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EXPLORATORY STUDIES OF PRESCHOOL CHILDREN'S TASTE DISCRIMINATION AND PREFERENCE FOR SELECTED CITRUS JUICES

RICHARD L. D. MORSE

Professor of Family Economics

Florida State University

Tallahassee

These studies constitute the first published attempt to estimate preschool children's discriminability and preferences for citrus juices. An extensive search of the literature for previous studies in the area yielded reports on children's likes and dislikes for specific foods, the effect of size of serving on food consumption, the social dynamics of food preferences, e.g., the effect of the group leader's preference on the preferences of the followers in the group, and studies involving children's taste reactions to salt, bitter, sweet, and sour. Since none pertained directly to this problem, these investigations constitute an effort to discover methods of taste-tests appropriate to this age level of children.

DISCRIMINATION AND PREFERENCE

Discriminability is measured in terms of degree to which the individual or group can distinguish between two stimuli and can communicate this distinction to the investigator. Factors which affect discriminability are: individual's taste acuity at the time of the test; the consistency or stability of this ability over time, if the results of tests conducted at several different times are to be compared; the "distance" or difference between the stimuli, measured in terms of their physical properties; the design of the test, especially its complexity and premium it places on memory; and, the method of communicating the results from the subject to the investigator. Furthermore, any declaration as to the discriminability depends on the arbitrary standard the investigator sets as the number of correct versus incorrect judgments required. For example, this investigator required that the subject make at least 10 correct judgments out of 12 trials to be declared discriminating, reasoning that such ratio of judgments between equal stimuli could have occurred by chance guess in slightly less than 5% of similar repeat trials. If this arbitrary level were reduced, more subjects could qualify as discriminating. The lowest limit would be to include all those subjects who made more correct than incorrect judgments. Such discussion soon leads to the probability theory. The point of emphasis here is the arbitrariness of the level set.

Preference assumes discriminability; that is, it is logically inconsistent that one can prefer one stimulus over another if the two stimuli are not distinguishable (discriminable) by the subject. This point is well developed by Clements (1951). (If, on the other hand, the arbitrary level for discriminability were set too high, it is possible that stimuli which are declared non-discriminable may be declared unequally preferred.) Frequently overlooked is the point that preferences are relative; that is, one cannot declare a preference for a stimulus without reference to some standard for the product or its close substitute. In the simplest case, two stimuli are provided and one serves as a standard for the other; one is ranked relative to the other in the paired comparison test. Interpretation of such paired tests is obvious, although here again, as in the discriminability

tests, the probability level selected for declaration of preference is arbitrary. Less complicated in outward appearance is the test which presents only one stimulus at a time and secures a judgment rating from the subject as to whether the stimulus is "excellent," "good," . . . "unacceptable." This is a difficult test for the subject, and these difficulties, in turn, make proper interpretation of the results by the investigator precarious. The subject must conceive of a standard before making a rating. Whether the standard is in accordance with his current living pattern, his desired living standards, his concept of the public's standards, etc., and how this subjective standard varies from time to time and test to test confounds the ratings and defies simple interpretation of the results. Between the two extremes, namely the paired test where one stimulus serves as a standard for the rating of the other, and the single stimulus with no objective standard specified, lie other tests which more or less define the frame of reference in which the stimulus is to be rated. The point of this discussion, however, is that since all preference ratings are manifestly relative, the results of such studies must be viewed in terms of "standards" the test assumes or constructs. It is for this reason that two well administered preference tests may yield conflicting results; each may have been placed in a different context. A corollary to this observation might be that the more alike the preference test setting is to the conditions under which the population under study behaves, the more likely will the results of the preference test reflect probable population behavior. This should not be misconstrued to mean that preference tests yield predictive data as to market behavior: the "steps" between the two are much too complex to discuss here (see Morse, 1951, for a full discussion). The same factors which affect tests of discriminability also affect preference tests.

