INTEGRATED COMPUTERIZED SENSORY ANALYSIS

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ABSTRACT

A computerized sensory analysis system, based on an IBM-PC compatible local area network, was developed. Panelist input was simplified through the use of a light pen and interactive questionnaire program. The system was integrated to allow preparation of descriptive, hedonic, triangle, structured and unstructured ballots; registration of panelists; collection of data; statistical analysis and report generation. The primary benefits are the simplicity of response for panelists, flexibility for the sensory analyst to design questionnaires and the elimination of time-consuming manual scoring and data manipulation involved in conventional sensory analysis.

INTRODUCTION

Sensory analysis has been greatly influenced by the general availability of computerized methods of statistical analysis. This has led to greater sophistication in experimental methods and analysis. While the computer has had a large impact on data analysis, the collection of sensory data has continued to be a manual operation. Many attempts have been made to incorporate the computer into different aspects of sensory analysis. Systems that have been integrated to a specific sensory analysis and flexible have been complex and expensive (Wesson and Truty 1984) while inexpensive systems have been dedicated and inflexible (Brady *et al.* 1985). Both panelists and analysts have demonstrated mixed responses to computerization in terms of ease of use, "friendliness" and the investment of time involved in learning the technology (Brady 1984). Most attempts at computerization have been compromises that have not delivered the advantages expected.

The objective of this research was to develop an integrated sensory analysis system that would be both user and operator "friendly", flexible, comprehensive and relatively inexpensive.

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SYSTEM DEVELOPMENT

Panelist Input

The keyboard has been recognized to be a barrier to communication with the computer. Simpler alternatives, including the "mouse", touch-screen and digitizer, have been utilized. Drawbacks of these approaches include, eye-to-hand coordination, high expense, fingerprints on the monitor screen and the continued requirement for paper ballots. The light pen was chosen for its simplicity of operation, its durability, precision and the elimination of equipment from the working surface of the sensory booth. Since the IBM-personal computer format has become an industry standard and it supports a light pen, it was chosen for developing the software for the system.

Software

Initially, the program to present an unstructured ballot on the monitor screen and record the panelist's light pen response was written in IBM Basic. The monitor display resembles a paper ballot. To allow the sensory analyst to design questionnaires, a menu-driven program was devised to permit editing, saving and customizing ballots. As each new need was identified, additions were made to the program to incorporate the following formats into the system:

Discriminative Testing:
Triangle, Duo-Trio, Paired Comparison.
Descriptive Testing:
Unstructured Line Scale, Hedonic, with the capability of modification into other structured scales, Multiple Choice, Time Intensity.

Options were added to allow registration of panelists and to restrict participation to authorized panelists and to provide the panelist with the option to make comments. All the program modules were compiled into machine language to speed up their execution.

Hardware Installation:

A prototype system was installed in Sensory Analysis facilities of the Department of Consumer Studies of the University of Guelph. Each of the five panel booths was equipped with a 12 in. amber video monitor (Zenith, ZVM 1220) and a light pen (FTG Systems, Stanton, CA) (Fig. 1), which were connected to individual IBM-compatible station microcomputers (256K RAM, 360K floppy drive). These station microcomputers were networked to a master microcomputer using a local area network (Novel 8 with Omninet Servers). Cabling for light pens and network was achieved using standard four strand telephone wire. A high speed dot matrix printer (Epson FX-85) was attached to the master

microcomputer for production of printed reports. All the microcomputers were located together in a shelf unit in the food preparation area, permitting easy access for use and servicing (Fig. 2).

