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EXTENDED COMMUNICATION SAMPLES OF AUGMENTED COMMUNICATORS I: A COMPARISON OF INDIVIDUALIZED VERSUS STANDARD SINGLE-WORD VOCABULARIES

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Vocabulary selection for linguistically intact augmented communicators is a growing clinical concern. The purpose of this study was to compare and contrast the relative benefits of word lists that were individualized for these augmented subjects to word lists selected from standard vocabulary sources. Communication samples were collected for 14 consecutive days from 10 subjects who used augmentative and alternative communication (AAC) devices. These samples were analyzed to determine the frequency of single word occurrence, and the results were compared with those obtained from analysis of standard vocabulary lists. The conclusions of the study were (a) that when vocabulary lists are individually created, based on the frequency of word occurrence in natural communication samples, relatively short lists can represent a large proportion of the total communication sample; (b) that individualized word lists are more efficient than standard vocabulary lists, if efficiency is defined as a large proportion of the total sample represented by a small list; and (c) that if used in their entirety, standard lists are not efficient because they contain a large number of words that are rarely used.

KEY WORDS: augmentative communication, communication, vocabulary

Vocabulary selection for linguistically intact augmented communicators remains an important clinical concern. These individuals can access large numbers of words through letter-by-letter spelling. However, their reduced access rates result in a communication rate often as slow as 2–10 words per minute. The goal of vocabulary selection for individuals with intact linguistic skills is not access to words that would otherwise be unavailable to them, as it is with linguistically developing children. Instead, the goal of vocabulary selection in this population is improved rate and efficiency of communication and reduced fatigue.

The selection of vocabulary for an augmentative and alternative communication (AAC) system user is a complex process. Vanderheiden and Kelso (1987) reviewed many of the strategies that might be used to meet the vocabulary needs of the augmented communicator. Some words are selected to accelerate communication rate. Typically, these words contain a relatively large number of letters, and efficiency of message preparation is realized when these words are retrieved with short codes. The relative frequency with which these words are used in the communication samples of the individual is directly related to the overall communication efficiency that will be experienced if the words can be retrieved with an abbreviated code.

The selection of large vocabulary lists for the augmented communicator may be viewed as a compromise between costs and benefits. The potential benefits include increased communication rates and possible reduction in fatigue that may be related to the large number of selections required for letter-by-letter typing. The costs include such factors as the use of computer or device memory that then cannot be used for other functions. Other costs relate to the cognitive demands of the retrieval task. The instructional and learning times required to master multiple retrieval codes are a reflection of these cognitive demands. In addition, the perceptual/motor demands of selecting the target word from a large array of options will also be reflected in additional learning costs. During clinical intervention, the following issues are often considered in order to evaluate these costs-benefits concerns. First, are so many words stored in the system that computer memory must be conserved in order to allow other functions? Second, do the benefits of the keystroke savings outweigh the instructional and learning costs of memorizing a large number of codes? Third, do the benefits of keystroke saving outweigh the instructional and learning costs imposed by the perceptual/motor demands of complex arrays?

In previous work, Yorkston, Dowden, Honsinger, Marriner, and Smith (1988) suggested that standard vocabulary lists are a good source of potential words for AAC devices. However, the vocabulary samples studied were limited to words contained on communication boards or programmed into computer-based devices that were utilized by augmented communicators. The assumption of this preliminary work was that these vocabulary lists, selected for AAC applications, had indeed been well chosen. Even if this assumption proves to be correct, use of such vocabulary lists is limited because one is never able to document the proportion of natural communication actually represented by the AAC user lists. Therefore, the current research project is an extension of previous work and allows for better documentation of actual benefits of large storage vocabularies for linguisti-

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cally intact augmented communicators. The purpose of this study was to compare and contrast the relative benefits of word lists individualized for specific AAC users versus existing large standard vocabulary lists.