The Tests

The studies are concerned with individual children's taste acuity with respect to different juices under various test conditions. The results of six tests are reported. The tests were conducted in cooperation with the Florida State University Nursery School in which the children were enrolled, and were administered as a substitute for their regular mid-morning juice time. The essential difference was that the children participated in the test individually and apart from the group; this was done to avoid group dynamics. The graduate student (Gustafson, 1953) who served the juice in 5 of the tests was professionally trained in child development and knew the children, who accepted the test as a game. Unless otherwise specified all children were between the ages of 4 and 5. In all tests, three-ounce, non-waxed paper cups were used, and cookies were not given until after the test was completed. Each test is characterized by the juices served and the test method employed. Tests 1 and 2 were conducted in the academic year 1951-52; tests 3-6, in the year 1952-53, with another group of children. All juices used were reconstituted frozen concentrate unless otherwise specified. They were packed by the Florida Citrus Experiment Station, cooperating with the Florida Citrus Commission in this and other taste studies conducted by the author. The Florida State University Research Council provided financial assistance.

Test 1

Reconstituted Valencia Orange and Grapefruit Concentrate; Modified Paired Comparison Method

The modified paired comparison test utilized two identical ceramic figurine pitchers, each containing one of the two juices under study. After the child was seated at the test-table, a one-ounce serving was poured from one pitcher into a paper cup. When that was consumed a similar quantity was poured into the empty cup from the other pitcher. After the second juice was consumed, the child was asked, "Which juice would you like more of?" and the child pointed to the pitcher containing the juice of his choice. The order-position of the juices was reversed each successive test to enable analysis of choice based on juice and choice based on order-position. This test method was designed by Marjorie J. Morse, professionally trained in child development. Its primary merit lies in its simplicity, particularly since it requires of the child only his typical reaction of "I want more of that one," and avoids lengthy memory span or complex communication.

This test, administered to 16 children, was repeated 44 times (days), but because of absences from school most of the children participated in fewer than this number. Table 1 presents for each child the frequency of his participation and choice for each juice in rela-

tion to its order-position. Most surprising to this author were the 5 children who were perfectly consistent in their choices, 4 for orange and 1 for grapefruit. Eleven children (*A-K*) expressed significant choice for orange juice, one child (*P*), for grapefruit. Of the 4 remaining, *O* tended to prefer grapefruit (during the test period this child had a tonsillectomy), *N* was indifferent, and children *L* and *M* gave the order-position of the juice greater significance than the juices, and chose the first juice offered.

Test 2

Reconstituted Valencia Orange, Grapefruit, and Tangerine Concentrate, Modified Paired Comparison Method

The success of the orange-grapefruit combination test established faith in the test method and suggested its use with other combinations of juices. Two relatively unskilled assistants were utilized because of their availability, and the results may thus have been affected.

The orange-grapefruit combination was offered the initial week to establish confidence in the assistants, and again for a week two months later to test the children's continued ability to demonstrate their preferences. The results of the 10 trials, presented in Table 2, indicate that the 9 children who had expressed significant choices at the 1% level (*A-H, P*) continued in their preferences. Children *J* and *K* whose choices were significant at the 5% level in favor of orange, failed to continue an indication of choice, and child *O*, who had indicated a preference for grapefruit, reversed this indication of choice in favor of orange. Children *L* and *M* persisted in indicating no choice between the two juices. Children *Q* and *R* replaced children *I* and *N* in the group, and their participation does not warrant generalizing. These additional data indicate: (1) the persistence of choice or non-choice for 11 of the 14 comparable children through time and with change of personnel administering the test; (2) the danger of prediction of choice for the other 3 children (*J, K, O*) who had strongly indicated a preference in the previous test.

Grapefruit juice was paired with itself for 5 weeks (24 trials) to establish the randomness of choice when two equal stimuli are presented. The immediate reaction among those who had strongly favored orange juice was refusal to take a third cup—that is, to make a choice. Children *A, C, G,* and *H* refused 20, 15, 5, and 2 times respectively, thus validating their preference for the orange and indicating a strong dislike for the grapefruit. The results shown in Table 2 indicate the randomness of choice; none differs significantly from a 50-50 distribution, as should be expected.

