Microreaction timer

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A small unprepared simple reaction time (RT) system is described in which the visual stimuli are presented at quasi-random intervals of 3-13 sec. The device is battery-portable for administration in the field and for immediate presentation of mean RT and standard deviation after the test. These data plus all individual RTs are stored in digital memory for printout or further analysis in the laboratory. Up to 24 10-min tests may be accumulated in memory.

The microreaction timer is the latest in a range of battery-powered portable performance tests designed for collection of data in the field without the need for a mains power supply. Visual stimuli are presented at quasi-random intervals of 3-13 sec. The subject responds to the stimuli by pressing a button as quickly as possible. The duration of the test is optional, but 10 min is usual. The stimulus is the onset of an LED 000 display, which immediately starts to count in milliseconds until the subject's buttonpress response stops it, whereupon the arrested display remains on view for 1 sec, informing the subject of his/her reaction time (RT).

There have been two previous versions of this system. The first (Houghton & Wilkinson, 1973) possessed a limited digital store for 100 RTs. The second version (Wilkinson & Houghton, 1982) used magnetic-tape cassettes to provide permanent and virtually unlimited storage of the data. While this format has had considerable success, cassette storage has certain drawbacks. No reduction of data is possible on site, and the data have to be analyzed off-line in the laboratory in real-time.

The version described here uses a CMOS microprocessor board to overcome these disadvantages. The microprocessor produces a lightweight and highly reliable unit. The device provides mean RT and the standard deviation of this mean on the spot following each test. At any time, the data for all tests recorded can be printed on a standard RS232 terminal or transferred to computer or digital recorder for more permanent storage and analysis. Storage is limited to 2,040 RTs (about 24 10-min tests), and there is a limit of approximately 20 days on the time the data can be retained in store before printout or transfer to a more permanent medium.

OPERATION

The microreaction timer is illustrated in Figure 1. The steps for initializing it before a series of tests and carry-

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Figure 1. Microreaction timer.

ing out a single test are as follows. Before the experiment or series of tests, (1) move the front panel ON/OFF switch to ON, (2) open the sliding panel at the right-hand side of the unit to gain access to the supply ON/OFF switch and turn it ON, (3) close sliding panel, and (4) move the front panel ON/OFF switch to OFF.

Note that turning on the internal supply switch provides the power for the memory, which must remain on throughout the cycle of tests until the data are transferred to a printer or other more permanent store; otherwise, the data will be lost. It is for this reason that this switch is placed within the machine where it cannot be accidentally moved by the subject. It may be a good idea to secure the side panel, or at least warn subjects not to open it, before initiating a series of tests.

To carry out each test (for which only the front panel

controls are needed), (1) turn the switch ON, (2) press the START/RESPOND button (this produces a figure between 050 and 055 on the display, indicating the battery voltage; if this value falls below 050, it will be unwise to attempt to carry out the test), (3) press the START/RESPOND button again, to start the test, and wait for the first stimulus, (4) press the START/RESPOND button to this stimulus and to each successive stimulus as it occurs, (5) press the STOP button at the end of the test (usually indicated by an externally supplied alarm timer; mean RT for the whole test will be displayed), (6) press the STOP button again to display standard deviation of mean RT, (7) switch OFF (on the front panel).

Again, it is worth noting that the front panel ON/OFF switch merely turns off the supply voltage to the display, leaving on a small voltage required to preserve the data collected in memory until it can be transferred to a more permanent store.

The memory size allows 2,040 RTs to be stored. The number of RTs per test of, say, 10 min duration will depend on the random selection of intertrial intervals, but it should average about 75. This will allow at least 24 10-min tests before the memory is full. If a test is attempted when the memory is full, or if the memory becomes full in midtest, the display will show 000 as a warning and the program will return to the beginning. The data should then be transferred to an independent store, the internal supply switched off, and a new cycle of tests started as described above, if required.

Data Retrieval

The RTs, their mean, and the standard deviation are stored in the instrument's memory and can be printed out subsequently on a computer terminal or entered into a computer for further analysis. An external 10-pin connector socket is provided for this purpose. The reaction timer should be connected with a lead from this socket to a terminal employing the RS232 standard for serial data transmission, for example, a Teletype 43. The terminal plug connections are as follows: data from terminal, Pin 2; data to terminal, Pin 3; common return, Pin 7; linked together, Pins 5, 6, 8, and 20. Output is initiated by pressing the TYPE DATA button, which is found inside the case at the top right-hand side when the sliding panel is opened. The following sequence of operations should be used for data retrieval: (1) front panel switch ON, and, if battery voltage level is required, press START/RESPOND, (2) open sliding panel, (3) press TYPE DATA button, (4) close sliding panel, (5) front panel switch OFF. The data will then be printed on terminal at 30 characters/sec or transferred immediately to computer or digital recorder as required.

Each time the data are typed out, they will contain all the test results collected since the internal supply was switched on. The data can be typed out between tests, if desired, without losing anything from memory.

Table 1
Sample Test Printout

215	187	173	180	215	198	182	191	185	170
186	173	168	182	159	215	199	179	205	193
178	213	181	181	204	183	192	213	215	215
200	215	170	194	179	179	197	186	215	209
197	215	206	164	201	215	203	215	207	215
189	205	215	215	215	215	215	215	196	215
215	211	215	215	197	215	178	162	189	171
200	185	193	215	215	215	211	205	215	215
215	212	215	215	215	186	215			
199									
16									

A printout of a sample 10-min test is shown in Table 1. The first nine rows are the individual RTs in order of occurrence. The last two entries are the mean and the standard deviation. Entry of data into a computer is achieved in a similar way, except that on the interconnecting lead, the wires to the terminal plug pins 2 and 3 must be reversed. When the data are transmitted, transmission is terminated by the nonprinting ASCII character DC3, which can be interpreted by the computer program as indicating that all data have been received and analysis can start.