METHOD

Subjects

Ten linguistically intact adolescents and adults who used AAC devices to communicate served as subjects. Table 1 contains information regarding etiology, age, gender, communication device, and functional level of natural speech. A review of the table suggests that etiologies included both congenital and adult onset disorders. Four subjects had cerebral palsy, whereas 6 subjects had survived traumatic brain injury or aneurysm. A number of different communication devices were used by the subjects. All had the capacity to produce printed messages prepared in a letter-by-letter fashion. Although some devices also had the capacity to store and retrieve a large number of messages, at the time when the communication samples were obtained, all messages were produced in a letter-by-letter fashion. All subjects were severely dysarthric; however, the usefulness of their natural speech varied. Half of the subjects used some functional speech. Placement in this speech category implies that the subject was not an independent natural speaker but used speech functionally in some situations or with some listeners. Three of the subjects used vocalization as an attention-getting signal but had no other functional speech. Two of the subjects were unable to produce vocalization.

Communication Samples

Extended communication samples were obtained in natural settings and contexts from all subjects. The goal was to collect a large, representative sample of messages produced using the AAC device. For all of the subjects, this was accomplished by collecting a printout of all messages produced by the subject during a 2-week period of time. Two of the subjects (Subject 4 and Subject 8) also kept personal journals describing their experiences. Journal entries along with daily communication samples were analyzed for these individuals. No attempt was made to maintain the order in which the messages were produced. As the samples were entered into the computer for analysis, no grammatical or stylistic editing was done. However, spelling errors were corrected and when alternative spellings were possible, a single alternative was selected and used consistently across subjects. Contractions were entered as different words. For example, *don't, do,* and *not* would all be entered as different words if they all occurred in a subject's sample.

Analysis

All of the communication samples were entered into an IBM XT computer and stored as a word processor file (Microsoft Word™, Version 3.0[1]). This word processing program has the capability of generating a list of all different words appearing in a sample in order of frequency of occurrence along with the actual number of occurrences of each word. A listing of different words from each subject's sample along with the frequency

[1]Microsoft Word, Redmond, WA: Microsoft Corp.

TABLE 1. Subject characteristics.

Subject	*Etiology*	*Age/Gender*	*Communication device*	*Speech*
1	Cerebral palsy	13/M	Sharp Memowriter	Some functional speech
2	Cerebral palsy	30/M	TouchTalker (Minspeak)	Some functional speech
3	Cerebral palsy	21/M	Canon Communicator	Vocalizes as signal
4	Traumatic brain injury	28/F	LightTalker (Express)	Some functional speech
5	Traumatic brain injury	18/M	Canon Communicator	Vocalizes as signal
6	Cerebral palsy	27/M	Expanded keyboard	No vocalization
7	Traumatic brain injury	23/F	Canon Communicator	Vocalizes as signal
8	Aneurysm	30/F	LightTalker (Express)	No vocalization
9	Traumatic brain injury	22/M	Canon Communicator	Some functional speech
10	Traumatic brain injury	26/M	Canon Communicator	Some functional speech

of occurrence was then entered into a database (Revelations™, Cosmos Inc., 1985[2]). The database was structured so that each word was entered as a record. Sixteen fields were created, 1 for the data from each subject and 1 for each standard vocabulary list. Subjects' fields contained the number of occurrences of each word (record), and the standard vocabulary list field simply contained a +/− indication of whether or not that word was contained in the standard vocabulary list.

In order to address the research questions proposed in this project, the database was queried so that the following measures were obtained for each subject:

Number of total sample: This is the number of words contained in the total communication sample and was obtained by summing all occurrences of all words in each subject's field.

Number of different words: This list contains the number of different words in the sample and was obtained by counting the number of words in each subject's field that occurred one or more times in the extended sample.

Number of nonunique words: This is the number of words that occurred at least two times in the total communication sample and was obtained by counting the number of words in each subject's field with an occurrence of two or more.

Reliability

Most of the computations were computer generated. However, because errors could be introduced as vocabulary items were entered onto the computerized database by the research technicians, a procedural reliability check was conducted on a 500-word list selected from the samples. When the accuracy of data entry was checked for this 500-word sample, two word entries were found to contain errors. This error rate of 0.4% was considered acceptable for this project.

