Letter-based communication techniques

This is an introduction to letter-based communication techniques intended for Speech Language Pathologists and Occupational Therapists interested in communication aids. A better but slightly more complicated text is twobit quartering 2008.

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Author: J.Verrips@planet.nl

Some people suffer from an acquired communication handicap due to a neurological disease. Even if they can no longer speak, write or type, paralysis is rarely complete and they can usually hear and understand. In order to select a communication method, one must consider the cognitive and functional status of the individual, the knowledge and skills of their family and their care-givers and economic restraints as well. This article is intended for readers with some background knowledge in Augmentative and Alternative Communication (AAC) and will describe various letter-based techniques for individuals who are unable to write though they have intact literacy skills.

Writing, pointing and yes-or-no

If a pen can be used one may write messages. However, if this is not possible individuals may point to characters on an alphabet card to indicate what they want to say, using a small laser pen or perhaps a mouse. Sometimes, such cards will also contain names, days of the week, and short messages as Yes, No, Today or Tomorrow that can be pointed at.

If only eye-movements can be used to communicate, a see-through frame is an interesting technique. It is placed between the speech-disabled person and the interpreter, with groups of characters on its four corners. The interpreter suggests members of the group that the client is staring at and so eye-pointing is combined with eye-blinks to spell. In more recent years eye-tracking by a special camera is combined with a computer and a projected keyboard; eye gaze moves a mouse to select letters, icons or symbols.

If just one finger can be used, it may be connected to a buzzer to request attention. One finger may give more information than one bit, if a short sound means Yes and a longer one No or if the finger is either stretched or bowed. Thus even with a single finger and an experienced interpreter who poses simple questions one can have something of a conversation.

Group-wise scanning

A buzzer, a moving finger or a blinking eyelid can also serve to scan the alphabet in a group-wise manner, as illustrated in Figure 1. The interpreter speaks slowly a e i o u and restarts when the subject reacts, to say a b c d, or e f g h, or i j k l m n, or o p q r s t, or u v w x y z. This time, the character is noted when the buzzer sounds again and so, very slowly, one may create a message. See Figure 1. The same alphabet card may be used with changed roles: the interpreter follows the client, who taps actively.

a b	**e f**	**i j**	**o p**	u v

c d	**g h**	**k l**	**q r**	w x
		m n	**s t**	**y z**

Figure 1. Card to aid scanning with a single switch. First with 'a e i o u' a group is chosen, then a character in a group. Of course, more groups may be added for instance with SP=space, period and question mark.

Tap-code

At a time, prisoners of war communicated characters by two series of clicks. Both shared the same matrix, see Figure 2. Two-bit tap-code, one switch for R and one switch for L, needs only one pause per character, one-bit tap-code needs one pause between R and L as well. Unlike Morse code, with two-bit tap-code RLL=LRL=LLR, RL=LR etcetera. A computer may take the place of the interpreter and usually offers several forms of scanning. See Figure 3.

Ø	t	i	SP	h	f	b	Right
e	o	r	c	p	z		
a	s	u	g	q			
n	d	y	j				
l	w	x					
m	k						
v							
Left							

Figure 2. Frequency optimized scan matrix for tap-code. The focus starts at ø. If L(eft)=vertical, R(ight)=horizontal and P=pause at the end of the code, then RRP=i, RRRRLLP=q, LP=e.

Ø					
SP	t	i	h	f	b
e	o	r	c	p	z
a	s	u	g	q	

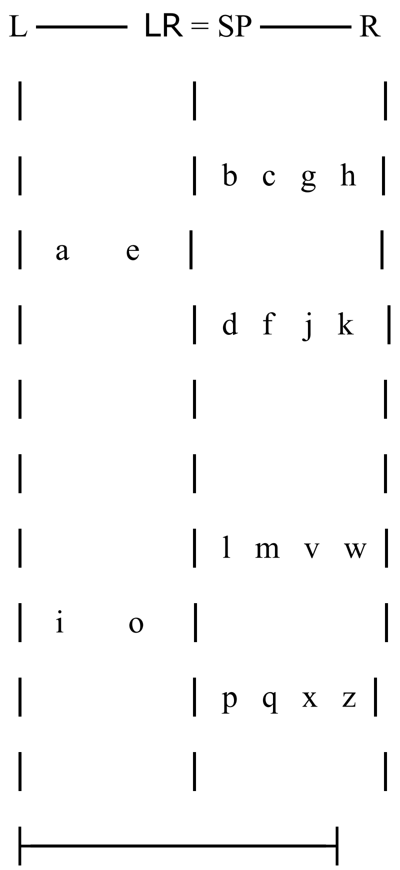
n	d	y	j		
l	w	x			
m	k				
v					

Figure 3. Frequency optimized scan matrix with empty first row, to reduce errors. The focus starts at Ø, as in Figure 2. Users may first select the column, wait as long as they want, then select the row.

