Writing by Talking to the Computer: Experiences, Ideas and Questions

Colin J, Laine
Michele Breen

Abstract: This paper discusses the observations and implications of using speech-recognition access to computers. The authors used themselves as subjects in this initial exploration using *VoiceType2.* What they learned about the system was used in the training program they have initiated with dysfunctional adults. Observations from clients are reported. The paper suggests that such access may change the way we will write in the future. It also provides impressions for thoughts on ways in which we shall have to modify writing instruction for dysfunctional adults. Enhancements to such systems are portrayed concerning environments that may be disabling.

Resume: Ce document formule des observations relativement a l'utilasation de systemes a reconnaissance vocale comme voles d'acces a l'ordinateur et en examine les incidences eventuelles. Les auteurs servent de cobayes pour cette prem iere experimentation du systeme *Voice Jype2,* dont ils ont applique par la suite les resultats a un programme de formation concu a l'intention d'adultes dysfonctionnels. Les observations de clients y son) egalement consignees. Cette etude laisse entendre que l'acces vocal a l'ordinateur pourrait bien changer completement nos fagons d'ecrire. Elle lance egalement des pistes de reflexion sur les nouvelles voles que Ton pourrait eventuellement suivre pour l'enseignement de l'ecriture aux adultes dysfonctionnels. Les auteurs decrivent certainesamelioraitons qu'il serait possible d'apporter a ce genre de systemes en fonctlon d'environnements presentant des handicaps.

Adaptive vocabulary systems allow the user to access a computer by talking to it directly: thus bypassing the keyboard and 'writing[1] without the use of the hands. It is different from any method of writing that I have ever used. "Writing" is not exactly the word that comes to mind. It feels nothing like I was taught about the act of writing. This article is being composed by talking to the computer. What you are reading is a result of this interaction. There is no pencil to sharpen, no pen to dip in an inkwell, nor any worry about maintaining a consistent cursive slant. There will be some cheating as not all the specialised keystrokes have been mastered yet. Have you noticed the difference? Apart from those few keystrokes, "what I say is what you get." It seems a little futuristic at times.

Shows like *StarTrek* have characters saying "...Computer!..." weekly. Itis fiction; but is it all fantasy? Just how far away are "star dates" ? Picard and his crew might look back at us here in 1993 and smile at our crude technology. They would also observe that we have defined and set up structures and models that are little different to those on the "Enterprise". Many technical features we see in films such as Star *Trek* are already here. By comparison, we see young children's attempts with language as crude; but we know that by the time they are five, most have a 5,000+ word vocabulary, with our complex language structures and models already in place. There are significant parallels between the ways we learn language and the computer's learning to recognise speech.

Language & Learning

We converse in language that increasingly contains acronyms that have become nouns: abstractions that are made concrete by the contexts in which they are used. Second, we have expanded how we reach, analyze and distribute our knowledge. Using the computer in these processes is changing how we learn, how we work, and how we communicate. Many learners (both children and adults) continue to grapple with understanding the essentials of communication. There are others who, because of disease (e.g., Multiple Sclerosis) or injury, look for hope in technology; yet many find that same technology and rehabilitation frustrating. They have active minds in distorted bodies, yet the technology that they need to use in the workplace often presents barriers, rather than access.

The dysfunctional and non-literate adults with whom we work rely on a few abilities that are relatively strong. Most of these strengths are used very little in the traditional learning of scribal skills. These adults are more competent in oral language than in visual language (Laine & Geddis, 1992). Our studies show that these clients are continually frustrated with visually-based learning and make slow progress where the sole or primary form of instruction is visual. Consequently, they have problems maintaining their high initial motivation. The abilities they are expected to use in class focus on *memory,* on being systematic and on using *symbolic content.* Yet we found their strengths to be in *semantic content, evaluation,* and using *relations (analogies)* to solve problems.

Our clients voiced their frustrations at the complexities of much of the 'accessible' technology. Software that was designed to assist often had features (like very limited time delay) that caused observable frustration in clients with disabilities. There were many questions related to language levels in manuals and errors due to spasticity. A variety of assistive devices were tried out with several exceptional adult colleagues. Most of them were frustrated by the physical rules and limitations demanded by traditional keyboard access to a computer. However, a most positive writing access features for those colleagues with disabilities was *word prediction.* The discussions concerning this assistive feature focussed on the separation of the *mechanics* from the *semantics* of writing. Into this context was raised the potential for adaptive vocabulary systems (voice-activation and speech recognition) to access information and technology.

