METHODS & DESIGNS

Scoring and interpreting the MMPI with a desk-top calculator

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The development of a hospital-based routine system for off-line scoring and interpreting the MMPI with a small desk-top computer (HP 9830) is described. Main features of the system include the use of optical mark reader (OMR) cards instead of ordinary answer sheets and a software monitoring system allowing operator-independent processing. In terms of flexibility, speed, and economy, the system compares favorably with other computer-based test systems.

Computer application in clinical assessment has mainly moved along two lines. One is represented by companies that offer scoring and/or interpretation services for psychometric test devices: special machine-readable answer sheets are forwarded to a scoring location and computer-generated reports are returned (for a review, see Eichman, 1972). These services do not require computer hardware at the testing location and thus are relatively inexpensive. They have several disadvantages, however, including time loss due to mailing and the lack of flexibility if the requirements of the test user do not exactly correspond with the kind of information that is being offered.

On the other hand, several attempts have been made to automate assessment procedures completely by using on-line computers (e.g., Cole, Johnson, & Williams, 1975; Johnson, Giannetti, & Williams, 1975; Klinge & Rodziewicz, 1976; Space, 1975). These solutions offer almost unlimited flexibility and speed, as shown, for instance, in the on-line computerized system for MMPI interpretation by Miller, Johnson, Klingler, Williams, and Giannetti (1977). However, the use of a terminal-based computer system as a clinical routine service is ordinarily prevented by the excessive amount of money and time necessary for installation and programming. Moreover, computerizing the administration of paper-and-pencil tests does not seem to be of any economical advantage. The only test devices requiring on-line computer capacity during administration are those involving test items selected according to patients' answers ("tailored testing"; see, e.g., Holtzman, 1970).

Manual administration of tests combined with off-line data processing with an installation combines the

advantages of flexibility, speed, and economy. The present paper describes the development of a system for scoring and interpreting paper-and-pencil tests (in this specific case, the MMPI). The system is based on a small desk-top calculator originally purchased for other purposes.

METHOD

Apparatus

Equipment consists of a Hewlett-Packard desk-top calculator system (HP 9830 A) with 8K bytes of core memory. The built-in 16K-byte hardware BASIC interpreter is supplemented by four add-on ROMs (matrix, string, extended I/O, and advanced programming I-ROM), that provide the calculator with software elements for manipulating alphabetical strings and for bitwise processing of I/O data from peripheral devices. The 9830 A calculator has a built-in magnetic cassette drive. Peripheral devices include a second cassette drive (HP 9865 A), a card reader (HP 9869 A) that reads marked as well as punched cards, and a thermoprinter (HP 9866 A).

Administration and Scoring

The MMPI is administered in two forms: In the usual and most economical form, patients answer MMPI statements with a soft pencil on optical mark reader (OMR) cards that are especially designed for this purpose. Each card has space for 200 items with alternative response categories (Figure 1). The HP 9869 A reader and the extended I/O ROM can read and convert cards of this type. The second form of test administration is used with patients of lower intelligence and/or higher overall psychopathology. In this version, the task consists of sorting ordinary punched cards with the item number punched on the front and the item text on the back in two categories (true, false). This form is assumed to be less demanding, since it is not necessary to watch for a correspondence between item numbers on the test form and the answer card. Automatic processing is rendered possible by means of the punched-in item number. From a practical point of view, however, this version is more time consuming, since the card stacks have to be rearranged in the original item order before the test may be administered again.

In both versions automatic processing guarantees the accurate scoring of the test. As part of the program organization, OMR cards are routinely checked for reading errors.