Orange and tangerine were paired for 8 successive trials and the results are presented in Table 2. Children *A-H* as a group chose tangerine 33 times to orange 11 times; thus among those who favored orange, tangerine

TABLE 1.
Frequency of Choice for Valencia Orange[1] and Grapefruit[2] Juices, by Order

Child	Orange-Grapefruit Order		Grapefruit-Orange Order		Summary Juice		Summary Order	
	O[1]	G[2]	O[2]	G[1]	O	G	1	2
A	18	0	22	0	40**	0	18	22
B	20	0	20	0	40**	0	20	20
C	12	0	13	0	25**	0	12	13
D	9	0	10	0	19**	0	9	10
E	19	0	20	1	39**	1	20	20
F	17	1	20	0	37**	1	17	21
G	21	0	21	2	42**	2	23	21
H	15	2	18	1	33**	3	16	20
I	19	0	18	4	37**	4	23	18
J	18	1	8	8	26**	9	26**	9
K	15	5	11	7	26*	12	22	16
L	18	2	1	20	19	22	38**	3
M	20	1	0	23	20	24	43**	1
N	6	9	7	7	13	16	13	16
O	2	9	4	8	6	17*	10	13
P	0	20	0	21	0	41**	21	20
Group	229	50	193	102	422	152	331	243

* Significant at the 5% level.
** Significant at the 1% level.

[1] 12° Brix, 12.6 ratio.
[2] 12.2° Brix, 10.7 ratio.

TABLE 2

Frequency of Choice for Designated Juices, by Order

Child	Valencia Orange[1] and Grapefruit[2]						Grapefruit[3]						Valencia Orange[1] and Tangerine[4]					
	Orange-Grapefruit		Grapefruit-Orange		Summary		Grapefruits R-W Order		Grapefruits W-R Order		Summary		Orange-Tangerine		Tangerine-Orange		Summary	
	O[1]	G[2]	O[2]	G[1]	O	G	R[1]	W[2]	R[2]	W[1]	R	W	O[1]	T[2]	O[2]	T[1]	O	T
A	0	0	0	0	0	0	1	2	1	0	2	2	1	1	0	1	1	2
B	4	1	5	0	9*	1	1	8	6	4	7	12	1	4	1	2	2	6
C	4	0	4	1	8*	1	1	2	3	1	4	3	0	4	0	0	0	4
D	5	0	4	1	9*	1	7	4	6	4	13	8	3	2	1	2	4	4
E	3	0	3	0	6	0	5	5	6	2	11	7	0	2	0	1	0	3
F	5	0	5	0	10**	0	3	8	9	1	12	9	1	4	1	2	2	6
G	4	0	4	1	8*	1	2	8	5	4	7	12	0	2	0	1	0	3
H	2	1	3	1	5	2	6	3	7	1	13	4	1	3	1	2	2	5
I	0	0	0	0	0	0	0	6	4	2	4	8	withdrawn					
J	3	2	2	3	5	5	6	4	4	7	10	11	3	0	1	1	4	1
K	4	1	1	4	5	5	3	10	9	2	12	12	2	3	1	2	3	5
L	3	0	1	4	4	4	7	3	3	8	10	11	3	2	2	1	5	3
M	4	1	1	4	5	5	9	4	3	8	12	12	2	3	0	3	2	6
N	1	0	0	2	1	2	3	2	0	4	3	6	withdrawn					
O	3	2	4	0	7	2	10	3	7	3	17*	6	1	4	0	2	1	6
P	0	5	0	5	0	10**	1	8	1	8	2	16**	1	1	0	0	1	1
Q	2	1	2	0	4	1	3	3	2	1	5	4	4	1	0	3	4	4
R	2	1	0	2	2	3	5	1	0	4	5	5	4	1	1	2	5	3
Group	49	15	39	28	88	43	73	84	76	64	149	148	27	37	9	25	36	62

* Significant at the 5% level.

** Significant at the 1% level.

[1] 12° Brix, 12.6 ratio.

