# VOCABULARY SELECTION FOR INTELLIGENT PARSING IN AN AAC SYSTEM FOR APHASICS

Bruce R. Baker, Semantic Compaction Systems
Kathleen McCoy, University of Delaware / A.I. DuPont Institute
Sheela Stuart, University of Nebraska
Eric H. Nyberg 3rd, Carnegie Mellon University / Semantic Compactions

## Abstract

A communication aid which incorporates a parser with limited intelligence is under development, and is intended help individuals with aphasia to communicate. There are three important issues that must be addressed in the design of such a system: language representation (how to represent words, phrases, and topics in a way accessible to a person with aphasia), vocabulary selection (which words, etc., to include in the system), and syntactic and pragmatic defaults (what kind of sentence structures should be included in the parser's generative capacities). This paper explores a methodology for designing an intelligent communication device that pays particular attention to these issues. Much of what is discussed should also be useful for designing conventional communication systems as well

## Background

The term *aphasia* refers to an acquired disturbance of communication resulting from damage to areas of the brain that are responsible for language function. Aphasia varies in terms of severity and predominant symptoms, but for most people, aphasia involves problems in talking, listening, reading, writing, and gesturing. Other motor and sensory problems, such as dysarthria and apraxia, frequently coexist with aphasia (Katz, 1990, p. 167). Defining aphasia in terms of general versus specific language impairment leads to controversy about classifying persons with aphasia into various types.

Those who require classification of specific impairment (Rosenbek, LaPointe, & Wertz, 1989; Goodglass & Kaplan, 1972; Kertesz, 1979) divide aphasic patients into groups according to salient symptoms. There are numerous classification systems. Some of the most popular systems reflect universally observed symptomatic differences. Some people with aphasia talk a lot, while others speak very little, leading to the binary classification of *fluent* versus *nonfluent* aphasia (Goodglass & Kaplan, 1983b). Some aphasic patients have predominant problems in understanding and others have predominant problems in word finding. Thus classification may be made on these bases: *expressive-receptive* aphasia (Weisenburg & McBride, 1935) versus taxonomic categorization of aphasia (Kertesz, 1979).

Supporters of the generalist approach (Darley, 1982; Schuell, Jenkins & Jimenez-Pabon, 1964) resist categorization, and maintain that patients suffering from aphasia have in common symptoms which can be described as impairment of the capacity for interpretation and formulation of language symbols. Such symptoms include multimodal loss or reduction in efficiency of the ability to decode and encode conventional meaningful linguist elements (such as morphemes and larger syntactic units), reduced availability of vocabulary, reduced efficiency in application of syntactic rules, reduced auditory retention span, and impaired efficiency in input and output channel selection (Darley, 1982).

Augmentative/alternative Communication (AAC) systems which would be useful for people with aphasia must incorporate features which address both the diversity and the commonality of this population. For example, it may seem as though a system which provides speech output for pre-stored sentences might be quite successful for an individual with aphasia who is unable to formulate and articulate his or her own sentences. However, a sentence vocabulary can be difficult to process for many individuals with aphasia, because they may have difficulty placing a sentence lexicon into working memory. Pictorial rather than orthographic indices have been shown to improve the ability of some aphasic individuals to access vocabulary (Steele, 1987), yet a system making use of single-meaning pictures requires a picture for each vocabulary item, making it impractical for all but the most limited vocabularies. The generative power of a word-based system has been deemed beyond the reach of many individuals with aphasia owing to their problems with syntax and lexical access, although some systems with elaborate hierarchical indices have been proposed (Steele, 1987).

Identifying the major needs of a broad range of individuals with aphasia would seem to supply a direction for AAC application of technology.  Kraat (1990) states that early research and clinical reports suggest that AAC techniques might have three important roles in aphasia treatment:

> "First, as a compensatory or alternate means of communication in lieu of spoken language, secondly, as a facilitation technique for the re-acquisition of spoken language skills; and thirdly, as an associative ' link' to enable spoken language skills to take place."- (p. 322)

The task of this paper is to report recent efforts and progress toward providing a means of accomplishing the first role. A new type of electronic communication device geared toward speech output for this population is currently under development. The hope is that the device will help people with aphasia to overcome both the lexical access problem (by providing an appropriate interface for word selection) and the syntactic production problem (by providing an intelligent parser that can generate well-formed sentences from an underspecified input).

## Statement of the Problem

The first problem that arises in the design of a communication aid for people with aphasia is the representation of vocabulary, It is a challenge to represent a large vocabulary in a transparent manner for individuals experiencing substantial lexical access problems. The iconic technique under exploration may provide individuals with a cognitively syntonic representation of several hundred words.

