

## Augmentative Communication: A Low-Cost and Lightweight Communication Device with Natural Speech

### Overview

Augmentative and alternative communication (AAC) devices are designed to facilitate communication among individuals who have difficulty in speech, writing, and sign language. Speech synthesis and digitally recorded speech provide a voice for these nonspeaking people. Unfortunately, keyboards and other conventional input devices are difficult to use and sentence production is often slow. Furthermore, commercial AAC devices are cumbersome and expensive—with many costing more than \$1,000.

The Livescribe Pulse smartpen provides the means for teachers, parents, and other caregivers to easily enable customized augmentative communication through a low-cost and lightweight smartpen with paper.

### From Theory to Practice

Gorenflo, C. W., & Gorenflo, D. W. (1991). The effects of information and augmentative communication technique on attitudes toward nonspeaking individuals. *Journal of Speech and Hearing Research*, 34, 19-26.

The study investigated three augmentative communication techniques on attitudes of nondisabled individuals toward nonspeaking persons with physical disabilities. In Condition 1, the nonspeaking individual used unaided communication techniques; in Condition 2, the nonspeaking individual using an alphabet board; in Condition 3, the nonspeaking individual used a computer-based voice output communication aid. **Attitudes towards of nondisabled persons towards nonspeaking individuals increased with the sophistication of the augmentative communication technique.**

Trembath, D., Balandin, S., & Togher, L. (2007). Vocabulary selection for Australian children who use augmentative and alternative communication. *Journal of Intellectual & Developmental Disability*, 32, 291-301.

Augmentative and alternative communication (AAC) systems are commonly used to support children with complex communication needs in Australian preschools. However, **such systems will only be effective if they contain words and messages that adequately meet these children's communication needs.** The results of the study indicate that children use a small core vocabulary comprising frequently and commonly used words, together with large and highly individualized fringe

vocabularies highlighting the importance of providing children both core and fringe vocabulary in AAC systems.

## Background

Commercial AAC devices come in many shapes and sizes and use a variety of methods to program and use them. The devices range from the simple 6-key *GoTalk 4+* (\$179; [www.attainmentcompany.com](http://www.attainmentcompany.com)) that provides 4.5 minutes of recording time, to the sophisticated 128-key *Green Macaw 5* (\$2,076; [www.zygo-usa.com](http://www.zygo-usa.com)) that provides up to 78 minutes of recording time. The Livescribe smartpen approach described in this Activity Guide costs \$150 (current retail price of 1GB Pulse smartpen) and provides 100 hours of recording time.



Figure 1: *GoTalk 4+* and *Green Macaw 5*

## Unit of Speech

AAC systems vary with respect to the units of speech they produce. Letter-based systems provide the greatest flexibility, but at the cost of speed. Nonspeaking users can communicate any idea they have, but it may take more than a minute to convey a single thought. Word-based systems allow a nonspeaking user to select individual words and word-endings. This approach can be very efficient when combined with word spelling since the 100 most frequently used words in English account for approximately 50% of all words used in normal conversation and writing. Finally, sentence- or phrase-based systems allow a nonspeaking user to produce an entire sentence by tapping a single key, resulting in the fastest production possible. A system that combines letters, words, and sentences will provide the best balance of efficiency and flexibility. (Note: For users who cannot read, a word or phrase-based approach based on images is required.)

## AAC Page Creation

It is important to understand that when you create a Livescribe-enabled AAC page, the smartpen you use to create it is the *only* smartpen the page will work with—the smartpen and page are a matched set. Accordingly, construct the page using the nonspeaking user’s smartpen.

### The Basic Procedure

A simple word-based AAC page can be prepared using the Paper Replay application as follows:

1. Tap the Paper Replay *Record* button.
2. Speak a word while writing it. (Note: it is best to begin writing slightly before you begin speaking. That way, when you tap on the first letter of the word, the audio file will play back at the right moment.)
3. Tap the *Stop* button.
4. Repeat steps 1-3 for a list of words.
5. To use the page as an AAC device, the nonspeaking user simply taps on the beginning of each word to hear it spoken.

An alternative approach to the basic procedure that improves the quality of the audio is as follows:

1. With the smartpen turned **on**, but with Paper Replay *Record* **off**, write a word on the page.
2. Tap the Paper Replay *Record* button.
3. Write a check mark (or other small symbol) next to the word.
4. Speak the word.
5. Tap the *Stop* button.
6. Repeat steps 1-5 for the list of words.
7. To use the page, the nonspeaking user simply taps on the mark next to each word to hear it spoken.

The benefits of the second approach compared to the first is 1) better timing between the tap and the recorded audio, 2) the speaker’s articulation is more clear (some people have a difficult time speaking naturally while they are writing), and 3) there is less scratching sound associated with pen on paper while speaking. Writing the check mark prior to speaking assures the clearest recording.

More useful pages can be produced by writing phrases and sentences in addition to single words—for example, “My name is John Smith.” and “How are you?” Phrases may be drawn from introductory foreign language texts where phrases are chosen based upon frequency of use in spoken language. These should be supplemented with phrases unique

to the character and intentions of the nonspeaking user. These personal phrases may relate to food, medications, hobbies, or mood. With four taps of the smartpen, a nonspeaking user could say, “I’m hungry ... Would you please bring me ... a peanut butter sandwich ... please?”

Some users may also enjoy adding buttons that play music—like ring tones on a phone—or lines from their favorite movies like “Hasta la vista, baby” or “There’s no place like home.” Other users may ask their friends and family to record personalized messages for them that they can listen to whenever they would like.