[2] 12.2 or 14° Brix, 10.7 ratio.

[3] R = 14° Brix, 10.7 ratio.
W = 12.2° Brix, 10.7 ratio.

[4] 12° Brix, 18.2 ratio.

may be even more preferred. Five refusals to make choices were from child *A*, who since the initiation of grapefruit test failed to respond to the test conditions and child *P*, who unerringly had chosen grapefruit in preference to orange, refused 5 of the 7 times present to choose between orange or tangerine, thus validating her choice of grapefruit and indicating a strong dislike for orange or tangerine.

Children *L* and *M* by the end of the year had departed gradually from their preference for the first order juice.

Test 3

Reconstituted Temple and Tangerine Concentrate; Modified Paired Comparison Method

The work of the previous year had successfully demonstrated the usefulness of the modified paired comparison test method in determining children's preference or non-preference between orange and grapefruit juices, a neutral preference as between two grapefruit juices, and a suggestion of a preference for tangerine over orange among those who had demonstrated a preference for orange. The data, however, were insufficient for reliable inferences. Test 3, therefore, utilized the orange-tangerine combination to secure further evidence as to the relative preference position. The trained assistant of Test 1 performed Tests 3-6, these latter tests being employed, however, with a different group of 16 children. (That is, child *A* in Test 1 is the same as child *A* in Test 2, whereas child *a* in Test 3 is the same child as child *a* in tests 4, 5, and 6.)

The juices were presented 15 times in the orange-tangerine order and 15 times in the reverse order and the choices are summarized in Table 3. No child indicated a significant preference for orange or tangerine although the group tended toward orange. More evidence of preference was shown for order-position. The group tended to prefer the first juice, with children *e, h, k, m,* and *o* showing a significant (at 5% level or less) tendency toward the first, and children *a* and *c* indicating a significant preference in favor of the 2nd order position. It may be concluded that for this group of children the two stimuli were not sufficiently different to be discriminable, or, if they were, they were somewhat equally preferred by each child.

Test 4

Reconstituted Temple Orange and Tangerine Concentrate; Triple-Same Discrimination Test

Failure of the children to demonstrate a preference for either of these juices in Test 3 suggested either that this new group of children were not as discriminating as the previous group, or that the children, if discriminating, had no preference. A test for discrimination was therefore employed in an attempt to establish ability of the children to distinguish between these juices. Three cups filled with one-ounce of juice were placed before the child; two of one juice, and one of the other juice identifiable by an inconspicuous marking in the cup. The order of presentation was altered each day to avoid fixed identification of

TABLE 3

Frequency of Choice for Temple Orange[1] and Tangerine Juices,[2] by Order

Child	Order T-O		Order O-T		Summary Juice		Summary Order	
	T[1]	O[2]	T[2]	O[1]	T	O	1	2
a	0	5	5	1	5	6	1	10*
b	7	5	5	8	12	13	15	10
c	3	11	12	2	15	13	5	23**
d	7	5	3	12	10	17	19	8
e	10	3	3	9	13	12	19*	6
f	2	1	1	3	3	4	5	2
g	6	5	5	6	11	11	12	10
h	12	0	6	8	18	8	20*	6
i	4	3	1	6	5	9	10	4
j	3	8	2	6	5	14	9	10
k	7	1	1	7	8	8	14**	2
l	3	11	6	9	9	20	12	17
m	6	1	1	7	7	8	13**	2
n	6	6	3	8	9	14	14	9
o	9	2	2	8	11	10	17**	4
p	5	2	5	1	10	3	6	7
Group	90	69	61	101	151	170	191	130

* Significant at the 5% level.
** Significant at the 1% level.

[1] 12.2° Brix, 13.0 ratio.
[2] 12.2° Brix, 13.8 ratio.

juice with order for the successive trials. The child was instructed: "Two of these juices taste the same, and one tastes different. Taste each one and tell me which two taste the same." The child's reply was usually made by moving the two "alike" cups toward the investigator. A cookie or cracker was then given the child who returned to his group.