Even with a transparent language representation, the size of the vocabulary that such an individual can access is necessarily limited. The second problem, thus, is in selecting an appropriate vocabulary. The vocabulary must be large enough for gratifying interaction, but small enough so that its access does not overwhelm an individual with aphasia

The goal is to provide an individual who has less than complete syntax with the ability to create well-formed sentences by entering just a string of content words, Thus, the third problem that must be addressed is configuring the syntactic prosthesis. The intelligent parser must be able to give an interpretation that is complete yet appropriate to the user's style and needs. It is certainly possible to decide in advance that certain more likely interpretations shall be made for given types of sentences, but the system must have a mechanism for incorporating the default interpretations that best fit the particular individual.

A large number of individuals with aphasia experience their lesions in the 7th or 8th decade of life. As adults reach their 60s, 70s and 80s, there are changes in many aspects of their lives. One of the areas that reflects this change is the way people of this age take part in conversation. Older persons are listened to in ways that are different from younger persons. Information expected from older persons is, at least in part, determined by the age-grade role. The type of request for information from them is often performed as though the aged person was a repository of cultural lore. It is hypothesized that this role, along with inherent biological changes, may cause older persons to recall and recode into a story-like mode, which often reflects the extensive elaboration of memory information and serves to make it highly digestible for the listener (Mergler & Goldstein, 1983).

The foregoing paragraph serves to illustrate the notion that elderly individuals, who comprise the majority of individuals with aphasia, have quite different communication needs from those of the general population. This certainly has an impact on the size and content of an effective vocabulary for such individuals; the story-telling mode of communication requires a rich vocabulary which may intersect with, but is not limited to, the everyday vocabulary most often associated with electronic communication aids. In addition, the types of sentences favored by these individuals can impact on the type of syntactic processing that should be available in a successful syntactic prosthesis. For example, the use of anaphora, ellipsis, and conjunction decline with the age of the storyteller and with the complexity of the narratives (Kemper, Rash, Kynette and Norman, 1990).

## Approach

*Language Representation*

A common problem experienced by people with aphasia is the failure to access the lexical items which correctly express the semantic meaning the individual wishes to communicate. An iconic interface may be helpful to such individuals because it may be easier to identify pictures or *icons* which represent the meaning they wish to express. In order to make this reasonable in terms of the physical layout of an interface, it is not enough to use single-meaning key actuations, since this would require an interface with 300 keys to represent 300 words. Instead, the project utilizes an iconic representation approach requiring two key actuations for each selection, which can therefore represent 300 words using far fewer keys. Consider, for example, the selection of the noun *sleeve*. The first actuation would be of a key representing the semantic category of the desired noun (e.g., CLOTHING). The second key in the sequence would be selected from a set of more complicated icons, implicitly representing items from several semantic categories. The multiple meanings associated with the second icon would be disambiguated based on the first selection. For example, if CLOTHING has been selected then an icon picturing a POLICEMAN might result in the selection of the noun *hat*, while the selection of an ARM icon illustrating an arm holding an ice cream cone might result in the selection of the noun *sleeve*. Note that the same icons can trigger different nouns if a different category has been chosen, e.g., selecting the ARM icon when the FOOD icon has been selected might give us *ice cream*.

The utility of such a representational scheme is being developed through interactions with able-minded individuals in their 7th and 8th decades, as a prelude to testing on individuals with aphasia. We hypothesize that this representation technique will support lexical access of several hundred lexical items for this population using a relatively small number of keys.

*Vocabulary Selection*

Our goal is not merely to provide an unstructured “word list” for this set of clients; rather, we feel that the following steps are necessary in the creation of a complete model of the client vocabulary:

- *Corpus Acquisition*. Using appropriate data collection techniques, a large representative corpus is gathered.
- *Language Analysis*. The corpus is analyzed in order to answer the following questions about the language model:
- 1. What words and classes of words are used?
  2. What syntactic structures are commonly used?
  3. What semantic concepts underly the communication?
  4. What pragmatic goals are evidenced in the communication?
- *Language Model.* The results of language analysis are compiled into the lexicon, syntactic rules, and semantic concepts needed to design and implement the communication aid.

*Syntactic Defaults*

The job of the intelligent parsing component in a communication aid is to determine which of the available syntactic patterns best fits a particular input given by the individual with aphasia. The knowledge required to perform this task successfully results from the construction of a language model for a particular client group (Fristoe and Lloyd, 1980). Construction of the language model will reveal patterned relationships between what the individual wishes to express and the syntactic patterns commonly used by non- aphasic individuals in similar life circumstances.