If two fingers can be used, let us assume one on the left hand and one on the right hand, communicators may shake two crossed hands to pass signals using L(eft)= Yes and R(ight)= No or may tap on each other's shoulder or pinch each other's ankles or elbows. As noted before communication often starts with Yes or No and two-bit tap-code may use Figure 3. Other possibilities with two bits, are repeated two-bit quartering and Morse code, as in Figures 4 to 8.

Two-bit quartering

Two-bit quartering employs a two-bit code to repeatedly select one of four quarters. It resembles a technique called successive quartering, described with a joy-stick in Vanderheiden (1988), but has to my knowledge not been previously described in this form. One uses signals L, LL, R, RR, LR, RL and Figure 4 that visualizes the code. LL is one signal of twice L followed by one pause.



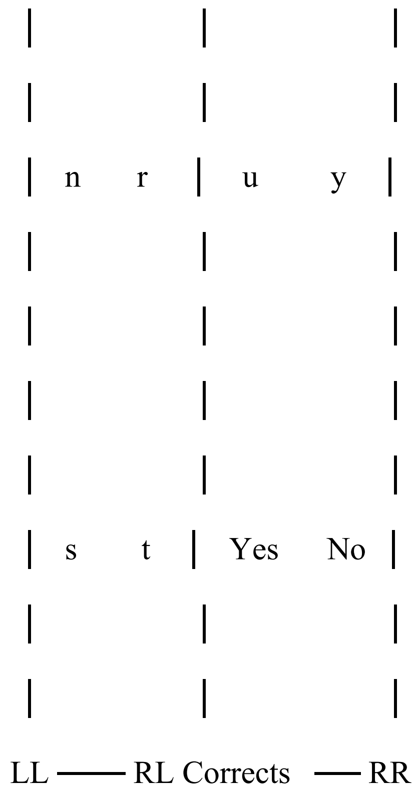


Figure 4. Optimized scan matrix for repeated two-bit quartering.

Four signals repeatedly select one of four quarters; after L one should visualize Figure 5 and choose again. Likewise, after LL one should visualize Figure 6 and choose again.

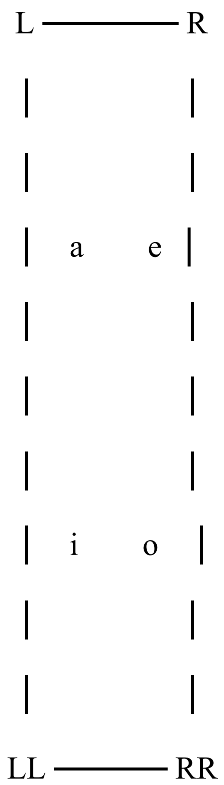


Figure 5. R now chooses e and RR now chooses o.

```
|          |
|          |
|  n    r  |
|          |
|          |
|          |
|  s    t  |
|          |
|          |
LL ——————— RR
```

Figure 6. RR now chooses t.

The reader should verify that L L means ‘a’ and L R means ‘e’ while R L L means ‘b’ and LL LL means ‘s’. LR means SP=Space and RR RR means Stop. Other codes may have special meaning, as RL ‘correct and restart this character’ or L+R together 'I accept your suggestion' when one’s partner speaks up her or his intuition. 'ams' may then be accepted to mean 'amsterdam'.

This communication system is easy to learn and is appropriate to signal words or names. With training it becomes relatively fast because it requires few signals per character. See Figure 7 for a different notation intended for learners. Once this matrix is memorized, two-bit quartering can be done blindfolded or with eyes turned elsewhere. A slightly faster matrix is in Figure 8.

```
. ————————.- SP————————— -
|            | -.. -.-   --. ---  |
|   ..    .- | b  c      g  h     |
|   a     e  | -.: -.=  --: --=   |
|            | d  f     j  k      |
|            |                    |
|            | -:. -:-  -=. -=-   |
|   .:    .= | l  m     v  w      |
|   i     o  | -:: -:=  -=: -==   |
|            | p  q     x  z      |
|            |                    |
```