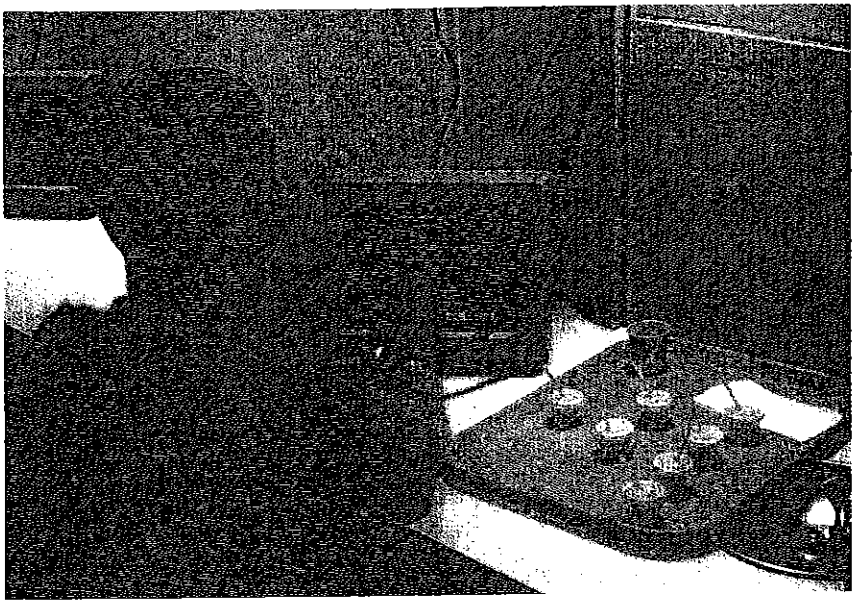

FIG. 1.
PANELIST USING THE LIGHT PEN TO INPUT A RESPONSE
FOR AN UNSTRUCTURED LINE SCALE QUESTION

DISCUSSION

When an analyst prepares a questionnaire, the program uses a menu format to present the design options. An example of this option is shown in Fig. 3. Random presentation numbers are generated by the program and assigned to each sample. If the number assigned is objectionable (i.e., associated with a particular product) or if numbers have already been assigned to sample containers, it may be replaced by a number entered by the analyst. Presentation of samples on the screen is then randomized by panelist over all the screens in the system. The operation of the system is discussed here for the unstructured line scale and the structured hedonic scale. The unstructured scale is used, it appears on the monitor as shown in Fig. 4. The sample number is shown at the end of each line.

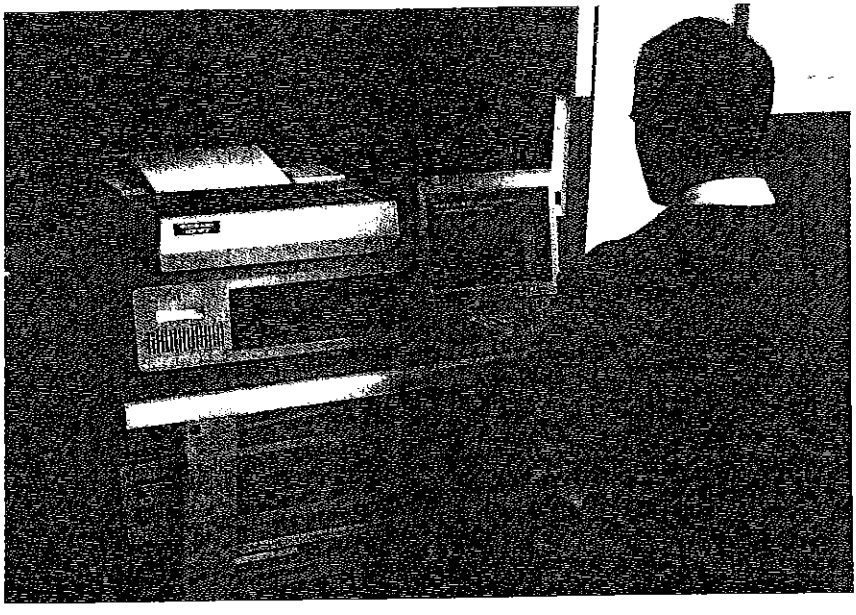

FIG. 2.
SENSORY ANALYST DESIGNING A QUESTIONNAIRE AT THE MASTER MICROCOMPUTER For easy access, the station microcomputers for each both are located in the rack underneath

COMPUTERIZED SENSORY ANALYSIS - Questionnaire Design

SAMPLES

Samp No	Presentation No	Sample Description
1	359	0 % sucrose
2	174	4 % sucrose
3	213	8 % sucrose
4	353	12 % sucrose
5	627	20 % sucrose
6	524	30 % sucrose

Samples Grouped into 2 Random Groups

SAMPLES : ADD DELETE EDIT GROUP REFERENCE NUMBER ACCEPT
Group Samples into 2 Random Groups