For adaptive vocabluary systems to work well, the user is presented with possible word options as responses to the speech sound the computer receives from the user. The more familiar the computer becomes with the user, the more efficient it becomes in offering the 'most correct' option first. This process paralleled the 'word prediction' feature that was a key facilitator to non-literate adults composing (Laine, 1989; Laine & Geddis, 1992). Speech-recognition technology is a very recent innovation and the literature relating the technology's application is small.

Extant Literature

There is a great deal of technical literature on the subject of how computers recognise speech sounds. It helped but we found most of it unintelligible! Little empirical work has been completed relating the interaction between speech-recognition technology and the user, its uses in learning, or its impact on independence and productivity. There is more relating voice-activated devices than speech-recognition. Only one article considers the topic of disabled persons' independence through voice-activation (Brown & Cavalier, 1992). One article discusses voice-activated vocabulary training with very young children (Kantrov, 1990). One describes using speech to simulate patient/doctor discussion in medical practice (Wilson, 1991) and one describes using voice-activated information-retrieval systems in libraries (Peters, 1989). Higgins & Raskind (in press) describe the use of speech recognition as a tool to help the writing skills of postsecondary students with learning disabilities. Much of the extant literature is based on assumption, and mostly produced by vendors. The contents of magazine articles that imply the value of speech recognition are based more on supposition rather than on empirical testing.

The best way to determine the accessibility and characteristics of speech recognition was to use the research team as guinea-pigs. Extensive notes formed the basis for research questions. After four months' trial using *VoiceType2*, the team raised several ideas, questions and paths for potential investigation. One idea — training and productivity of Employment Equity participants — is underway.

Technical Aspects

Before assessing writing by voice, it is important to review some technical aspects of speech recognition.

1. What is an adaptive vocabulary system?

There are two levels of an adaptive vocabulary system. A computer can be started by sounds (voice activated) and through a computer, one can send preset commands to activate other equipment. These do not necessarily have to be speech sounds. *Speech* is a different matter. Recognizing speech requires sounds be directly associated with a predictable language pattern. The computer then is not just changing switches through a single utterance. It provides the user with feedback in the same language form that one uses to compose. Even a 'grunt' can be associated with developing a word, or an idea - providing it is a consistent grunt. A single consistent utterance also can access particular system commands, parts or whole forms, letters, or papers. These commands are called 'macros' and can save a user with a disability significant time and energy.

2. How does the computer recognize speech or particular voices?

Speech-recognition systems like *Dragon Dictate* or *VoiceType* come with a base 'Vocabulary" of words and commands. The user repeats each word or command three to ten times into a microphone linked to the memory of the computer. The program digitises the phonetic presentation of a word, then compresses and stores the average of each word's repetitions as a mathematical code. *VoiceType* can combine these algorithms by sets of two (bigrams) and three (trigrams) embedded in its memory. They allow the program to recognize often-repeated patterns of digits so that it can begin the prediction process. Whereas voice-activated systems are multi-user, current speech-recognition systems are 'speaker adaptive' or speaker-dependent. This means that the program can recognise only one user at a time. Each user has a personal voice-file (about 2 Mb of memory) that has to be loaded before the computer will recognise the speaker. Each time we switch between users, the current user exits, savinghis or her voice-file, and the next user loads the name of his or her voice-file. It does not present a problem as there are only two users here, but as we accommodate more users, the system may become more cumbersome. This could be problematic in an office or classroom but within a year or so, this feature should change as programs able to adapt to multi-users become available.

3. How does one begin to use a speech recognition system?

Initially, one reads in the words supplied in the base vocabulary while using the tutorial. It can take about ninety minutes for *VoiceType* to digitise and store the phonetic patterns. As the program is used, some patterns are repeated frequently. For example, "nice" (N AY S) and "ly" (LIY) in the base dictionary are joinedas (user-defmedbigram)"nicely"(NAYSLIY). The more often this pattern is spoken, the more 'fixed' the bigram becomes in the computer's prediction program. The more fixed it becomes, the more accurate the response to our speech.