RESULTS

Description of the Samples

The extended samples produced by augmented communicators ranged in size (total number of words) from 2,263 to 9,551 words. Figure 1 illustrates information regarding the size of the total samples, the number of different words, and the nonunique words contained in each of the subjects' extended samples. Subjects in this figure are ordered according to the number of different words contained in their communication samples. Also shown in this figure is an indication of the type-token ratio (TTR) (number of different words divided by total words) for each sample. Generally, the TTR decreases with increasing sample size as would be expected (Loban, 1963; Nelson, in press). Finally, Figure 1 contains an indication of the number of nonunique words contained in each of the extended communication samples. These are the words that occurred two or more times in the extended samples. Note that the size of this list is small either in comparison to the total samples or in comparison to the list of different words. The list of nonunique words ranged from 248 words for Subject 1 to 704 words for

[2]Revelations™, Cosmos, Inc., Bellevue, WA (1985).

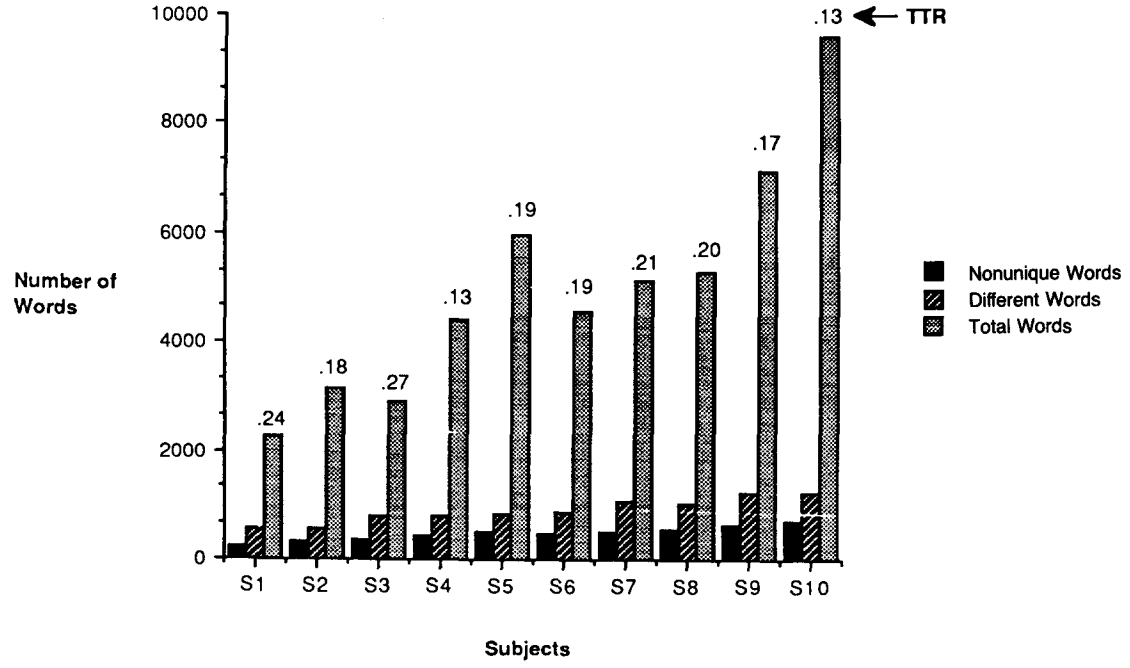

FIGURE 1. A histogram of the number of total words, different words, and nonunique words for 10 subjects. Also included is the type-token ratio (TTR) for each subject.

Subject 10. In the following discussion, the list of nonunique words will be considered the "best individualized list" because it represents a large proportion of the total communication samples. Only those words occurring once in the entire sample have been eliminated from this list.

Individualized Word Lists

Ideally, one would select only those words used most frequently by an augmented communicator for inclusion in a communication device. Our question was what proportion of the total communication sample would be represented by individualized word lists? Lists of various sizes were compiled and labeled as follows.