FIG. 3.
THE DISPLAY ON THE SCREEN FOR ENTRY OF SAMPLES AND ASSIGNMENT OF PRESENTATION NUMBER
(see text for more information)

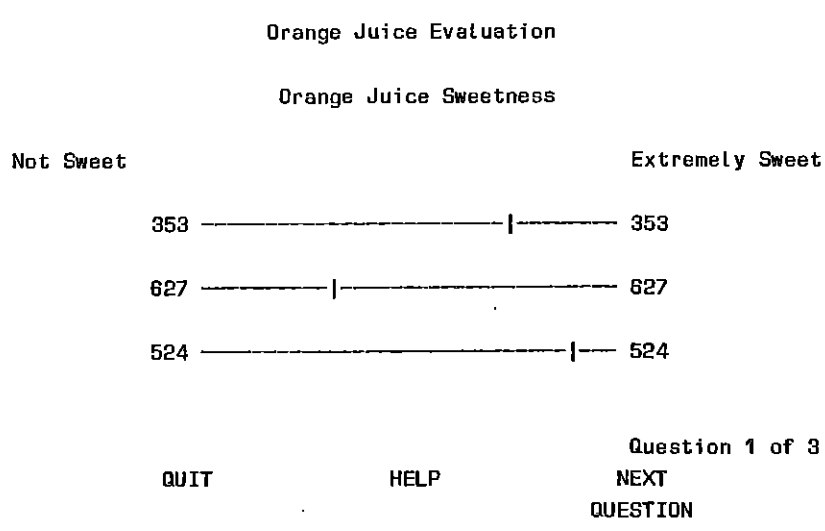

FIG. 4.
AN UNSTRUCTURED SCALE FOR SWEETNESS
(see text as is for more information)

The title of the panel session appears at the top of the screen. The attribute being tested is shown under the title with the extreme descriptors at each end of the line. The panelist responds by placing the light pen at the point on the line that best describes his response to the attribute. A line marker appears at that point. This mark may be changed by simply selecting another point on the line. The mark is recorded as a number, which the computer uses in subsequent data analysis. At the bottom of the screen, there are several options that may be selected by the panelist. Once finished the testing session, the panelist would select "QUIT". If a question is unanswered , the program informs the panelist which question(s) is incomplete. The "HELP" box permits the panelist to access another screen of information about the correct procedure to follow or any other useful hints for the panelist. At the lower right of the screen, there is a statement regarding which question the panelist is answering and how many questions there are to answer. Another box permits the panelist to move on to the "NEXT QUESTION", or back to the "PREVIOUS QUESTION". The structured hedonic scale is illustrated in Fig. 5. The question shown uses the standard labels for a seven-point scale. Individual labels can be customized to provide

structured scales other than hedonic and any number of points from two to nine can be used. The panelist responds by touching the box under the label which best describes the response to the sample. This response is recorded as a numerical value by the computer.

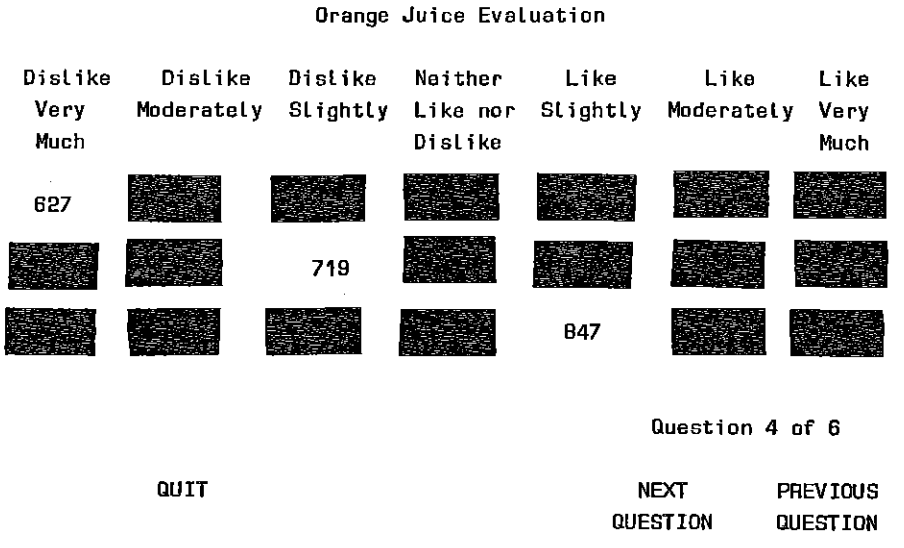

FIG. 5.
A SEVEN POINT HEDONIC SCALE FOR PREFERENCE OF ORANGE JUICE
(see text for more information)