4. How is the program set up?

Any system has certain basic needs. For example, *VoiceType* will run on a 386 MS-DOS computer but will run more efficiently on a 486 computer with a clock speed of at least 25MHz. It requires a minimum of DOS 5.0 and 8Mb of memory. Each user's voice files will take up 1.8Mb of space. (We found it very useful to backup our voicefiles on separate disks). The computer will also need an Audio CaptureandPlaybackAdaptorcard. The system comes with its own software and a microphone that connects to the M-ACPA card. *VoiceType* can be set up in the base directory or within an application. When set up in the base directory, the computer becomes essentially "hands-free" and the microphone is active from the start. By saying ". . . voice console. . ." all aspects of the computer can be activated vocally. The keyboard is also continually active, so one can move between each form of input. The system tested is compatible with several programs (e.g., dBase IV, Displaywrite 5, Lotus 1-2-3 V2.2, Microsoft Word 5.0, Wordperfect 5.1, Multimate V4, Wordstar 2000+ V 3.5). Voice commands (macros) are built into *VoiceType* to perform most of the basic functions offered by these applications.

5. How does it relate to our population?

We have found that the way in which the program recognises speech matches closely the ability profile we found in the non-literate adult population. The program makes analogies **(RELATIONS)** in the digitised speech to predict systematically the words being dictated (SYSTEMS). The program's prediction **(EVALUATION)** becomes more accurate with frequent use. Certain patterns become embedded in **MEMORY** that assist future prediction. Finally, the oral context (SEMANTICS) refines the accuracy of the letter patterns **(SYMBOLS).**

In summary, the technical journals and articles show that the speech-recognition models resemble both the ways in which young children acquire speech, and the cognitive patterns we found in our non-literate clients.

Observations on Speech Recognition

Many adults with disabilities report their computer use and their writing is more fluent when they do not have to concern themselves with using a keyboard. Those with eye-hand coordination problems have reported being able to work more freely through direct contact with the screen. Presently, speech synthesizers are not effective in relaying what is on the screen synchronously with speech input. Therefore, at this time, blind users cannot benefit from auditory scanning either word-by-word or spelling if they were to use this technology (Stoddart, 1994). As each word is impressed on the screen, it has to be checked for accuracy. When a word is impressed it modifies the user's voice-files. If a user cannot receive feedback until after the input is impressed, the voice-file will have to be re-examined constantly for errors between what has been said and what has been saved. Similarly, users with significant intellectual impairment are likely to be frustrated by the intellectual demands of the program.

1. Notes from Colin Laine

Initially, it felt very strange sitting talking to the computer: hoping no colleague would come to the office. Over the next few days, I spent thirty minutes daily reading several different passages of text. The initial accuracy rate was lower than I had expected. It was frustrating trying to remember the basic commands; how to spell words; the lack of speed and fluency. These things I ascribed to the crudeness of the technology. In my frustration, I raised the volume of my voice (at times); I even said some things that maybe I should not have said (they got erased). As the microphone was live all the time, a cough, a sigh, or any guttural noise was translated to words on the screen. This became quite fascinating. I wanted to see what a cough really looked like! (Have you *any idea* what a sigh looks like?) The sighs, sneezes and coughs in stories I read as a child are all wrong! They do not come out that way.

I felt that I would never learn the International Communications Alphabet, so I typed it out and pasted it to the side of the monitor ('Alpha' through 'Zulu'). I also cheated the program by getting into the "spell mode", typing the word in, then saying "choose one". (Every little bit helps). Within six sessions I found that the computer had become very smart. It had learned so much in a couple of weeks and its accuracy rate was over 85%. We were now progressing at quite a clip. There were fewer spelling errors and I began to recall the International Communications Alphabet unprompted. When I gave commands (like "exit"), the program reacted as I wanted it to rather than just print up the word. This was progress, and I did not pause to realise that the computer was guiding my processes to match those in its algorithmic memory. I had forgotten that this effort was *interactive.*

Once I came to grips with this discovery, our relationship articulated itself. My voice became slower and softer (except on occasions); its accuracy rate went to over 90% rapidly. My frustration level decreased: its fluency and speed became more accommodating. I then took the bold step of designing custom macros. lean now start a letter by saying "open letter" or "open work" (for formal business letters) and four lines of address appear properly formatted at the top of the screen. "Date" puts in the day's date two lines below and I'm away. At the end of the letter, I say "close letter" and a polite salutation, four lines of space, then my title is printed. I say "print" and I get a hard copy: "save" and a spoken title files it on the disk.

