Tachistoscopic software for the Macintosh

CLAUDE BARRON

University of Quebec in Montreal, Montreal, Quebec, Canada

The emulation of a tachistoscope with a Macintosh microcomputer and Pascal language is presented here. The software described is a complete program for the presentation of textual stimuli on the Macintosh screen and includes the recording of reaction times. The stimulus coordinates on the screen are user defined and variable from trial to trial for specific visual angles. The position of a fixation point on the screen and the distance between the subject and the plane of the screen, as well as the particular screen resolution, are taken into account in computing the visual angle.

In most stimulus presentation programs, the stimulus is shown on screen at a certain amount of pixels in relation to a fixed point on the screen, namely the top left coordinates (Finley, 1989; Lane & Ashby, 1987). To present a stimulus to a subject at a given angle from a fixation point, the experimenter must do trigonometric gymnastics to convert the desired angle into pixels representing the distance between two points on the screen. Moreover, the center point on a Mac Plus screen is not located at the same coordinates as it is on a Mac II. In the present software, the stimulus coordinates are redefined for each trial in relation to the fixation point coordinates for that trial, after the screen resolution has been read from a global variable. The experimenter enters the distance, in inches, from subject to screen, as well as the visual angle for the fixation point in relation to the screen center and the angle between the stimulus and the fixation point. The transposition from angle to pixel coordinates is then calculated by the software. The simple relations involved in doing the required transformations can be derived from the illustration in Figure 1.

Let a be the distance in inches between the subject and the screen plane, and A the visual angle for a particular trial. All coordinates of interest will be on the circle traced in Figure 1. If the stimulus and the fixation point are presented on the same horizontal axis, we have the simpler case where the angle B is 0° ; hence the distance is b pixels on the horizontal axis from the fixation point. But for a different angle B , the distance is equal to the radius ($c = b$), and the software computes the projections of c onto the horizontal and vertical axes. The answers are d pixels onto the horizontal plane and e pixels onto the vertical plane. The formulas for this manipulation are:

$$b = a \cdot \tan A$$

$$c = b$$

$$d = c \cdot \cos B$$

$$e = c \cdot \sin B$$

The stimulus is then displayed on the screen at the computed coordinates. It is important to note that the preceding explanation is written as if the stimuli were one pixel in dimension. In fact, this pixel is the center one of a larger stimulus area. The limitations on the various angles vary according to screen size, a larger screen allowing a greater maximum angle.

Stimulus Preparation

The graphic possibilities of the Macintosh can be fully exploited with the resident fonts as stimuli. This is an easy and quick way to have multiple and different stimuli available; it is convenient to call them by simulating a typed character from the keyboard to access a stimulus and show it on screen. A stimulus may, therefore, consist of a single character, a string of characters, a small picture, or a sequence of pictures in a row. The toolbox utility allows easy formatting of characters and pictures with standard functions (i.e., bold, italic, underline, outline, shadow) and also allows the user to change font size with one call. As for picture presentations, they are quite easy

Figure 1. Calculation of presentation coordinates from angles.

Special thanks are given to Henri Cohen for his suggestions and support. Correspondence may be addressed to C. Barron, Département de psychologie et Laboratoire de neuroscience de la cognition, Université du Québec à Montréal, P.O. 8888 Succ 'A' Montréal, Québec, Canada H3C 3P8.

to draw with specialized commercial software such as Fontographer, which digitizes them in a new font.

Software Use

The software package is written and programmed entirely for a tachistoscopic paradigm. The following is an example of the general way in which a trial proceeds: A fixation point is shown on the screen. After a time lapse determined in the input file, the next stimulus is shown, and the response from the keyboard is recorded, followed by an interstimulus interval. The use of this software is straightforward. With a standard ASCII editor such as Edit, or the powerful Qued/M, one enters the values needed to control every aspect of stimulus presentations for all trials. A quick way to do this is to write the default values that will be used for most of the trials, and to use the Macintosh functions "Copy" and "Paste" to replicate this line for the number of trials. After that, only values that differ from the standard ones need to be changed.

As noted previously, it is possible to control the aspect and appearance of fonts. To achieve this, a control word is written in the input file. This word is made up of eight characters—0s or 1s. The meaning of these characters is, from left to right, *standard*, *bold*, *italic*, *underline*, *outline*, *shadow*. The last two are reserved for future development.

Moreover, the fixation duration, the stimulus presentation duration, the response waiting time, and the interstimulus interval are programmable down from 1 tick (16.625 msec) and up to 400 days, in 1-tick increments.