To evaluate the effectiveness of the computerized sensory analysis system, actual product evaluations were conducted at the University of Guelph. In one case, 19 panelists evaluated three different formulas of cooked chicken nuggets for each of seven different sensory attributes using the unstructured line scale. The average panelist required seven minutes to complete the ballot. In general, the panelists adapted rapidly to the use of the light pen and found they were able to concentrate on the product being tested rather than worrying about the computer system. Analysis of variance and a printed report were produced with in five minutes of the end of the panel.

In another case, 26 panelists were divided into four separate groups to evaluate nine sugar cookie formulations, produced and presented using a rotatable design, to optimize the dextrose and sucrose levels. The evaluation of each of three attributes presented to the panelists four samples at a time, required less than 10 min. The accumulated data were analyzed and reported in less than five minutes. To illustrated integrative capabilities of the system, the data set was then transferred to a mainframe computer for multiple regression analysis using SAS. The resultant data were used to generate three-dimensional response surface plots indicating the effect of the two independent variables on each attribute and permitting optimization of the formula.

The elimination of the keyboard from the panel booth raised an immediate question. How could a panelist enter spontaneous comments on the product? To overcome this problem an "on-screen" keyboard was devised (Fig. 6). The panelist uses the light pen to "type" comments directly into the space provided. This operation was found to be no more difficult than "one-finger" typing.

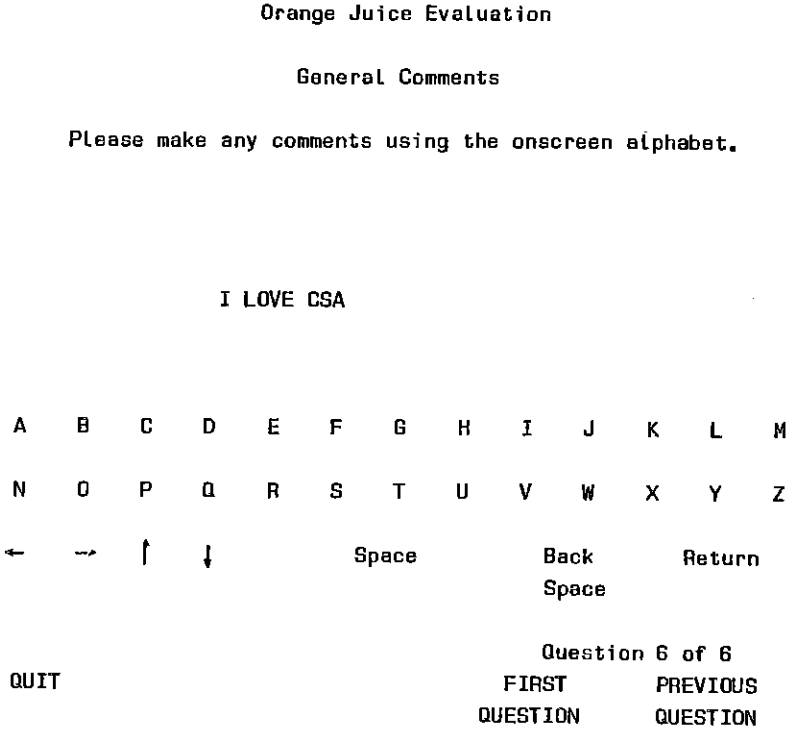

FIG. 6.
THE "ON-SCREEN" KEYBOARD FOR ACQUISION OF PANELIST COMMENTS

The integration achieved using computerized sensory analysis, coupled with the elimination of manual data handling, cuts the time required to conduct a sensory panel in half. The simplicity of the system lends itself to rapid learning and acceptance both by the panelist and the analyst. The enhanced and flexible method for ballot preparation makes the acquisition of more extensive data feasible. The use of IBM-PC compatible hardware makes this system accessible to most sensory labs and, at the same time, permits easy maintenance.

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