List 30—This list contained all words occurring at or above a frequency of 30/1,000.
List 20—This list contained all words occurring at or above a frequency of 20/1,000.
List 10—This list contained all words occurring at or above a frequency of 10/1,000.
List 5—This list contained all words occurring at or above a frequency of 5/1,000.
Best individualized list—This list contained all words occurring two or more times in the extended samples. These are the nonunique words.
All words—This list contained all the different words contained in the extended samples.

Frequency data were converted to ratios expressed in occurrence per 1,000 words to equate for differing sample sizes. The proportion of the total communication samples represented by each of these lists was computed using the database software. This was done by summing the number of occurrences of all words over a particular frequency of occurrence and dividing that sum by the total words in the samples. The data displayed in Figure 2 represent the mean and standard deviation values across 10 subjects. Note that even short lists of frequently occurring words represented a relatively large proportion of the total sample. For example, the small list (List 30, containing only an average of 65 words) represented an average of 55.2% of the total sample. As the lists increased in size, a greater proportion of the total sample is represented. The best individualized list, a list containing on the average 475 words, represented 90.3% of the total sample.

Comparison of Standard and Individualized Vocabulary Lists

In order to compare the standardized lists and individualized lists, the proportion of the total communication sample represented by lists of various types and size was computed. For this analysis, six standard vocabulary lists were selected and entered into the database. These vocabulary lists were selected to represent either word lists utilized in commercially available AAC devices or composite lists that have been used as sources for vocabulary of linguistically intact augmented communicators. The database was queried in order to select all words that occurred both in each subject's list of different words and in each of the following standard lists that are ordered from smallest to largest.

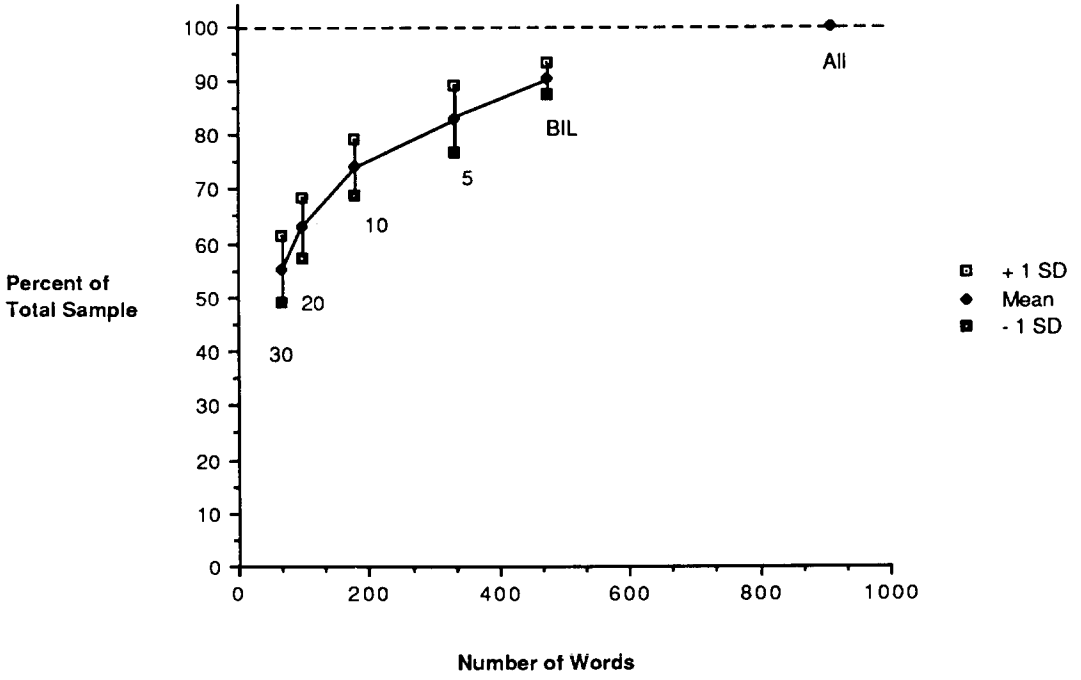

FIGURE 2. A line graph of the mean percentages and standard deviations of the total communication sample represented by subsets of frequently occurring words across 10 subjects. The best individualized lists (BIL) contain nonunique words, those occurring 2 or more times in the total communication sample.

