time for all responses to arrive. A new cycle is initialized at the instant the cycle time counter halts. However, if a sufficient number of responses has not yet been given before this counter halts, the new cycle is initialized at the instant of the last response. In the *paced mode* the signal patterns succeed automatically as described before.

Peripherals for Output

Two peripherals are available for data output: a Digital Printer and a Tape Punch (Fig. 5). As the system has a storing capacity for data of four responses coming simultaneously, the rate of signal pattern presentation is limited by the maximum speed of the slowest output device. Although printing provides an on-line display of response data, its data feed-out rate is about a quarter of that of the tape punch (e.g., five responses in 1 sec). Thus, for pilot experiments and trials, responses are printed and punched, or printed only, whereas the printer is switched off for fast and complex experiments.

A signal group number is added to the response data (Fig. 4 and 5) in order to label the momentary signal pattern in the response output data. As well as facilitating interpretation of the printed output, this number is indispensable in the punched output tape.

First Applications

The first experimental project which made use of PSARP was carried out while the response processing part of the system was only partly finished. So, processing of judgment was possible at that time but not of reaction time. The project concerned a series of experiments on short-term memory for discrete spatial positions. Twenty-six lights, each corresponding with a specific individual from a set in PSARP, were mounted in a 13 by 2 matrix on a board. The lights had been fixed on top of reaction keys, enabling Ss to respond by just touching the particular light. In a typical experiment, a variable number of lights flashed successively, preceded by a warning signal and an indication about the number of flashes. Since the total signal capacity of PSARP is 32, six lights could be used to program the warning signals. An "empty" cycle, i.e., a cycle in which only a cycle time was programmed, controlled the interval between presentation of a trial and the next warning signal.

It is clear that the possibilities of PSARP are only partly used in these experiments (see Sanders, 1968). More intensive use of the possibility to present several signals simultaneously or overlapping is made in experiments on the psychological refractory period. PSARP enables presentation of up to four signals in rapid succession, instead of the traditional series of two signals. All time intervals have an accuracy of 1 msec. This feature makes the apparatus very appropriate for the study of judgment of simultaneity, when signals are presented in succession, but spaced with very small intervals. It is clear from these examples that PSARP can be used for a variety of experiments on human perceptual motor skills, while the experimental task can reach a considerable level of complexity.

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Report of a nonnutritive food substance, palatable to rats

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Formulas are presented for two food substances matched in taste and texture characteristics, one nutritive (4.00 cal/g) and the other nonnutritive (0.00 cal/g). Mean consumption amounts and body weight changes over a five day period are given for both male and female rats. Areas of possible application are suggested for experiments where natural ingestion of bulk is desired.

A nonnutritive food substance (caloric value = 0.0032 cal/g) has been devised which rats will eat. Taste and texture characteristics of this nonnutritive substance were matched as closely as possible to those of an adulterated version (4.00 cal/g) of a high-fat substance (6.00 cal/g) reported by Smith, Pool, & Weinberg (1962). The substances have a taste and texture judged by humans to be similar to the standard dough of "refrigerator cookies".

Both substances (with vitamin supplement of 4 g, Nutritional Biochemicals, added to the nutritive substance) have been used as the sole diet for a five day period (Taylor & Bruning, 1967). All animals were 150 days old; additional growth was minimal. Body weight changes, previously unreported, were as follows: males (mean start weight = 435 g) on nonnutritive (NN) substance lost approximately 17% of their initial body weight and ate an average of 32 g of NN substance daily; females (mean start weight = 301 g) on NN substance lost approximately 16% of their initial body weight and ate an average of 42 g of NN substance daily. In contrast, males (mean start weight = 426 g) on nutritive (N) substance gained approximately 4% of their initial body weight and ate an average of 39 g of N substance daily; females (mean start weight = 301 g) on N substance gained approximately 3% of their initial body weight and ate an average of 28 g of N substance daily.

The body weight changes under NN substance schedule compare favorably with body weight changes reported by Bolles (1965) of animals on continuous food deprivation. Bolles found that 270-day-old males after five days deprivation lost 17% of the body weight of their matched, undeprived controls; that 150-day-old males after five days deprivation lost 18% of the body weight of their controls; that females (120-days-old) after four days deprivation lost 21% of the body weight of their controls. It should be noted that rats on NN substance diet drink considerable amounts of water—a factor which may have made weight measurements in the present study somewhat high. The body weight gain under N substance diet in the present study would be expected since the caloric value of this substance (4.00 cal/g) exceeds the caloric value of laboratory Purina Chow (3.61 cal/g; Corbit & Stellar, 1964).