We have to become accustomed to current programs. The codes and idiosyncrasies of speech-recognition seem more complex than keystrokes, but once the main commands are known and the International Communications Alphabet is mastered, the fluency suddenly jumps. Once one experiences that boost, the program is no longer a frustration. For those who find typing difficult, using speech-recognition should be less frustrating. The primary cost is eye-strain. *VoiceType* had little difficulty discerning my speech even when I had a cold. Like any listener, it took a few words to understand and recognise that something was different. When that adjusted patterning was established, the accuracy rate increased significantly. After getting over the cold it took a few words to readjust.

A frequent challenge is how the computer can recognize numbers from words and homophones. The number/word transformation is already built into most of these systems. For example, writing a number like '1993'; by choosing the number when you say "one" automatically sets the numeral in preference to the word when you say "nine". As to homophones, we have had to correct the computer regularly on this point. As we use *VoiceType*, the more frequent homophone appears as the first choice with the lesser-used homophones down the list. This does not mean that the program can distinguish among homophones, but it does mean that the more frequently-used spelling will more likely be the first choice.

2. Notes from Michele

When I began as a Graduate Research Assistant, little did I know that I would be talking to a computer. I did not realize that such advanced computer technology existed except on television. Initially I was both excited and intimidated about the prospects of interacting verbally with a computer. My past limited experiences with computers were not all that positive. Therefore, since I am hardly a computer whiz, I feared that *VoiceType* would not pick up my speech patterns or understand my Newfoundland accent. Questions that went through my mind were "What if I make a mistake? What if I ruin the program? Will it be as accurate if I do not use the program for long periods of time?"

In retrospect, I am relieved to say that my apprehensions were unjustified. The program is user friendly and did respond well to my speech patterns. I now realize that this program has a different memory for each user, so although my accent is different from Colin's it does not make any difference. I was amazed at how well it responded to my training and only had to repeat words three times sequentially. Now and then I have had to retrain a certain command if I found that it did not respond after two utterances. I see myself gradually training *VoiceType* to "tab", "indent", or "edit". It is intriguing that this program can perform any of the tasks that can be completed with a regular keyboard. However, much patience and time is required to develop the dexterity, since the manual is anything but user friendly. Colin and I collaborate and through trial and error we usually figure things out.

VoiceType remains accurate even if I do not use it for three or four weeks. When I returned after Christmas break it was not *VoiceType* that was rusty. It took me a couple of hours to get reacquainted with it, the same as it would with any computer program, I assume. *VoiceType* adjusts to changes in speech patterns as they occur as longas the user is consistent when dictating and corrects mistakes as he/she goes along. When I say "consistent", I mean pronouncing the word I want the same way every time I use the computer. For example, I say "thee" instead of "thugh" when I want the word "the" to appear on the screen. If I continually interchanged my use of these pronunciations, *VoiceType* would become less accurate and definitely confused.

Speaking of accuracy, *VoiceType* is about 90% accurate most of the time for me and the speed is improving with practice. It was accurate because I have been consistent in dictating and corrected any unwanted utterances or mistakes as I have gone along. Still, when I am talking to the computer, I have come to feel that it is more thanjust a program in a computer: although it does not talk back! (You may have already noticed how often I have used the title *VoiceType* so far. I prefer to acknowledge it by name as opposed to just calling it "the program".) Unlike keyboarding, *VoiceType* is a more personal interaction. I have found myself scolding the computer when it did not perform my commands instantly! I have raised my voice and said "Wake up!" or "Go to sleep!". I'm sure many people outside the office were puzzled by these outbursts. The fact that the commands are human-like and down-to-earth probably contributes to this personification. I spent about sixteen training sessions with *VoiceType* ranging from 45 to 90 minutes in length. I find that after ninety minutes I need a rest for my eyes and my patience. My frustrations have diminished over time. Also, as I have to pause between utterances, my speech is becoming generally slower. This is a definite change, as I am told that I usually talk too fast.

