uncomplicated by the relatively large and unkown contribution of sebaceous-gland products (*4*), were not possible previously.

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Paired Comparison Method for Measurement of Sugar Preference in Squirrel Monkeys

Abstract. *The glucose preference of four squirrel monkeys was determined by presenting 5-, 10-, 20-, 30-, and 40-percent solutions according to the paired comparison method. Scaling of the data for the amounts of each solution consumed yielded a preference function which increased monotonically with the concentration of the solutions.*

In previous studies of food preference it has not been uncommon for the results to vary according to the method used. The two methods most often used as an indication of the kind of food preferred involve measuring the amount of each type of food consumed or observing the operant (bar-pressing) behavior expended to obtain the different foods. These two methods often yield conflicting conclusions [see Young and Greene (*1*) as opposed to Stebbins *et al.* (*2*)] and this is the case especially within variations of the latter method (*3*). An example of a difference in preference produced by a difference in procedure is furnished by Guttman (*3*), who found that the rats rewarded at 1-minute intervals would bar-press more for a 32-percent sugar solution than they would under a continuous reinforcement schedule.

When the amount of sugar solution consumed is measured, the results indicate that most animals prefer liquids of low to intermediate concentrations. When the response rate in operant situations is measured, it increases with higher concentrations of sugar solutions. (It is usually assumed that a higher response rate indicates a greater preference or value attached to the food offered as a reward for the bar-pressing.)

Although based on measurements of substances consumed, the paired comparison method (*4*) allows relative intake of the different concentrations to be scaled, and thus may provide a link between preference functions obtained by the original two methods. Therefore, we have evaluated the paired comparison method as a means of determining sugar preference in squirrel monkeys.

Five concentrations of glucose solution, 5-, 10-, 20-, 30-, and 40-percent, were made by mixing anhydrous glucose with tap water on a weight-by-volume basis suggested by Pfaffmann *et al.* (*5*). Four young male squirrel monkeys (*Saimiri sciureus*) (*6*) were tested in their home cages 2 to 4 hours before they were given their daily meal. Every day, each subject was allowed to drink from a pair of solutions which were presented simultaneously in graduated cylinders with metal drinking tubes. The pairings were random, such that over a period of 25 days every solution was paired with every other solution twice and with itself once, thus allowing counterbalancing of position and determination of position preference. During the 1-hour test period, the animals had no access to water and readings were taken at 10-minute intervals.

Figure 1 shows that the curves representing the mean amounts of each solution consumed after 10 minutes and 60 minutes are nearly parallel, with almost 80 percent of the total intake occurring in the first 10 minutes. Wagner (*7*) has also found that satiation influences rate of intake over extended time periods but does not affect relative preference for sugar solutions. The fact that these consumption curves have maxima at intermediate concentrations indicates that they are typical for the measure used and that squirrel monkeys have generally the same preference function as other, better-tested subjects. Since the curves for 10 minutes and 60 minutes resemble each other closely, and since the data for 60 minutes are confounded by a satiation effect, the remainder of this report is based on the data obtained after 10 minutes.

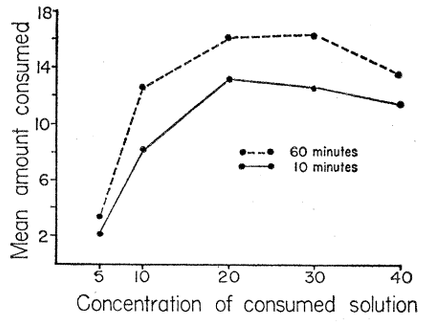

Fig. 1. Mean amount of each glucose solution consumed after 10 minutes and after 60 minutes.

The effect of solutions presented for comparison can be seen in Fig. 2, where a general tendency is shown for less of any given solution to be drunk when the solution with which it is paired increases in concentration. It is of interest that when each solution, except the 5-percent solution, was paired with itself the amounts consumed were nearly equal, and only a slight tendency to

Table 1. Comparison of obtained proportions with estimated proportions for choices of solutions with the higher concentrations.

Percentage concentration of comparison solution	Percentage concentration of consumed solution				
	5	10	20	30	40
5		0.875 *.999**	1.000 *0.999*	1.000 *0.999*	1.000 *0.999*
10	0.125 *.000*		1.000 *.999*	.875 *.999*	.750 *.999*
20	.000 *.000*	.000 *.000*		.750 *.993*	.750 *.998*
30	.000 *.000*	.125 *.000*	.250 *.000*		.625 *.667*
40	.000 *.000*	.250 *.000*	.250 *.002*	.375 *.323*	

* Numbers in italics are estimated proportions.