An example for two trials as they appear in the input file follows:

```
36 1 10000000 0 0 120 TOY monaco 12 3 0 120 120 60
36 2 01000000 0 0 120 W image 18 3 30 120 120 60
```

These codes are interpreted, from left to right, as follows:

- Subject-screen distance.
- Trial number.
- Stimulus appearance.
- Visual angle of subject for fixation stimulus.
- Rotation angle on trigonometric circle for fixation stimulus.
- Fixation duration.
- Stimulus.
- Font.
- Font dimension.
- Visual angle of subject for stimulus in relation to the fixation point.
- Rotation angle on trigonometric circle for the stimulus in relation to the fixation point.
- Maximal duration for stimulus presentation if no response.
- Waiting time for a response.
- Duration of the interstimulus interval.

The structure of the results file is very similar to that of the input file; the results file includes subject identification, response, response latency, and two additional codes to indicate whether the trial has been invalidated by the experimenter or by the program itself. If the experimenter clicks the mouse during the interstimulus interval, the word "void" will appear in the output file for that particular trial. As well, a stimulus presented partly or completely off screen will be noted with the word "long" in the output file. To end the experiment prematurely, the experimenter depresses "q" on the keyboard during an interstimulus interval and holds it through the beginning of the next trial; the results from previous trials are saved on disk, and the program terminates.

Results: Precision and Synchronization

In the present version (Version 0.5), the software runs with 1-tick precision (16.625 msec). It has a procedure of synchronization with the vertical retrace signal. In a future version, Time Manager procedures will be used aiming for a precision of 1 msec. A precision of ± 8.3125 msec, however, is not a serious handicap, because this error is small compared with the standard deviation of human reaction time (Lane & Ashby, 1987). Lincoln and Lane (1980) analyzed the power loss due to the increase in error variance associated with this timing error and concluded that, in most cases, the loss could be compensated with an augmentation of 1 subject or with a slight augmentation of the number of trials per subject.

Various techniques to minimize timing errors were tried with the present software. For example, the control file, containing all control variables for the experiment, is read entirely before the first trial. Moreover, the fonts to be used in the experiment are brought and locked in memory. The number of different fonts should be limited to avoid cluttering of memory. All computations needed for the conversions of angles to coordinates are also made at this moment for all trials. In addition, all Init files that can slow down the Event managing process are removed from the Macintosh. Finally, to minimize disk access time, all results are kept in memory (350 bytes per trial) until the experiment is over and then saved on a disk file.

Conclusion

This software package was originally developed to run a prestudy on laterality in an impaired population. In its present state, the software is used to test different variables. It has been run on a Mac Plus, Mac SE, and a Mac IIcx with operating system Version 6.0.3 without any modification, except that compilation switch had to be set for either the 68000 or the 68020 processor's instruction set. Because the program is time critical, and will not be run concurrently with others, it is not MultiFinder compatible. It has been tested with Virex (Version 1.3), Disinfectant (Version 2.3), and SAM Intercept (Version 3.0.0).

Availability

The software can be obtained on disk for a nominal fee of \$5 and can be freely copied for nonprofit use. Requests should be addressed to the author, Department of Psychology, Université du Québec à Montréal, P.O. 8888 Succ 'A', Montréal, Québec, Canada, H3C-3P8. (e-mail: R12734@UQAM.BITNET.CA).

REFERENCES

- FINLEY, G. P. (1989). Tachistoscopic software for the Hercules display controller. *Behavior Research Methods, Instruments, & Computers*, **21**, 387-390.
- LANE, D. M., & ASHBY, B. (1987). PsychLib: A library of machine language routines for controlling psychology experiments on the Apple Macintosh computer. *Behavior Research Methods, Instruments, & Computers*, **19**, 246-248.
- LINCOLN, C. E., & LANE, D. M. (1980). Reaction time measurement errors resulting from the use of CRT displays. *Behavior Research Methods, Instruments, & Computers*, **12**, 55-57.

APPENDIX**Availability of Mentioned Software**

Pascal Compiler
Think Pascal
Symantec Corporation
10201 Torre Avenue
Cupertino, CA 95014

Fontographer
Altsys Corporation
720 Avenue F., Suite 108
Plano, TX 75074

Qued/M
Paragon Concepts, Inc.
4954 Sun Valley Road
Del Mar, CA 92014

(Manuscript received October 17, 1990;
revision accepted for publication August 26, 1991.)