Our presentations on speech-recognition havesparked a great deal of interest in people. Some questions posed were "Will *VoiceType* improve our oral skills?" and "Will such programs increase our writing skills or will they replace written work in the future?" As a teacher, I believe that they could be extremely beneficial in classrooms, especially for disabled students. During a writing period, for example, a student who could not physically write could use *VoiceType* to complete assignments. This might take additional pressure off teachers and parents. If introduced to students at an early age, voice-activated computers could spark children's interest and boost their confidence in future computer usage. This is especially important in our technological and computer-oriented world today. *VoiceType* has helped me overcome my fear of computers. Now I feel confident to attempt any macro.

Ideas, Questions and Conclusions

Speech-recognition has several features that hold much promise for all users and especially for those with disabilities. First, writing with *VoiceType* is not merely dictating. It requires as much creativity and involvement in the writing process as traditional hand-operated writing systems, but in a different way. We have found that using *VoiceType* has led us to change the way we compose and articulate our ideas. The composition is more likened to a discussion with another party. Right now, I am more engaged in adiscussion with the reader than I would be if I were using my keyboard. My eyes and my attention are focussed on the screen and what I am communicating, rather than on worrying about where my fingers are or on holding a pen. Our research subjects have found this aspect a freedom from having to learn how to use a keyboard. Some have said that using a keyboard continually is a distractive, even invasive, option. They can focus their energies and attention on what is happening on the screen and interact directly with it.

The down side has been that we have found ourselves more noticeably tired after a session with *VoiceType* due to the degree of concentration and focussing on the screen. We feel that the writer/user should take time out from the screen at regular intervals: just look away at more distant focal points. As an alternative, we have used the speech for a period, then switched to the keyboard and back again. We have the benefit of both options now. Second, like Higgins & Raskind (in press), we have found that we have used a greater variety of words and number of propositions in our writing. But then we find that, for most people, there is greater variety and complexity in oral discussion than in written work. We have to be very conscious of what we want to communicate when writing. This aspect should take advantage of the relatively stronger oral language abilities of our non-literate population. If the hypothesis is true, we would advance the idea that use of speech-recognition systems should greatly enhance users' self-esteem and give them a greater sense of control (cf. Brown & Cavalier, 1992; Kantrov, 1991). We have initiated activating the entire computer system (start-up, e-mail, virus control, scheduler) through voice and speech recognition. This investigation has opened ideas for on-line library ordering and data-base searching: both localised and commercial. This interface has been suggested as well-suited for these processes (Peters, 1989).

Today & Tomorrow

Currently we have four adult clients with disabilities. There is a range of disability: Multiple Sclerosis, Cerebral Palsy, severe physical and vocal disability with intermittent spasticity, and learning disability. Each adult has been using the system at least three months. At this time, they have achieved 83% to 90% efficiency with the system. The productivity of all the adults has increased. In two cases, the time taken to write a letter or schedule appointments has more than halved. The use of macros has enabled them to design an opening, a closing, even an entire letter with a single vocalised set of keystrokes. In the early stages of training, each user was frustrated by the error-rate of *VoiceType's* recognition. The clients soon learned that by cleaning up the errors that they had originally accepted or had missed, the accuracy rate jumped. One client has marginally intelligible speech. He is more invigorated at his job because the computer can understand him better than his colleagues. Further, he can now work uninterrupted on an average 29 minutes. This compares to stopping to rest for five minutes four times hourly in a more traditional environment.

All our clients had ten to fifteen hours of direct instruction. They also had a tutorial on video and an on-line reference that comes with the system. We have also provided assistance, direct and by phone, when there have been difficulties. Over a period of three months, the calls for assistance have diminished from one or more a day in the first week to one a week or less. For anyone wanting to introduce such a system, we have concluded that *VoiceType* is not a self-instructional system and a planned training program is essential (Laine & Breen, 1994). The manual uses sophisticated language and suffers from considerable vagueness. Several instructions are convoluted: some are wrong. A new user would have difficulty getting beyond the introduction without substantial computer knowledge. Even with that knowledge, a new user would have no appreciation of the critical importance of keeping voice files cleaned of phonetic or keystroke errors. The tutorials are not sufficient for self-instruction unless you have worked with some speech recognition system before. Any user will need some direct training. Any approved dealer should provide direct instruction/ tutorials to new users plus assistance and advice.