List F—500 Frequently Occurring Words (Beukelman, Yorkston, Naranjo, & Poblete, 1984). This is a list of the 500 most frequently occurring words in the communication samples of severely physically handicapped individuals who used Canon Communicators.

List U—User Composite List (Yorkston et al., 1988). This is a composite list of words from AAC devices. These words occurred frequently across a group of nine augmented adolescents and adults.

List V—Vois 140 Word List. This is the list of words that are stored in the VOIS 140 (Phonic Ear, Inc.[3]) speech output communication device.

List S—Standard Composite List (Yorkston, et al., 1988). This is a composite list of words that occurred frequently across 11 different standard vocabulary lists.

List W—Words+ Word List. This is a list of words stored in the Words+[4] AAC devices.

List M—Minspeak Single-Word Vocabulary (Baker, 1988). This is the word list included in the Minspeak Single Word Strategy[5] word list.

After a list of words common to both a subject's sample and the standard lists was generated, the number of word occurrences represented by that list was summed and the result divided by the total number of words in the extended sample. Thus, the proportion of the total sample represented by the words in the standard vocabulary lists was computed. In Figure 3, the percentage of the total sample averaged across 10 subjects is plotted against the number of words in each of the standard vocabulary lists. This figure illustrates the mean and standard deviation data for each of the standard vocabulary lists. The individualized lists (displayed in Figure 2) are also plotted in Figure 3 in order to facilitate comparisons. A review of Figure 3 suggests that the standard lists tend to be larger than most individualized lists. Further, the standardized lists tend to represent a smaller proportion of the total sample than do the individualized lists. Even the largest of the standard lists do not contain all of the words used by our augmented subjects. Note that the large standard vocabulary from the Minspeak Single Word Strategy (M) contains nearly 1,600 words and represents an average of 82.6% of the total sample.

The relationship between size of the standard vocabulary list and the proportion of words in the lists that were actually used by the subjects was also explored. Figure 4 illustrates means and standard deviations of the percentage of words in the list used by our subjects for each of the standard words lists. Note that when words lists are ordered from smallest (F) to largest (M) there is a consistent decrease in the proportion of words from the lists that are actually used. Over 60% of the words from List F are used by the subjects, whereas an average of only 27.1% of the words from List M are ever used by our subjects in an extended 2-week sampling period.

[3]Vois 140 Word List, Phonic Ear, Mill Valley, CA.
[4]Words+ Word Lists, Words+, Sunnyvale, CA.
[5]Minspeak: Word Strategy, Wooster, OH: Prentke Romich Co.