BATTERIES

Two TR134N, 5v4 batteries are used to power the reaction timer. They are inserted in the battery compartment after opening the sliding panel. During this operation, the main (internal) supply switch should be in the OFF position. Battery life is roughly 20 days, dependent partly on test duration and frequency. The display will present 001 repeatedly if a test is attempted when the battery voltage has fallen below the critical level. When this occurs, a move should be made to print out, or otherwise store, the data as soon as possible, since the remaining battery life for printing may be only a few hours. In the event of battery voltage falling so low that data cannot be typed out, it may be possible to redeem the situation by carefully replacing one of the batteries while leaving the other in position to maintain the supply.

HARDWARE DETAILS

The timer is based on an RCA microboard-type CDP18S601,¹ which is a single-board computer using low-power CMOS integrated circuits (ICs) and a CDP 1802 microprocessor. Digital input and output and RS232 serial interface are incorporated. The other major component is a Lascar Electronics CB-C-7217R LED display counter module. Before mounting in the 205 x 140 x 40 mm case,² the circuit boards need to be custom wired and a small "BATEST" circuit board needs to be constructed.

Table 2
Front Panel Connections Via J1

CDP18S601 Function	CDP18S601	P2 Pin	J1 Pin	Counter Function
+5 V	30	—	8	+5 V Supply
Output 2	1	—	2	Reset
Output 0	5	—	4	Blank
0 V	2	—	3	Supply 0 V
Output 1	3	—	5	Count Input
				Switch Common Connection
Input 0	25	—	9	Start/Response
Input 1	23	—	7	Stop
Input 2	21	—	6	Type/Data
	CDP18S601	P1 Pin		
WAIT-N	10	—	10	ON/OFF

Various links have to be set up on the CDP18S601 board.¹ The printed links of Lk4 are cut out, and new links are soldered in Positions 1:18, 4:15, 4:14, and 8:11, which selects conditions for 2716-type EPROMS. EPROM addresses from 0000 to 0FFF are set by Lk10 and Lk22 Positions 1 and 5. RAM addresses from 3000 to 3FFF are selected with Lk11 Positions 1:16 and 8:9. A negative supply for output of RS232 data is obtained from the terminal input by connecting a general-purpose silicon diode such as a BAX13 with its anode to the negative supply line on the board and from the cathode via a 2k2 resistor to J2 Pin 2. R7 and R11 are removed, and the positive supply to U1 is severed to save current. R9 is replaced by a link to permit a positive supply to be connected via J1 Pin 8. C2, the +5 V supply 22 F smoothing capacitor, is exchanged for 1,000 F. A 100-ohm resistor is connected between Pin 4 of J2 and the +5 V supply. The +5 V supply is also connected to J2 Pin 9. J1 is reconnected, as shown in Table 2, so that it can be used to make connections between the micro-board and the instrument front panel. The START/RESPOND, STOP, and TYPE DATA switches are single-pole changeover push-button switches whose normally closed connections go to 0 V and whose normally open connections go to +5 V. A two-pole slide switch is used for the ON/OFF control on the front panel. In the OFF position, one pole interrupts the positive supply to the counter circuit board and the second pole is used to connect the CDP18S601 WAIT-N signal to 0 V in the OFF position and +5 V in the ON position.

Unused inputs of the DI/O IC CDP1851, that is, 27, 28, 29, and 30 to Pin 20, are connected to 0 V; also, Pin 35 is connected to Pin 40 to enable the inputs.

The BATEST circuit board is built on a matrix board, as shown in the circuit diagram (Figure 2), and is fixed to the CDP18S601 board in piggyback fashion. Its input is connected to CDP1851 IC Pin 22, its output to Pin 31, and its 0 V connection to a convenient 0 V land on the CDP18S601 board. The function of this additional circuit is to give a time delay that is proportional to the battery voltage and can be measured by the

Figure 2. BATEST circuit.

microprocessor, thus giving an indication of battery voltage.

ENCLOSURE

The case is of plastic,² with separate lower and upper halves and two side panels of aluminum. Assembly involves mounting the CDP18S601 board in the lower half and the switches, battery cases, and display in the upper half. A rectangular hole is made in the lower half of the case in order to allow access to the terminal plug J2. Access to the batteries, battery ON/OFF switch, and TYPE DATA button is given by sliding open the aluminum panel on the right.

SOFTWARE³

The program is stored in a 2716-type EPROM in machine language. When the power supply is turned on, an R-C time constant causes the microprocessor to reset and the program starts at hexadecimal address 0000.

CONSTRUCTION

The component cost is approximately £350 in the United Kingdom, but it will be less expensive in North America because many of the components are made there. Construction time is around 15 h and should be carried out at the professional or skilled amateur level.

REFERENCES

- HOUGHTON, D., & WILKINSON, R. T. Miniature reaction timer with memory. *Behavior Research Methods & Instrumentation*, 1973, 5, 273-276.
- WILKINSON, R. T., & HOUGHTON, D. A portable unprepared simple reaction time test with cassette data storage. *Human Factors*, 1982, 24, 487-493.

NOTES

1. For further details, see RCA manual MB601.
2. The case is Type 75-1410J and is obtainable from Vero Electronics Limited, Industrial Estate, Chandlers Ford, Hampshire SO5 3ZR, England.
3. Contact the senior author for a copy of the program listing.

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