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Adapting Cued Speech to Additional Languages

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As of October, 1993, Cued Speech had been adapted to 56 languages and major dialects. In most of these adaptations, the writer had the assistance of one or more native speakers of the target language. In a few cases he had advice from experts on the phonetic and phonological aspects of the language in question. Other persons produced five of the adaptations (Alu, Malagasy, Maltese, Korean and Polish) with little or no guidance from the writer.

Persons other than the writer will likely produce increasing numbers A adaptations to other languages. This article is intended to provide guidance and suggestions that will facilitate such adaptations. It aims to furnish the benefit of experience gained in the original design of Cued Speech and its adaptation to 50 languages by the writer. It will summarize the following:

1) the basic theory of Cued Speech
2) procedures followed in grouping the phonemes of American English in the basic version of Cued Speech
3) recommended procedures for adapting Cued Speech to additional languages
4) the timing movements of Cued Speech
5) special problems encountered in adapting CS to various languages

Basic Theory of Cued Speech

Speech is based upon this simple principle: If all the sounds of a spoken language were clearly different from each other as they appear on the mouth, the deaf child could learn the spoken language through vision, just as the child with normal hearing learns it through hearing. In most languages CS utilizes eight handshapes, in three or four locations near the mouth. These cues supplement the information visible on the mouth so that all the phonemes of a specific spoken language look different from each other, either on the mouth or on the hand. Sounds which look the same on the mouth look different on the hand, and sounds which look the same on the hand look different on the mouth. Thus, the spoken language is clear, through vision alone, at the levels of phonemes, syllables, stress, and duration. If needed, approximate intonation can be indicated by the angle of inclination of the hand from the horizontal, with 45 degrees for middle pitch, near 90 degrees for high pitch, and near the horizontal for low intonation.

The preparation I made for developing Cued Speech included four steps.

1) From basic physics I decided that the hand is too massive to make movements equivalent to those of the vocal organs at the speed of normal speech. This means that no manual system (such as phonemic fingerspelling) can convey the equivalent of the speech message at a normal rate.
2) I determined that slightly more than half the information in the speech message, in mathematical terms, is visible on the mouth. This does not mean that half the message can be perceived by seeing the mouth. It is analogous to the fact that the longitude of a location on the earth is half of the information needed to locate it.
3) I concluded that if I could design a system in which the hand provides the half of the information that is not available from the mouth, it might work. My calculations showed that the hand could carry that amount of information.
4) I decided that the information conveyed by the hand must be in a mathematical relationship to the information on the mouth making the combination equivalent to a double, two-dimensional matrix. In nonmathematical terms, the idea is that the identification of a group of look-alike consonants by the mouth, and the simultaneous identification of a group of consonants by the handshape, result in the identification of a single consonant, at the intersection of the two elements of the two-dimensional consonant matrix. Also, the identification of a group of look-alike vowels from the mouth, with simultaneous identification of a group of vowels by the hand location identifies a single vowel, as the intersection of the two elements of the two-dimensional vowel matrix. Thus, the combination of hand shape and hand location, with the information visible on the mouth, identifies a single consonant-vowel syllable, the normal unit of speech.

Procedures Followed in Assigning Phonemes to Cue Groups in the Development of Cued Speech in its Original Form

The development of Cued Speech in its initial form was primarily for General American English, though phonemes used in various other dialects of American English were included. Subsequently, additional phonemes were added to accommodate Standard

Southern British, Australian, Cockney, Scottish, Irish, Australian and New Zealand dialects of English, in the one system. Adaptation to other languages followed swiftly, among the earliest being Spanish, French and German, bringing the total to 48 languages and major dialects as of September 1989, and to 53 as of September 1992.

Compatibility among languages was an objective in all the adaptations, to the extent possible without diminishing the accuracy and effectiveness of the system in each specific language. For English, priority was given to accuracy of discrimination provided by maximum visual contrast on the mouth between phonemes grouped by a single cue, balance of frequencies of appearance of groups, assignment of most-used groups to the handshapes easiest to make, ease of change from one handshape to another in frequent consonant clusters, and other considerations. In the adaptations to other languages, the additional factor of compatibility among languages (for bilingual use) had to be considered along with the other factors listed. Accurate information on phoneme frequencies in some languages was not as readily available as in English. For this reason, and because there is a high degree of correlation in phoneme frequencies across languages (at least for the most frequent phonemes in western languages), compatibility was given a higher priority than phoneme frequency in languages other than English.

