see it.

Additional Tests

Non-verbal IQ: Leiter International Performance Scale, Revised (Roid and Miller, 1997)

This standardized test is a non-verbal measure of intelligence designed to assess the child's IQ independently of language. We use only the figure ground, form completion, sequential order, and repeated patterns subtests, which comprise the Leiter Brief IQ Screener. Tests are administered through gestures and demonstration rather than in any particular language (although many gestures permitted by the test designers, such as pointing and "pantomime," resemble signs). Each child takes this test only once.

Despite the fact that we used only a small subset of the possible tasks included in the Leiter, this test is still quite lengthy to administer, and some younger children are not able to complete it. Generally, however, participants scored above the average for their ages on this task. Again, it is worth noting that, while the test instructs experimenters to use gesture and pantomime in order to avoid giving the child "verbal" (i.e. linguistic) cues, these cues may be perceived as linguistic by bimodal bilingual children, who have been acquiring a visual language from birth.

Parent–child interaction sample

We use a series of pictures showing scenes from familiar contexts (at the grocery store, at the zoo, etc.) to help elicit a short sample of naturalistic interaction between each child and a parent. No target language is imposed in this task; the child and the parent are free to use whichever language(s) they wish, with the goal of capturing a sample of typical language input that the child receives from the parent. The parent and the child are seated at the angles shown in Figure 14.16, to record a clear video capture.

Parents vary widely in how comfortable and spontaneous they are during this task. Some appear nervous in front of the camera and unsure how to proceed. For these parents, it is helpful to have ready a list of other common activities they might find easier to discuss with their child than those portrayed in the provided pictures. For this reason, an experimenter can remain in the room during filming, sitting discretely behind the camera but available to facilitate conversation if needed.

Figure 14.16 Camera angle for parent–child interaction sample.

Adjusting the Tasks and the Details of the Applications

Following the first round of testing, we met with experimenters to evaluate the effectiveness of each test and to modify it if necessary. This step is useful, as it identifies both positive aspects and problems with regard to the experimental approach. Some problems are language- or culture-specific, for instance the higher degree of nervousness of Brazilian children in front of the camera by comparison to their American counterparts. We attribute this difference to the relative absence of a testing culture in Brazilian schools. However, the Brazilian children were distinctly more at ease in the second round of testing, which suggests that children are able to acclimatize to testing and filming fairly quickly.

Post-testing evaluations also generated a list of best practices for optimal test administration, a practical resource that resulted in more effective testing at subsequent data fairs. The list had the following points:

1. Experimenter preparation must include explicit training related to the goal of each test, as well as very specific instructions on the kinds of help and clarification that experimenters can and cannot give to the child. Experimenters must know their test very well before administering it.
2. When creating tests, tasks should be simple enough to be quickly grasped, yet challenging enough to engage children's interest.
3. Parents sign informed consent and video release forms before their children can participate in testing. It is most effective to either fill the forms out with the parents or create an explanation in sign language, then post it as a YouTube video prior to the data collection fairs. This allows parents to review the video ahead of time, so they can be ready to ask any questions or express any concerns they might have on the day of testing.
4. Testing rooms should be carefully prepared prior to testing, following standardized instructions for the arrangement of test materials and the placement of the camera. All experimenters must be trained in proper use of the camcorder and of the microphone (if used).
5. Some children are nervous upon entering the testing room and would benefit from a bit of light chatting designed to break the ice and set them at ease before the testing begins. Showing children themselves on camera as they make funny faces is also a useful way of making them comfortable with being filmed.
6. Children should be asked for verbal assent before test-taking begins and should understand that they can stop the test at any time. If a child shows signs of anxiety mid-test, the experimenter should stop testing and return the child to the playroom to rest. The child will be given the chance to resume the test later.
7. At the beginning of each videotaped test session, experimenters should write the participant's pseudonym, the test name, and the date on a mini-whiteboard held up to the camera before filming begins.[4] Training the camera on the whiteboard contents before hitting the Record button results in this information appearing as the thumbnail image for that video session, which makes it easier to identify the film when it is copied from the camera and transcribed.
8. All instructions and clarifications should be presented to the child together with the practice items rather than later, during the actual test. The experimenter

should not proceed with the actual test until it is clear that the child understands the task. If the child does not understand the task, the experimenter must explain it again; and, if the child still does not understand, testing should be suspended and reattempted at a later time.

9 Experimenters should try to maintain positive, encouraging facial expressions during testing, even when a child answers a test question incorrectly. Regardless of whether a child gives a correct or an incorrect answer, the experimenter should respond with a neutral-to-positive comment like "Good job."

10 During tests in which the child selects an answer by simply pointing at some stimulus, the experimenter should always reiterate the child's answers in some way, for example by pointing or commenting on which item was selected, to clarify the child's choice for later coding.

11 Some children respond in speech only, even when they are being tested on their sign language by Deaf experimenters. In such cases the experimenter should gently remind the child that (s)he did not understand the spoken response because (s)he is deaf and should ask the child to repeat his/her response in sign. Alternatively, the presence of a Deaf parent in the testing room might encourage the child to sign. Speech-only responses are not necessarily a reason to abandon testing, unless the child is repeatedly unable to produce signed responses. In the Bibibi study all the children were able to switch to the appropriate language after prompting.

12 Scheduling individual children for specific tests at set blocks of time is not the most effective method for fair testing. A fluid organization is more effective, allowing children to decide after finishing one test whether they want to return to the playroom to rest or continue with the next test. To keep track of which child has finished (or simply attempted) which tests, all experimenters should check in with a central "schedule keeper" as they take each child to be tested, and again as they return that child to the playroom. The experimenters should also keep track of the children who have participated in their room on a participant checklist with notes and other information.