### Image-Based AAC Pages

For nonspeaking individuals who cannot read, image-based AAC pages can be produced just as easily as word-based systems. The AAC creator simply draws a picture with Paper Replay turned off. She then turns on Paper Replay by tapping the *Record* button and speaks the word or phrase as she writes a keyword or symbol next to the picture. The nonspeaking user simply taps the keyword or symbol to play the audio recording.

Alternatively, the caregiver and the nonspeaking user can select photos and drawings found in magazines, books, or websites. The AAC creator simply cuts out and glues the pictures to the page and then records the associated audio while writing a keyword or drawing a symbol next to it. Alternatively, AAC creators can print images directly onto Livescribe notebook paper fed into an inkjet or laser printer.



Figure 2: Image-based AAC using pictures pasted onto the page.

## For Advanced Users: Creating Large “Tappable” Regions

If a nonspeaking user is having a difficult time tapping on a word or phrase because it is too small, it is possible to create a much larger “tappable” region. Producing these regions requires a more advanced understanding of how the dot pattern is printed in Livescribe notebooks and how the Paper Replay *Pause* feature works.

### *Production Method*

The AAC creator can produce large tappable regions as follows:

1. With the pen turned off, draw a rectangle on the page the size you want the “button” to be. Write a word or draw a picture inside of it.
2. Take out the ink cartridge and replace it with the stylus.
3. Tap on the Paper Replay *Record* button and then immediately tap the *Pause* button.
4. “Shade” the rectangle in using the stylus. (*Note:* Obviously, because there is no ink in the stylus, you will not leave any marks on the page. Just pretend you are filling the rectangle with invisible ink. The regions do not need to be completely covered, relatively loose cross-hatching works fine.)
5. Tap *Pause* and then speak a letter, word, or phrase.
6. Tap *Stop*.
7. When the user taps anywhere within the box, the associated audio will be played back.
8. Repeat for as many regions as you would like.

Using this advanced technique, an AAC page developer can create a grid of large tappable regions. This would be a particularly useful technique to produce a QWERTY keyboard or numeric keypad. (See Figure 3 on the next page for an example.)

By understanding grammar and common phrase patterns it is possible to create a “sentence-building” structure that would allow the nonspeaking user to form a variety of sentences using a small number of mix-and-match components. As with the word list, actual use will determine, to a large degree, which phrases end up being useful on a day-to-day basis. The example on the next page includes a keyboard, sentence builder, and list of common phrases. It is not unreasonable to expect that an experienced user would use both sides of a page, or multiple pages.

### Refining the AAC Page

Over time, a nonspeaking user may notice that some frequently used words are not included in the list and must be tapped out on a hand-drawn QWERTY keyboard. Obviously, words that are tapped out frequently should be added to the list. The same is true for phrases. Because Livescribe AAC pages are easy to produce, it is possible to produce “generations” of pages quickly. Once it is found that an AAC page is relatively

stable over time (where new words or phrases are rarely added), the page can be laminated for durability. In fact, several laminated pages can be spiral bound together or inserted into the pockets of a small photo album. The Livescribe smartpen can read the dot pattern through plastic lamination or the plastic pocket of a photo album.

The page is divided into several sections of handwritten text:

- Key Phrases:**
  - YES • NO • OK • MAYBE
  - HELLO • GOOD MORNING • GOOD NIGHT • GOOD BYE
  - HOW ARE YOU? • I'M FINE • I'M ANGY • NICE TO MEET YOU
  - YES PLEASE • NO THANK YOU • THANK YOU • YOU'RE WELCOME
- Sentence Builder:**
  - I
  - HE • SHE • YOU • THEY • WE
  - CAN • WANT • HAVE TO • HAS TO • AM GOING TO • IS GOING TO • ARE GOING TO
  - TO WEAR • TO START • TO FINISH • TO GO • WITH • TO GO BACK • TO COME • TO CALL • TO TELL • TO ASK • TO EAT • TO DRINK • TO BUY • TO WAITER • TO PATTER • TO GO • TO LEAVE • TO SLEEP • TO LISTEN TO • TO HELP
  - MOM • DAD • JOHN • EMILY • GRANDMA • GRANDPA • ME • HIM • HER • THEM • YOU • NOW • RIGHT NOW • LATER • SOON • TODAY • TOMORROW • TONIGHT
  - HOME • SCHOOL • BATHROOM • BEDROOM • OUTSIDE • INSIDE • COT • IN • UP • DOWN • MONDAY • TUESDAY • WEDNESDAY • THURSDAY • FRIDAY • SATURDAY • SUNDAY • NEXT WEEK • NEXT MONTH • NEXT YEAR
  - MILK • JUICE • COKE • HAMBURGER • SANDWICH • PIZZA • McDONALD'S • TACO BELL • MEXICAN FOOD • CHINESE FOOD • JAPANESE FOOD • IPOD • COMPUTER • CELL PHONE • WALLET • TV • FOOTBALL • BASKETBALL • SPRING BED • NOTHING
- QWERTY Keyboard:**

1	2	3	4	5	6	7	8	9	0
Q	W	E	R	T	Y	U	I	O	P
A	S	D	F	G	H	J	K	L	: ;
Z	X	C	V	B	N	H	0	:	30

clock :30 :45

At the bottom of the page, there is a control bar with the following elements:

- record pause stop
- jump
- bookmark
- 0% jump to position 100%
- playback speed
- volume

Figure 3: Example of a hand-drawn Livescribe AAC page with key phrases, sentence builder, and QWERTY keyboard