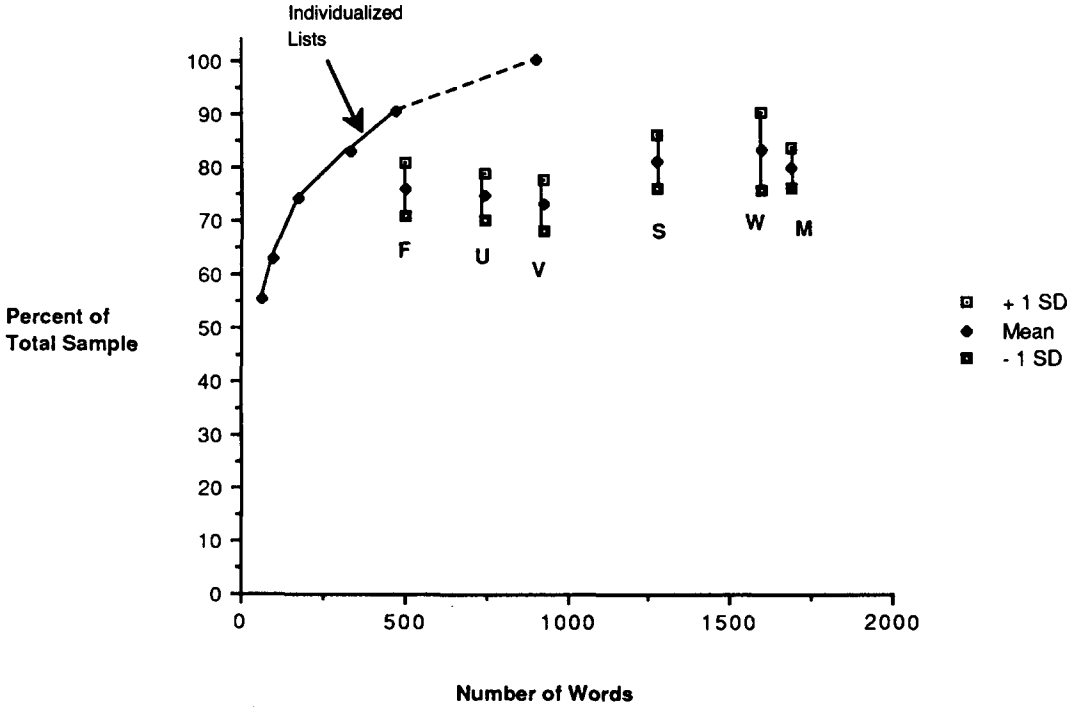

FIGURE 3. The mean percentages of the total communication sample represented by subsets of frequently occurring words for individualized lists averaged across 10 subjects and six standard word lists: (F) 500 frequently occurring words (Beukelman, Yorkston, Naranjo, & Poblete, 1984), (U) User composite list (Yorkston, Dowden, Honsinger, Marriner, & Smith, 1988), (V) Vois 140 word list (Vois 140 by Phonic Ear, Inc.), (S) Standard composite list (Yorkston et al., 1988), (W) Word+ word list (Words + Company), and (M) Minspeak single-word vocabulary (Baker, 1988).

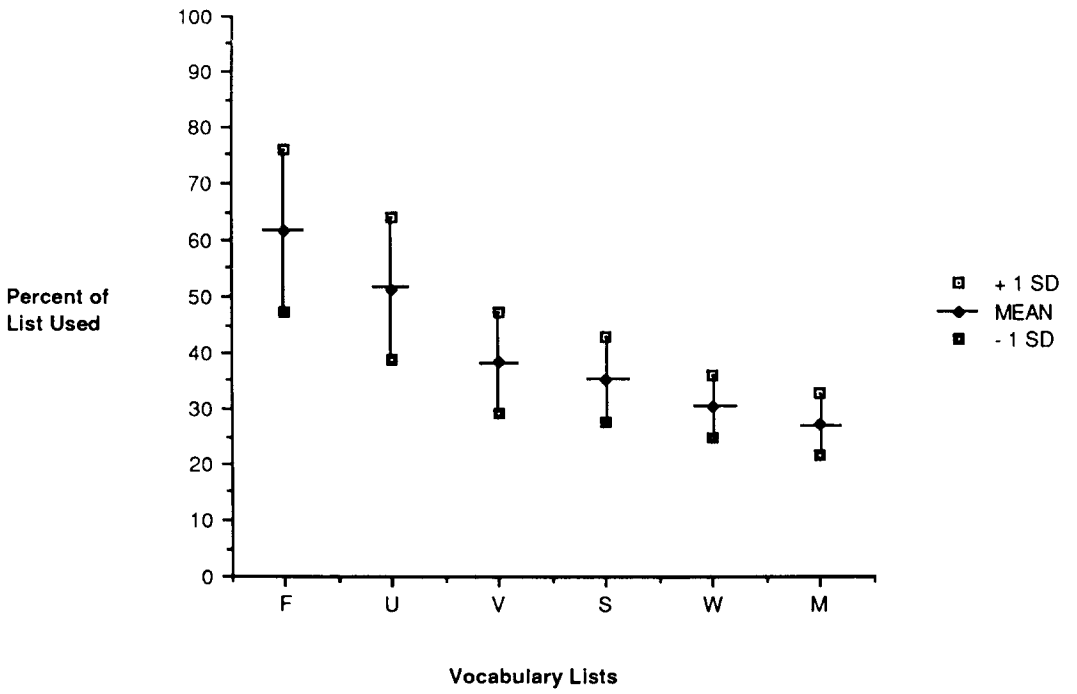

FIGURE 4. This figure illustrates the mean and standard deviations of the percentage of words contained in the standard lists (identified in the legend for Figure 3) that were used by 10 subjects.