The recipes for the respective substances follow:

- Nonnutritive Substance.* (approximately 0.0032 cal/g) 50 g methyl cellulose (4000 centipoise, Fisher Scientific)
70 g "baseline"
36 g calcium carbonate
28 g mineral oil (heavy weight)
4 g salt mixture (U.S.P. XIV, Nutritional Biochemicals)
50 ml "Diet-Pepsi" (non-carbonated fountain syrup)
24 ml tap water

Order of mixture. Methyl cellulose and vaseline should be mixed together with an electric mixer. Then add the calcium carbonate while mixing and finally add the mineral oil. Combine the "Diet-Pepsi" and water and mix slowly into the solid mixture.

Nutritive Substance. (approximately 4.00 cal/g) 50 g methyl cellulose (4000 centipoise, Fisher Scientific)

43 g "Crisco"

20 g vitamin free casein (Nutritional Biochemicals)

33 g sugar (confectioners grade)

4 g salt mixture (U.S.P. XIV, Nutritional Biochemicals)

45 ml "Pepsi-Cola" (non-carbonated fountain syrup)

55 ml tap water

Order of mixture. Add all of the dry ingredients together and mix with an electric mixer. Combine the "Pepsi-Cola" and water and mix slowly into the solid mixture.

For larger amounts of substance, it is advised that smaller mixtures of the proportions indicated be made and combined, since doubling and tripling the amounts indicated often causes variation in the mixtures. Also, because of the nature of the methyl cellulose and the way in which it combines with other ingredients, the above amounts are only approximate. At times it is necessary to add an additional, small amount of one of the

ingredients to a substance so as to equalize its texture to that of the other substance. The above formulas are accurate within 5%; therefore, ingredients should not be added above that percentage amount. The order of mixture is important. Adding the liquids last prevents gumming of the methyl cellulose and provides the resultant smooth texture.

These two substances provide a means of varying natural ingestion of bulk. Such a methodology allows: (a) variation of body weight on an ad lib feeding schedule, (b) study of the consummatory response as it is influenced by bulk aspects of the diet, and (c) variation of quality of a reinforcer on a caloric basis. The natural ingestion aspect of these materials provides a procedural advantage over the surgical and stimulus-confounding problems in previous bulk experiments.

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A note on luminance control in tachistoscopes

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Procedures are described for measuring tachistoscopic luminance levels for brief light flashes and over longer intervals. Stability of luminance levels is discussed for both conditions.

In several articles concerned with reporting perceptual research in which tachistoscopes were used, the luminance level has been critical. In many reports, the investigator has obviously gone to a great deal of trouble to specify the luminance conditions at the start of experimentation. Implicit in statements reporting a given luminance level is the assumption that the luminance remains constant. Unfortunately, with phosphor-coated light sources, this assumption is not correct.

I have conducted a reasonably thorough calibration of two different commercial, three channel tachistoscopes powered by the standard phosphor-coated light sources. Over a series of several days the following procedure was used. A Spectra Brightness Spot Meter calibrated to read directly in ft-L was focused upon a 5 by 7 in. white card placed in one channel of the tachistoscope. The lamp was allowed to burn continuously. Potentiometers on the instrument used to control luminance were set to one of three positions. The same white card was used in each channel. Eventually, data were obtained for nine separate conditions, the three channels each at three different potentiometer settings. Luminance readings were made when the lamp was first turned on and at each succeeding minute for at least 10 min. In every case luminance increased as a function of the amount of time the lamp had been burned. In every case the luminance level reached a point of stability, but in some cases this required 15 min of continuous operation of the lamp.

Measurements were also made of the luminance of brief light flashes. Because of the lag of the photometer, it was necessary to employ a different method of measuring luminance. A photo cell¹ and oscilloscope proved adequate. When the same calibration procedure was used as with the continuously burning lamp, essentially the same results were found. In each case initial measurements of luminance were low and later measurements were higher. Furthermore, on days in which the room temperature was low, initial luminance readings were particularly low. In addition, when very brief flashes, up to 20 msec, were used with relatively long off periods, about 1 sec, the luminance never stabilized. Apparently, in order to reach a point of stability, lamps must achieve a certain temperature. When operated continuously, such temperature is reached, usually within 7 or 8 min. With brief flashes, some of the heat generated can dissipate while the lamp is off and stability may never be achieved.

Luminance is clearly a function of temperature. The tachistoscope with the photometer is, in effect, a reliable though expensive thermometer. When the tachistoscope is used in the manner in which it was designed to be used, namely, as an instrument to deliver very brief light flashes, it is unexcelled. When, instead, it is used where the luminance requirement is critical or where the spectral composition of the light must remain invariant, the apparatus will be found wanting. If luminance control is more important to the experimenter than the very brief exposure permitted by the phosphor-coated lamps, a mechanical shuttering system together with a light source which remains on constantly is advisable.

NOTE

1. The 934 photo tube is a vacuum type with fast response. It peaks at 4000 Å.