Once the client has selected a sequence of icons that express the intended communication, the parser must “fill in the gaps” left behind owing to a lack of syntactic knowledge on the pan of the client. Some individuals with language loss are prone to lapses in correct word order and the omission of function words, such as determiners and prepositions. For example, the user might key in the icon sequences for the words TABLE CUP PUT when the intended communication is *Put the cup on the table*. In this case, the intelligent parser must determine that CUP is the object of PUT, and that TABLE is the locative of PUT, and reorder the words appropriately. The parser must also add any missing determiners (like *the*) and prepositions (like *on*).

## Implications

*Corpus Acquisition.* Cerebro-vascular accidents (CVAs) causing aphasia often strike individuals in their 7th and 8th decades (60’s and 70’s). Stuart and Beukelman (in press) examine the topics and lexica used by 5 non- aphasic individuals in this age group. While these individuals are not aphasic, it is reasonable to expect that their vocabulary and syntax needs are similar to those of aphasics in this age group (Holland, 1975). Beukelman and Stuart’s data collection methodology has resulted in the recording of a large amount of previously unavailable data concerning the vocabulary and topics prevalent in an age group commonly affected by aphasia. These data and the language corpora resulting from Stuart's subsequent work (Stuart, forthcoming) form the basis of the vocabulary being developed.

*Language Analysis*. The analysis of the acquired corpus involves morphological and syntactic analysis of each sentence to determine not only the actual word forms present, but also the underlying lexical form and inherent meaning of each word. For example, the verb throw can appear in various surface forms. If a system fails to perform morphological analysis, it will be unable to determine that *throws* and *threw* are both forms of the same verb. In addition, if we fail to perform syntactic and semantic analysis, we will conflate the occurrence of a single form of throw in sentences like *John threw up* and *John threw the ball*. The key point is that the same surface form can be used to indicate different meanings, depending on the surrounding words (i.e., syntactic structure). It should be noted that syntax is sufficiently rich to render ineffectual the use of simple two-word co-occurrences; for example, in *John threw his hands up*, an entire noun phrase is interposed between the verb and its particle. In this case, the verb and its panicle can only be related through a more complete syntactic analysis. Without this type of detailed analysis, broad classes of words (such as phrasal verbs, non-neighboring collocations, etc.) cannot be distinguished on the basis of key-word analysis only. It is also difficult to appreciate the pragmatic communication goals of the client group unless this type of analysis is performed, since the overall desire expressed by a particular communication act depends quite heavily on its syntax and semantics.

*Language Model*. Once the corpus has been analyzed, a language model is constructed that includes not only the selected vocabulary, but also a set of syntactic constructions, pragmatic goals, and semantic concepts that must be present to support communication by the client group. This is necessary to support the subsequent design and development of a communication aid for the particular client group, since not only the vocabulary itself but also the syntax, semantics, and pragmatics must also be encoded in the device (McCoy, et al., 1990).

## Discussion

The use of intelligent parsing in augmentative communication has been a distant dream for many years. The actual development of such a system is now at hand. Older adults with aphasia have been selected as its first target population, because the needs of this community are underserved, and the potential benefits of intelligent parsing are great. A substantial corpus, reflecting the actual speech and language use of this population has been gathered and is now the object of attention by computational linguists and speech pathologists in 3 major centers of research.

Some form of intelligent parsing may hold great promise in the design of AAC systems for aphasic individuals. The strengths of intelligent parsing (filling in missing words and re-ordering scrambled input) complement the difficulties of individuals with reduced language function. In addition, an intelligent parsing system that utilizes an iconic interface can make that capability available in a pictorial form that might be easier for aphasics to access, thus addressing the important problem of lexical access faced by individuals with aphasia.

To make intelligent parsing successful for a broad range of clients, we must envision not a single system with a single vocabulary, but several systems with vocabularies tailored for particular client groups and indeed particular clients. The effectiveness of intelligent parsing techniques can only be as effective as the the amount of care taken to acquire and support the vocabulary and language model required by the particular client or client group. Note we are not suggesting that our initial corpora vocabulary will in itself be sufficient for all clients. Indeed, the content of individual "stories" must be client specific, and will draw on both the common vocabulary and a vocabulary specific to the particular client. The client-specific vocabulary must also be acquired and made available in the communication aid. However, analysis of the collected corpus should provide us with a set of contextual guidelines which will make it much easier to query close family members for vocabulary content specific to a given individual in specific communication situations.

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## Contact

Bruce R. Baker
Semantic Compaction Systems
801 McNeilly Road
Pittsburgh, PA 15226