The primary factor in assignment of phonemes to groups associated with a single handshape or hand location was visual contrast on the mouth, within groups. Use was made of the data of Woodward and Barber (1960) on visual contrasts of initial consonants in English. The frequency data of Denes (1963) was used for balancing the groups as to frequency, and assigning the easiest and least tiring hand configurations to the most frequent groups of phonemes. Woodward and Barber computed an "index of contrast" between the members of each pair of consonants, ranging from 2.00 to –2.00 They rated those pairs in the range 2.00 through 1.44 as contrastive, 1.33 through .06 as similar, and .02 through -2.00 as equivalent. In the original design, for English, I was able to arrange all the English consonants in groups in which the contrasts by pairs were all in the range 2.00 through 1.44, or contrastive, except one. Only one pair, /y/ vs. /ch/, has a contrast on the limit of the similar range. Later studies have confirmed that this pair is sufficiently contrastive for the vast majority of speakers, suggesting that the single speaker used in the Woodward and Barber study was atypical on this specific pair.

As reported in published studies (Nicholls, 1979; Nicholls and Ling, 1982), the basic Cued Speech system provides enough visual contrast (through the combination of the cues and the visual manifestations of speech on the mouth) to make it possible to read spoken language (through vision alone) at an accuracy comparable with that possible through normal hearing.

In my first attempt at design of Cued Speech, I grouped the phonemes by acoustic properties as well as visual contrast. The purpose was to make the system more useful in speech therapy by putting phonemes with a common phonetic characteristic (such as voice or plosion) together. Thus, I put /p/ /t/ /k/ (unvoiced stops) in one group, and /b/ /d/ /g/ (voiced stops) in another. The visual contrasts within these groups are not nearly as good as those achieved when I disregarded acoustic properties. As a result, my first design resulted in only 70% to 75% accuracy in the discrimination of consonant-vowel syllables. Incidentally, this pattern is essentially that followed in the AKA system developed in Belgium (for French) in an effort to make Cued Speech a better speech tool, which is the same idea I had in the beginning. At any rate, I found it necessary to give up grouping by acoustic properties to achieve the needed level of accuracy.

After assembling the consonants into groups designed for maximum average visual contrast within groups, I assigned each group to a handshape, choosing for the highest-frequency groups the handshapes that require less energy to execute. I then considered the frequency of appearance of consonant clusters, and the difficulties these might present in changing quickly from one hand configuration to another. For example, I deviate from the frequency/energy order of the groups in order to make it very easy to change from the handshape for /sl and /r/ to that for /t/ (and the reverse) This made it easy to execute the /st/, /rt/, /rm/, /sm/, /tr/, and /ts/ clusters, some of which occur very frequently.

The grouping of the vowels was worked out similarly. However, developed my own data on visual contrast for the vowels, and gave high priority to ease of cueing of the diphthongs.

The distribution finally chosen for English produces very high accuracy in recognition of CV syllables (Cornett, 1972), words (Nicholls, 1979; Nicholls and Ling, 1982), in discourse (Musgrove, 1985), and as reported universally by users of Cued Speech. Researchers on and users of Cued Speech in other languages have reported similarly (Périer, et al, 1987).

Recommended Resources and Procedures for Adapting Cued Speech to Additional Languages and Dialects

Resources

The following resources are needed for adaptation of Cued Speech to an additional language:

1) A good knowledge of the basic principles of phonetics, preferably including their application to two or more languages.
2) Access to an authoritative book (preferably several) on the phonetics and phonology of the target language.

3) The assistance of several native speakers of the target language, preferably with different dialects and degrees of sophistication.

4) A good cassette tape deck, for recording and studying speech samples, and for making audiocassette lessons, if their production is part of the project.

5) Ability to use Cued Speech accurately (not necessarily rapidly or fluently) in one language is desirable.

6) The application of several hours per day for several weeks, for completion of a trial adaptation, a like amount of time for writing and editing the lessons, and a similar period for recording and correcting the lessons. Additional time is required for evaluating and testing each trial version.

Procedures

The first step is to study the phonetics of the target language. It is not necessary to learn the language, but a modest degree of familiarity with common words is desirable. The ability to make all the sounds and accurately imitate the pronunciation of words is essential. Generally, this will result in the ability to read the language aloud, slowly, with good pronunciation. Of course, being a native speaker of the language is a great advantage, though a native speaker must guard against thinking of his/her own dialect as preeminent.