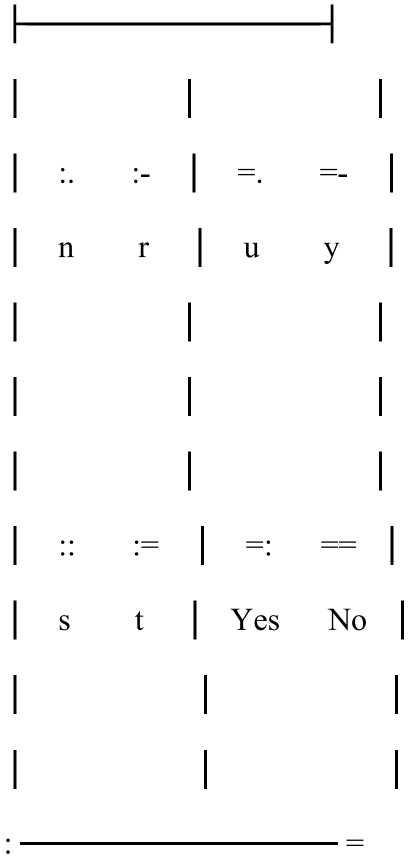


Figure 7. With Left . LeftLeft : Right – RightRight = the codes of different characters are displayed in this matrix for two-bit quartering.

```
.————.- SP ——— -
| a    e  |   n    t |
|         |          |
|         |   Ret    |
|         |          |
| i    o  |   r    s |
|         |          |
|—————————————|
|         | b  c  j  k |
| d    h  |            |
|         | f  g  p  q |
|         |            |
|         | u  v  y  z |
| l    m  |            |
|         | w  x. ,  . |
:————————————— =
```

Figure 8. Alternative matrix that requires fewer switches.

Morse code

An even faster system is Morse code, see Figure 9. Morse takes some time to learn and in low-tech applications requires an interpreter who learned it too. It has a remarkable history, see Standage, 1998, and becomes fully automated in the long run. An extended code exists to control a computer with special symbols for all keys, including Alt, Ctrl and mouse-functions.

a .-	f ..-.	k -.-	p .--.	u ..-
b -...	g --.	l .-..	q --.-	v ...-
c -.-.	h	m --	r .-.	w .--
d -..	i ..	n -.	s ...	x -..-

e . j .--- o --- t - y -.--

SP ..-- z --..

1 .---- 2 ..--- 3 ...-- 4 ....- 5 .....

6 -.... 7 --... 8 ---.. 9 ----. 0 -----

Figure 9. Morse code including numerals

Comparisons based on performance

My hobby is to program scan matrices and see how fast they get. If measured with copy tasks and healthy test-subjects I found that, once learned, Morse is the fastest input system, followed closely by two-bit quartering, active two-bit tap-code, active one-bit tap-code and passive one-bit scanning. This also follows from mathematical models about the psychological processes of users of these techniques and shall probably apply to people with an acquired communication handicap. Readers may verify that it is possible to achieve a speed of about 30 characters per minute (cpm) with pen, paper and signals .:- and =. To learn to read at such speeds requires practice.

	Time to learn	Speeds with repeated phrases and a high-tech system
One-bit tap-code	+	25 cpm
Two-bit tap-code	++	30 cpm
Two-bit quartering with pause reduction	++	33 cpm
Two-switch Morse code	++++	> 35 cpm

Table 1. Approximate values with the author as a test-subject, high-tech scanning and sufficient training. Tap-code used an empty first row. Pause reduction is a subtle detail in high-tech quartering; the software skips pauses if the length of a signal is two as with : or =. In Figure 7, ‘a’ with code .. has two pauses, but ‘t’ with code :: may have none while characters ‘o’, ‘n’, ‘r’ or ‘i’ may have just one pause.

Comparisons based on computed switch counts

Comparison of the number of switches and pauses needed to select the average character require computations with weighted frequencies of characters in large texts, such as newspapers or printers lay, once used by Samuel Morse himself. We concentrate on characters ‘a’ to ‘z’ because in Morse Code space is often replaced by a double pause, and we use an empty row for tap-code as in a high-tech system. Results are as in Table 2.

	Switches	Pauses
Tap-code	3.89	1
Two-bit quartering Fig 7	3.19	2.32
Two-bit quartering with pause reduction Fig 7	3.19	1.44
Two-bit quartering Fig 8	3.08	2.20
Morse Code	2.57	1

Table 2. Number of switches per character as well as number of pauses per character computed with frequencies in printer’s lay of ‘a’ to ‘z’, based on Stower (1817).

Research questions

Little research has been done that documents ease of learning and effectiveness of these techniques, compares cost-effectiveness or even documents how it feels to use them. They probably have value in clinical practice, might be combined with storybooks as in some high-tech communication aids and allow the experience of a locked-in patient. Finally, like writing instead of speaking, two-bit quartering seems a funny way to pass the afternoon at an introductory course of Alternative and Augmented Communication.

References

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