Selected Standard Lists

Selected standard lists were also created by selecting from the complete standard lists only those words actually used by a subject (including unique words). By eliminating the "unneeded" words, the word list size decreased markedly. Figure 5 illustrates the percentage of the total sample plotted against the average number of words in the selected standard lists. An examination of this figure suggests that the selected standard lists range in size from 325 (List F) to 486 (List W). Note that there is a clustering of data points for the standard word lists. However, none of the standard word lists resulted in a higher proportion of the total communication sample than the individualized lists of the same size.

DISCUSSION

Selection of Vocabulary

The selection of vocabulary to be included in the AAC device of linguistically intact augmented communicators involves consideration of a number of simultaneous but differing goals. First, messages are included that respond to urgent communication needs, such as "Suction me now!" "Please put my feet on the footrest before you move me!" "I am not finished yet!" Because proper timing of the message is important to effective communication, such messages are usually retrieved in their entirety as phrases or multiple-word sequences. Second, messages may be included in AAC devices that are repeated regularly such as one's name, address, greeting, or requests for assistance. Obviously, these messages are determined by an individual's communication need and the effectiveness of other modes of communication such as gestures or natural speech. These messages may be retrieved as complete phrases or on an individual word basis. Third, vocabularies are selected that contain words that are frequently communicated by the individual in a variety of different messages. Typically, these words are selected so that communication speed will be enhanced and fatigue reduced because the retrieval of these words will reduce the number of selections or keystrokes required as compared to letter-by-letter typing.

The decisions regarding the selection of individual words for an AAC device have been guided by a number of different strategies. Some of these strategies are individualized, in that they focus on the environment, needs, and vocabulary use patterns of the augmented communicator. Other strategies are more general, in that standard lists reflect the vocabulary needs or use patterns of numbers of linguistically competent individuals, some disabled and others nonimpaired. In the present research, we have attempted to compare individualized vocabulary usage patterns to those standard vocabularies derived from the performance of groups of individuals.

Our data suggest that when vocabulary lists for linguistically intact augmented communicators are individually derived based on analysis of natural communication samples of the given individual, relatively short lists can represent a large proportion of the total communication sample. One can question whether or not these "conver-