Transcribing Experimental Data

We transcribe our experimental data using ELAN (EUDICO Linguistic Annotator, http://www.lat-mpi.eu/tools/elan) (Crasborn and Sloetjes, 2008), a tool for multimedia annotation. ELAN is also widely used by researchers for linguistic annotation of sign language video data. Annotated utterances in ELAN are linked to their corresponding points in the video data, and researchers can view an utterance of interest by simply clicking on its annotation. ELAN also allows searches of multiple annotated files simultaneously, greatly facilitating data analysis.

Brief responses can be coded directly in ELAN, as can longer utterances or dialogues (such as the narrative and conversation samples). The advantage of using ELAN for bilingual data is that both languages are annotated in the same document and, when the participants produce blending, the speech and sign annotations are shown connected and aligned in timing to each other, in accordance with the video (see Figure 14.17). All annotations should be entered by trained bilinguals who are

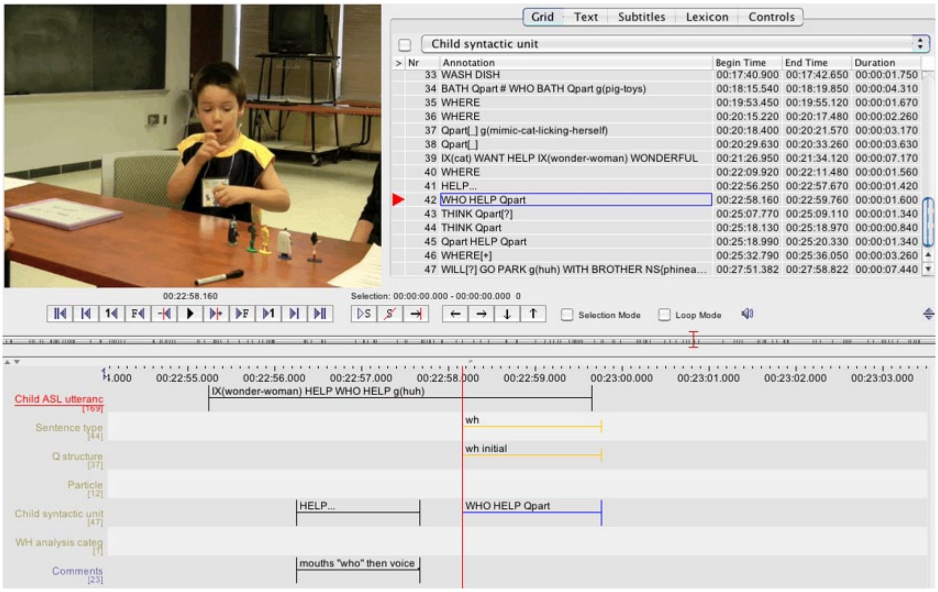

Figure 14.17 Screen shot of a test video coded in ELAN.

native users of at least one of the two languages of the child on video. Transcribers follow standardized notational and glossing conventions developed through frequent meetings with other transcribers (Chen Pichler, Hochgesang, Lillo-Martin, and Quadros, 2010). Sections of finished transcripts are reliably checked by other bilingual researchers and stored on a server with restricted access.

All the data from our experimental studies are stored in a shared FileMaker Pro database. Formats were created for inputting answers from each child on each test, so that reports can be generated and compared. All ELAN files, videos, participant background information, and scanned answer sheets from data collection fairs are also linked to the FileMaker Pro database.

Conclusion

The data collection fair methodology has allowed the collection of a wide range of experimental data in a short time, in a manner that is comparable across testing sites. The tests described here are only a selection of the growing number of tasks designed to investigate language development. This test battery was developed with the goal of obtaining as much information as possible about bimodal bilingual children's overall linguistic development, since there are so few existing publications on this population. Specific areas of linguistic development that have been the focus of previous studies on relevant comparison groups (Deaf children without cochlear implants, Coda adults, and unimodal bilingual children) have also been prioritized. Those who with to collect experimental data from bimodal bilinguals should choose tests on the basis of their particular research focus and resources; it is not necessary to test all of the areas described here. Helpful resources for sign language assessment tools are increasingly available online, including on the Sign Language Assessment web site (http://www.signlang-assessment.info) and the VL2 Assessment Toolkit web site (http://vl2.gallaudet.edu/document.php?id=14) developed by the Visual Language and Visual Learning Center based at Gallaudet University. Our project's web site (bibibi.uconn.edu) also includes downloadable resources related to our research and findings.

The only major drawback to the fair methodology is that it requires extensive planning and a large contingent of trained experimenters for each fair. The costs of traveling with a large number of people from site to site can be prohibitively high. Despite these costs, the concept of data collection fairs is an innovative solution for gathering large amounts of test data in a short time, and we continue to refine and improve it for future use.

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Notes

1 Capitalized *Deaf* is used with reference to a specific, self-defined cultural group with a common history and language. Lowercase *deaf* is used with reference to the deafness in general.
2 We would be pleased to share those test materials we developed with other interested researchers. Please feel free to contact us if you are interested in making such an arrangement.
3 The Libras adaptation is considered to be still at the pilot stage, as we are currently collecting data from native signing children.
4 Thanks to Marie Coppola for suggesting this practice to us.

Keywords

bimodal bilingual corpora; bimodal bilingual development; experimental studies; research in sign language acquisition methods; sign language acquisition

See Also

Chapter 4; Chapter 5; Chapter 17; Chapter 18; Chapter 19

Suggested Readings

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