The second step is to compile a complete list of phonemes of the target language. For the purposes of adaptation of Cued Speech the following simple definition of a phoneme can be used, though it lacks the rigorousness of formal (and very elaborate) definitions used by phoneticists: "A phoneme is a family of closely related sounds ordinarily thought of by native speakers as only one, and necessary as a distinct group in order to perceive differences in the meanings of words and phrases. For example, the various shades of the short **a** vowel in the English word **fat**, from that used by most Englishmen to the flat short **a** of southern Mississippi are all thought of as "short **a**," even though one is aware of the differences among them. Whether one uses the sound as made by an Englishman, or that used in the southern United States, the meaning of the word is the same. Thus, all the various shades of the sound of short **a** belong to the one phoneme, short **a**, and are the **allophones** that belong to the family of that phoneme. Cued Speech is a phonemic system. It does not distinguish between allophones within a phoneme, except in special cases that will be explained later. The test for determining whether two specific sounds belong to different phonemes is the existence of a **minimal pair**, a pair of words with differed meanings that are identical except for the two sounds in question. For example, the existence of **fat** and **fit** affirms that short **a** and short **i** are different phonemes. Remember that we are considering only **sounds**, not spelling. Another example: In many languages the two vowel sounds **pull** and **pool** are allophones, that is, they can be used interchangeably without changing meaning. In English they are separate phonemes, as is indicated by the different meanings of **pull** and **pool.** In English and German, the short **i** as in **fit**, the sound of long **e**, as in **feet** in English, **ie** in German (biegen) are separate phonemes. In most languages (Spanish, French) they are allophones, members of a single phoneme ranging in acoustic quality from short **i** to English long **e**, but all spelled as i.

A complete list of the phonemes of the target language can usually obtained from a book on the phonetics of the language. However, it necessary also to take note of allophones of various phonemes, in cases which there may be reason for Cued Speech to distinguish between allophones. For example, in the 21 countries in which Spanish is the major language, there is great variation in the pronunciation of the word **yo**, which means I. In Castilian, the most prestigious dialect of Spanish, used wide in Spain itself and by some speakers in several of the countries of South America (such as Columbia), the usual pronunciation of the consonant is that of **y** in **yes**. But, in Argentina and several other South American countries, and even by many speakers throughout Spain, the pronunciation is like **s** in **pleasure** and **vision.** In Puerto Rico, the prevalent pronunciation is like **j** in **Joe**, and many Spaniards use this pronunciation also. These three sounds are allophones; they can be used interchangeably without changing the meaning, and without causing confusion anywhere. There are two reasons for cueing these allophones differently in Spanish. The first is that their use is so much a matter of culture and pride in some countries that parents will want their deaf children to be able to distinguish and use the pronunciation preferred in that country. The second reason is that two of the three allophones (**zh** and **dzh**) are the same on the mouth, but the other one (**y**) is different. Thus, I designed the Spanish adaptation (on the advice of a committee of Spanish-speaking persons from six different countries) to provide for distinction among these three allophones. In most languages it will not be necessary to distinguish among allophones.

After a complete list of phonemes has been assembled, the next step is to group the vowels into groups assigned to the several hand locations, and the consonants according to the eight or so hand configurations. They must be grouped so that no group contains two phonemes that are too similar in appearance on the mouth. Usually, one begins by arranging the phonemes essentially as they are in English, and then making changes as needed. If in the target language the vowel **i** represents only a single phoneme (not **i** and **ee** as in English), the vowel arrangement of Spanish may be a better starting point.

When the list of phonemes is complete, and a trial arrangement is in place, three things should be checked. First, each group of vowels or consonants should contain at least two phonemes (preferably three), so as to follow the basic principle that the reader must use the information seen on the mouth separate the sounds within a group designated by a specific cue. Second, if there are only two phonemes in a group, one of them should not be a low-frequency phoneme, in order to prevent the cue being interpreted as a

"sign" for a specific sound. Finally, a series of trial drafts of the arrangement should be made and tested. For example, in the writer's work with Dr. Anna Metlyuk and Dr. Nadezhda Evtchik, of Minsk, the goal was to produce a workable adaptation that accommodated both Standard Russian and Byelorussian. It was necessary to work through four successive trial drafts, over a period of months, to arrive at one that was as nearly satisfactory as possible.

The Timing Movements of Cued Speech

Cued Speech is a time-locked system; that is, the cues must synchronized with the spoken sounds. Every cue is essentially a hand movement that is timed relative to the sound. The movements used include: 1) a movement from one location to another; 2) a change from one handshape to another; 3) a forward movement of no more than one inch the side location, for syllables containing **ah** or **oe**; 4) a backward movement (in the case above) to the original location, but *only* when the next cue also in the side location; 5) a downward movement in the side location, for the schwa (**uh**), ½, inch when it is unstressed, and up to one inch when stressed; 6) a return (upward) of the hand to the original location in 5), but *only* if the next cue is also in the side location; and 7) the *flick*, a small, ¼ inch movement forward and back, required in specific situations.