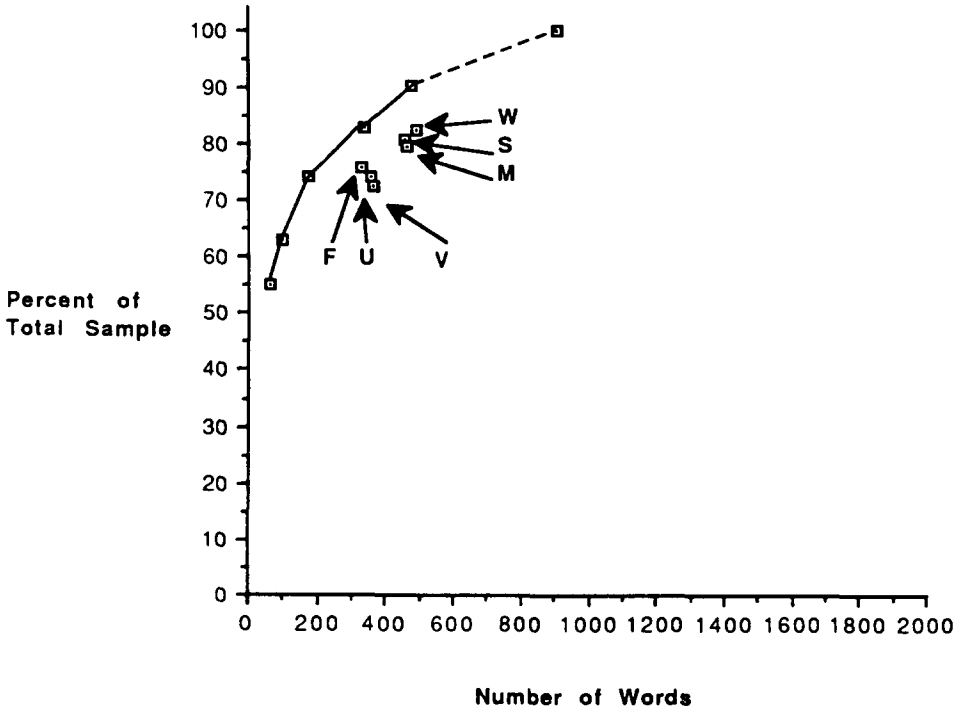

FIGURE 5. This figure illustrates the percentage of the total sample plotted against the number of words in the selected standard lists.

sational" samples are representative of communication in general for our subjects. If linguistically intact, augmented communicators are similar to nonimpaired speakers in their word usage patterns, conversational speech is expected to be simpler (Berger, 1967) and much less lexically diverse than written material (Hayes, 1988). Thus, the assumption that words selected from an analysis of conversation will be well suited for other vocational or academic writing is probably not warranted. The study of how word usage patterns change as a function of communication task and setting is an important area for future investigation.

Individualized word lists are more efficient than standard vocabulary lists, if efficiency is defined as the largest proportion of the total sample represented by word lists of limited size. If used in their entirety in an unmodified or unselected fashion, standard lists are not efficient because they contain a large number of words that are rarely or never used by a particular individual. The use of unmodified standard lists in an AAC device is of particular concern if perceptual/motor or cognitive demands are associated with "unneeded" words contained in unselected standard lists. For example, consider the case in which an AAC device such as the Minspeak TouchTalker or the VOIS 140 is selected for a linguistically intact individual, and that person is taught to retrieve the vocabulary items using a code without concern for the individualized use patterns. The instructional and learning costs will be very high considering that a large proportion of the words in the devices might not be used frequently. The instructional costs include the direct instructional costs of the teacher, clinician, facilitator, or family member who is involved in direct teaching. The learning costs are also incurred by the augmented communicator in the time spent learning the system. Depending upon the lifestyle of the individual, the learning cost might be quite low, because other demands for the individual's time are not great. However, for others, the learning time associated with the AAC device might be competing with time needed for work or education. The decision to recommend a vocabulary retrieval system that is associated with high instructional and learning costs must be made with consideration of the benefits that will be realized.

This is not to suggest that standard word lists should be abandoned. On the contrary, our data also suggest that they are an excellent source of potential words to be included in an AAC application. The inclusion of standard word lists in the memory of an AAC device is a great time savings for augmented communicators and their facilitators. However, these standard lists must not be taught without careful consideration. Systematic strategies are required to eliminate unnecessary or "costly" words from the standard vocabulary lists as an AAC device is individualized for a given client. In some cases, unnecessary words need not actually be eliminated from the system. In other cases, codes for useful words can simply be taught first. Thus, the sequence of teaching of codes is individualized rather than curricular with all students proceeding through the same learning sequence regardless of their needs.

Future Research

A number of potentially beneficial future clinical and

research directions appear to be warranted. First, the development of clinically feasible ways to statistically analyze individual communication samples is an urgent clinical need. Communication samples obtained from natural settings appear to be a very effective information source for vocabulary selection. Second, because many augmentative communication devices are computer based, development of "smart systems" to automatically track word usage patterns is an intriguing possibility. Such systems would provide augmented communicators with the capability of periodically analyzing their word usage patterns and updating personal vocabulary when necessary. Third, research is also warranted in the general area of reducing the various costs for persons who require large vocabularies. This could be accomplished by developing systems with such large capacities that computer memory is not a limiting factor. The costs of large vocabularies could also be reduced by continuing to develop efficient retrieval strategies that do not place excessive instruction or learning demands on augmented communicators. Finally, the potential benefits of supplementing storage of single words with frequently occurring multiword phrases is an area that warrants further exploration. In the companion article that follows (Yorkston, Beukelman, Smith, & Tice, 1990), the extended communication samples described here will be used as a basis for exploring the phrase usage patterns of linguistically intact augmented communicators.

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