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KARTE 1

1	51	101	151
2	52	102	152
3	53	103	153
4	54	104	154
5	55	105	155
6	56	106	156
7	57	107	157
8	58	108	158
9	59	109	159
10	60	110	160
11	61	111	161
12	62	112	162
13	63	113	163
14	64	114	164
15	65	115	165
16	66	116	166
17	67	117	167
18	68	118	168
19	69	119	169
20	70	120	170
21	71	121	171
22	72	122	172
23	73	123	173
24	74	124	174
25	75	125	175
26	76	126	176
27	77	127	177
28	78	128	178
29	79	129	179
30	80	130	180
31	81	131	181
32	82	132	182
33	83	133	183
34	84	134	184
35	85	135	185
36	86	136	186
37	87	137	187
38	88	138	188
39	89	139	189
40	90	140	190
41	91	141	191
42	92	142	192
43	93	143	193
44	94	144	194
45	95	145	195
46	96	146	196
47	97	147	197
48	98	148	198
49	99	149	199
50	100	150	200

Figure 1. One of the optical mark reader cards used as answer sheets.

In addition to the MMPI, several other tests (e.g., vocabulary) and questionnaires (e.g., social adaptation, adjective checklist) are currently processed this way.

Program Organization

The main difficulty in designing the program system was the continuous daytime use of the relatively slow and small calculator system. Therefore, the major parts of the program, especially those that were time consuming (like printing of reports, etc.) had to be programmed in the form of a self-monitoring system that would be operator independent and could run at night. The system uses two cassette tapes, one holding the programs and the other the text library, for the

MMPI interpretation. Excessive use is made of those features of HP BASIC that allow the chaining of several programs.

The program system is divided in three parts, as shown in Figure 2.

Input preparation. OMR cards are checked for reading errors by a small program that reads the input cards and prints out all items that are either unanswered or answered twice. This output is verified against input cards and pencil marks that are too light (the usual reason for wrong "item omissions") are darkened. Patients' identification data are input via calculator keyboard and temporarily stored on up to 20 data files reserved for this purpose on the cassette tape holding the programs.

Processing and interpretation. The operator-independent part of the program has a length of 12,000 words of memory and consists of 18 different programs called by a monitoring program. Since an average MMPI takes about 25 min to process (including two printouts of the final report), the number of MMPIs processed in one run is restricted to 20. For each patient, MMPI answer cards are first read, decoded, and scored. As a next step, items are packed in a way that each 16-bit word holds the responses to eight items. All items are temporarily stored on the programming tape together with raw scores, K-corrected t scores, and patient identification data as one complete record. Interpretation and printing of the MMPI profile and report is the largest and most time consuming part of the program. At present, interpretation consists of a German research version of Lachar's (1974) MMPI interpretational system, supplemented by a list of critical items (Grayson, 1951, cited in Dahlstrom, Welsh, & Dahlstrom, 1972, pp. 377-378) and various ad hoc interpretations used in research studies.

Final storage of data. When the MMPIs are processed (usually the morning after a night run), the monitor program waits for the text library tape to be interchanged with a data tape holding up to 400 MMPI data files. Records are then copied from the temporary files on the programming tape onto their respective files on the MMPI data tape. Copying is supervised by the monitor program to ensure correspondence of the tape file numbers to those referred to in the printed MMPI report.

The system is supplemented by several auxiliary programs used in special research applications. Examples are a program for converting 566-item MMPIs to the routinely used 383-item form that holds all items necessary for scoring the standard scales and several programs for file management, statistical treatment, and so on.

DISCUSSION

The test processing system has been in use for 3 years. During this time, about 4,000 MMPIs (or 25 per week) and 3,000 other paper-and-pencil tests have been processed. The high throughput is the result of maximizing the operator-independent functioning of the program system. About 95% of the necessary computer time is used at night. Thus daytime availability of the calculator for other purposes is practically unaffected.

The simple programming language of the 9830 A offers high flexibility for further processing of test data. Together with the automatic processing of the test itself, this facilitates the technical execution of a larger validity study regarding the accuracy and generalizability of a German version of Lachar's (1974) MMPI interpretational system (Engel, 1977).

Staff response to the MMPI system has been positive. Informal assessment indicates that clinicians appreciate report accuracy as well as speed of processing.

Figure 2. Flow diagram of MMPI processing.

From a technical point of view, maintenance of the digital cassette tape drives is critical. During MMPI processing, one or the other of the tapes is in use about two-thirds of the time (17 of 25 min), so tape drives have to be exchanged from time to time. Substituting floppy- or solid-disk drives would ameliorate this problem, with the added advantage of increased speed of processing.

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