Movement of the hand from one location to another, and changes from one handshape to another, clearly indicate the timing of the voice-hand synchronized pattern. The time of arrival of the hand at a given location indicates the instant at which the next sound is to begin. The time the hand reaches a new configuration likewise indicates accurately when the associated sound begins.

The third type of movement listed, a forward movement of about a inch in the side location, to accompany the vowel sounds made in that location (with the exception of the schwa), is necessary to help indicate when the sound begins and how long it is continued. The fourth movement the return to the original location after the forward movement, is require only when there is to be another cue in the same location.

The fifth movement, a very short movement downward in the side location, to accompany the neutral vowel (the schwa), is necessary if the schwa is used in the target language (and if it is placed in the side location as it is in all the languages adapted to Cued Speech to date). The sixth movement, the return (upward) following the fifth movement, occurs if the next cue is in the side location.

The seventh movement, the flick, is used whenever the same cue used twice or more in succession in the same location. For example, if one says and cues the word **meter**, cued 5 mouth, 5 mouth, it is necessary move the tips of the fingers away from the corner of the mouth a very small distance (¼ in.) and replace it, between the two syllables. Thus, the hand touches at the corner of the mouth as one says **mee**, is moved away and quickly back, and touches again as one says **tur**. The same movement occurs in the side location when the same cue is used twice consecutively, as in the word **left**, 6 chin, 5 side, 5 side flick. In the side location the flick movement is forward and backward. For a more detailed explanation of the timing movements, refer to Chapter 29, "The Fine Points of Cueing," in *The Cued Speech Resource Book for Parents of Deaf Children* (Cornett & Daisey, 1992).

Special Problems That May Be Encountered

In some languages certain acoustical characteristics of sounds, such as palatization, nasality (in languages having many nasal sounds), and aspiration, need to be indicated by supplementary aspects of the cues. For example, in the Czech language, the softening (palatization) of consonants is indicated by a tiny pronation (rotation forward on its axis) of the wrist as part of the cue. In the languages of India there are many cases in which two consonant phonemes differ only in that one of them is more strongly aspirated than the other. To keep from having more hand configurations than are feasible with a single hand, one can indicate aspiration in such cases by pronation of the wrist as part of the cue. In a language in which the difference between long and short forms of the same vowel is phonemic (changes the meaning), pronation can be used to distinguish the long form of the vowel from the short counterpart. There are other movements that can be used for similar distinctions.

In Standard Russian the existence of both palatized (softened) and unpalatized forms of many of the consonants caused the number of consonant phonemes to be so large that there had to be a choice between growing more fingers and finding a way to differentiate palatized consonants from their unpalatized counterparts without putting them in different groups. The solution, as in Hungarian, was to use pronation of the wrist (rolling it just slightly forward on its own axis) to indicate palatization.

If a language is tonal, that is, if changes in pitch can of themselves change the meaning of a word, variation in the angle of the hand (near vertical for high pitch, near horizontal for low pitch) can be used to indicate the tonal dimension in the phonemic structure of the language. This works very well in Thai, Igbo, Mandarin, Cantonese and other tonal languages.

Adaptations for Use in Two Languages

In many situations, there will be a need for an adaptation which will permit use of Cued Speech in two languages, the primary language of the family, and a second language which parents wish to teach to their deaf child to some extent. This may be

because of a heritage in the second language, because of relatives, because the family's immigration has placed' them in an environment where another language is dominant, or for some other combination of reasons.

It is best to make special adaptations to meet such needs by starting with the basic adaptation for the primary language, and trying to add any phonemes of the second language not found in the first language, in cues groups in which they will be different on the mouth from those already included. Such adaptations will tend to be less efficient in the secondary language, but will serve the purpose for which they are intended.

Persons interested in use of cueing with a child in two languages should check with the writer, on the possibility that an arrangement for combined use in the two languages in question may have already been made.

Conclusion

With some languages the solutions of some of the special problems listed above may be very difficult to work out. The adaptation to Arabic was particularly challenging. Accordingly, persons who are attempting to adapt Cued Speech to an additional language may wish to seek assistance from the writer, who will be glad to be of help. The charts of phoneme/cue, arrangements for several languages, illustrating some of the problems solved, may also be useful.

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