All the clients have experienced fatigue similar to ours. Eyestrain is a factor for the user who works with *VoiceType* for too long. An optimum period has been about thirty to forty minutes. After this period, we have advised everyone to take a break, look out the window and refocus. However, our clients have reported they are less physically tired and can work for longer periods of time than they have been accustomed to. Two clients told us they are no longer as tired at the end of their working day as they were before using speech access to their computers.

An intriguing side benefit of primary interest has been the changes in the ways the clients approach using the computer; the change in their styles of composition; and the ways in which their monitoring strategies have changed. First, they exhibit greater confidence in their computer use. They are more animated during their work-time on the computer. They are more conscious of what they are saying and how they are saying it. Second, we are seeing changes in their written composition. Their written language is now becoming more similar to their oral language than before: an important emergent feature for teachers. There is a closer match between written and oral reports. If this feature becomes a trend, then there are implications for the way we teach writing, the ways in which writers monitor their composition, and, in the ways we evaluate written composition.

We have had a teacher say that talking to the computer is not **exactly** writing. Using speech recognition to access computers for composition frees the writer from many mechanical demands. This freedom should allow the writer to focus on the content and propositions. We think that should lead to improved written communication by persons with disabilities.

Our logs also reveal changes to the ways we are approaching decision-making and learning new things. Mostly, we have seen an increase in our relating back to other experiences as we try new ideas. The use of **relationships** instead of sequential, systematic learning may be an important feature in increasing a reflective learningstance. Our clients are less impulsive in their approach to new learning situations and there has been an increase in peer-mentoring and cooperative working among the participants. The extent to which the introduction of a speech-recognition system has influenced these changes has yet to be documented, but I believe it has had a prominent role.

At the start, we spoke of *Star Trek.* Only a decade ago, this paper would have appeared fantasy to many readers. In the intervening years, the technology has leapt forward. The mathematical and statistical models that form the backbone of these systems have gone from monograms to multi-equation models. These models link algorithms together to predict what the new combined sound means, or will look like. Current systems work on a DOS or MAC base. Platforms like OS/2 and AIX can work with several applications simultaneously. The possibility for multi-user systems that require minimal training is at hand. Tomorrow is not a star-date away; it is not 300 years, months, even weeks. Tomorrow is a matter of a few hundred days. We should see accelerated speech recognition systems (simulating continuous speech) independent of speakers (allowing multiple users) as a reality very soon.

Currently we have stand-alone, speaker adaptive, versions. "Tomorrow's" systems - now being created and tested - will offer network versions coupled to multi-user platforms. These systems would allow offices or classrooms of users to access computer applications and write by voice. When the problems associated with word-by-word speech input/output are solved, then anyone in any environment should be able to access information, e-mail, emulators, information retrieval systems, or coded computer-controlled devices (especially in dangerous work environments). Alternatively, those who work in disabling ("hands-busy" or "eyes-busy") environments could work more safely with such adaptations. For example, surgeons could continue operating yet call for physical systems checks and analyses without stopping or looking up from their work.

The potential for speech-based multi-user, multi-language systems being available to ESL students in our colleges could decrease the time and costs of language training. Presently, we have to train the computer to recognize each user's speech pattern. Tomorrow's version will require little or no extended training of voice files. An oral introduction and voice-coded password would provide access to a specific voice file. The complexity of the new models will make predictions based on more intricate algorithms. With these more complex and accurate mathematical models, the computer will predict words contextually. In such a model, the challenge presented by homophones would be nearer to being solved. The computer would understand the context, provide the composer with the most appropriate word and, possibly suggest grammatical alternatives. Then how will teachers grade essays...?

Postscript-

First, the prices of these systems are falling rapidly. Second, this article has taken me about 125% of the time I would take with the keyboard as I'm still learning. The statistics tell me that the *VoiceType* has been 91% accurate. Maybe I'll give it an 'A': after all it has been very patient.

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AUTHORS

Colin J. Laine is Assistant Professor of Education, The University of Western Ontario, London, Ontario.

Michele Breen is a Graduate Student in Counselling, Faculty of Education, The University of Western Ontario, London, Ontario.