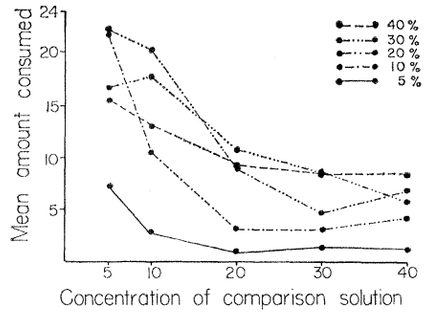

Fig. 2. Amount of each glucose solution consumed as a function of the concentration of the comparison solution.

decrease with increasing concentration was shown.

Position preferences were initially displayed by all subjects. However, the effect of position is considered negligible because the subjects consistently chose the solution with the higher concentration in the trials immediately preceding and following the trials in which identical solutions were presented. As days went by the position preferences decreased and in the case of two subjects actually reversed.

Of the models available for the scaling of paired comparison data, the obtained data best fit the assumption for Torgerson's condition B (*4*). Preference was determined by assuming that if an animal consumed more of one member of a pair of solutions, then the solution of which more was consumed was preferred. Table 1 shows the proportionate frequency for preference of each solution. The number of such preferences for the higher-concentration solution in each pair, expressed in terms of relative frequency, was the basic data to which the model was applied. The resulting scale is shown in Fig. 3, where the 40-percent solution has the highest scale value. If the model is applied to the data for amounts, the resulting scale again shows a similar order of preference. Both scales reflect the fact that more was consumed of the higher-concentration solution in each pair.

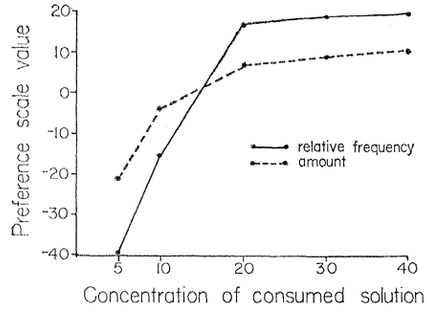

Fig. 3. Preference functions based on relative frequency of choice of the higher-concentration solution of a pair and on amount consumed of each member of a pair.

The goodness of fit of the model to the data was checked in Table 1 by finding the average deviation of proportions obtained from the raw data (*4*). In the case of the data for relative frequency, the average deviation was 0.098; in the case of the data for amounts consumed, it was 0.192. While these deviations are somewhat "large," the exploratory nature of this study must be borne in mind: that is, a relatively small number of observations was made on a small number of subjects.

The paired comparison method appears to yield a monotonically increasing preference function over the range of concentrations tested. Since the amounts of each solution consumed show a curve typical of such data, and since the scales produced by an appropriate paired comparison model show a curve which is qualitatively similar to operant data, it is suggested that the paired comparison method may provide a means of resolving differences in the results obtained with the two methods and may thus provide a useful tool in the determination of preferences in animals.

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Nucleic Acid Polymerases: Possible Subunit Structure

Abstract. *A hybrid polymerase which catalyzes the synthesis only of helical polynucleotides with one DNA-like strand and one RNA-like strand can be altered by certain treatments so that it will then synthesize DNA and RNA. There is evidence that the alteration involves a separation or rearrangement of polymerase subunits of several kinds. Two types of RNA polymerase activity have been found: one produces single chains, and the other, two complementary chains simultaneously. The latter type of RNA polymerase, the hybrid polymerase, and the DNA polymerase behave as though they were bifunctional, and each may be composed of two monofunctional subunits.*

Although a variety of nucleic acid polymerases have been observed in vitro, no attempt has been made to correlate the structures of the responsible enzymes. The striking similarities in the reactions catalyzed provide compelling evidence for structural similarities among the enzymes. All of the reactions require a polynucleotide template, divalent metal ions, and nucleoside-5′-triphosphate substrates; the products are polynucleotides which have been synthesized in a base-pairing fashion.

From studies on interconversions among the various polymerase activities presented here, we suggest that the nucleic acid polymerases are composed of subunits and that different activities may arise either by dissociation or rearrangement of the subunits. If this is true, then caution is required in interpreting the biological significance of results in vitro. The DNA-dependent synthesis of polyadenylate (*1*), for example, or the synthesis of other single homopolymers described here, may be due to enzymes which have lost or gained subunits on isolation. Furthermore, differences in primer requirements reported by others may also arise from such alterations.

Our work evolved from studies of a "hybrid" polymerase from *Escherichia coli*, which catalyzes the synthesis of hybrid molecules in vitro with DNA or helical polyribonucleotide templates (*2*). For example, with the homopolymeric complex poly(C+I) (*3*) as template and dGTP and CTP as substrates, the hybrid polymerase produces helical poly(dG+C), in which each polynucleotide chain is a homopolymer. Similarly, when the substrates are dCTP and GTP, the product is poly(dC+G). We have demonstrated that DNA polymerase from *E. coli*, in con-