The test was administered 11 times, 4 in the Tang.-Tang.-Orange order (TTO); 4 in the Orange-Orange-Tang. (OOT) order; and 3 in the Tang.-Orange-Tang. (TOT) order. The frequency of right or wrong identification is presented in Table 4. Identification by chance selection alone among the three juices would have yielded 1 correct to 2 incorrect judgments, and none of the children differed significantly in their judgments from such random judgments. In fact it would appear that several of the children tended to make unusually large wrong judgments. The group total closely approximates random identification of the two juices. The ratio of right to wrong identification was least among the TOT order trials and most among the TTO order trials. In no case were the same juices the last two. This suggests biases inherent in the test design. It may be concluded therefore that the test failed to indicate any ability of the children to discriminate between the juices, suggesting that (1) the test is unreliable, or (2) the children are non-discriminating, or (3) the stimuli are too close for discrimination.

TEST 5

Reconstituted Temple Orange Concentrate and Canned Single Strength Valencia Orange Juice; Triple-Odd Discrimination Test and Preference

The failure of Test 4 suggested need for a change in stimuli and change in method. Substituted for the tangerine concentrate was canned single strength Valencia of 8° or 9° Brix and 12-1 or 16-1 Brix-acid ratio which had been stored at room temperature for over 18 months. The juice tasted so poor that none of the adults at the nursery school would drink it. It was used in an attempt to determine whether with this extreme difference in palatability the test would detect a reaction from the children. The test was similar to Test 4 in that three juices were presented with one juice being different from the other two. It was modified to the extent that the child was asked to tell the investigator which juice was different. The instructions were: "Two of these juices taste the same and one tastes different. Taste them all and tell me which one tastes different." The child usually moved the cup with the juice considered different toward the investigator. The child was then asked his preference, "Which one of the three did you like the best?"

After a trial period of two days, the test was administered 14 times, each successive day employing a different combination of the juices. The Temple concentrate-Valencia

TABLE 4

Frequency of Right and Wrong Identification of Same Juices, Temple Orange[1] and Tangerine Juices,[2] by Combination Order

Child	Combination Order TTO R	TTO W	OOT R	OOT W	TOT R	TOT W	Total R	Total W
a	0	2	1	3	1	2	2	7
b	3	0	2	0	0	2	5	2
c	0	2	0	2	0	3	0	7
d	2	1	0	4	0	4	2	9
e	2	0	1	1	0	3	3	4
f	1	0	0	1	0	0	1	1
g	0	3	1	3	2	2	3	8
h	0	3	0	4	1	3	1	10
i	1	0	0	2	1	2	2	4
j	0	1	2	0	0	2	2	3
k	1	1	2	2	0	2	3	5
l	1	0	0	0	1	1	2	1
m	2	1	0	4	0	4	2	9
n	0	1	0	3	0	3	0	7
o	2	1	3	1	1	2	6	4
p	3	0	2	1	1	3	6	4
Group	18	16	14	31	8	38	40	85

[1] See Table 3.
[2] See Table 3.

single strength-Temple concentrate (TVT) order was used 3 times, as was the TVV and the VTV orders. Twice used was the TTV order and the VTT order (also in the pre-test period), and once the VVT order. Juice T (Temple concentrate, reconstituted) appeared in the first order position 8 times, in the 2nd, 7 times, and in the 3rd, 6 times. Juice V (single strength canned Valencia) appeared 6, 7, and 8 times in these respective positions.

The inability of the children to show discrimination between these two juices under these test conditions is obvious from the results presented in Table 5.1 which shows the frequency of correct and incorrect identification of the odd juice, by each combination order of the juices. Only child *n* and possibly child *g* show indication of significant discrimination (identification of the odd juice). The group failed to exceed chance identification of the odd juice (1 right: 2 wrong) when the odd juice was first and had to be remembered. It may be concluded that change in the test and the change in the stimuli failed to yield satisfactory results.

A further indication that the test, designed for discrimination, is not appropriate for this population may be seen from the children's selection of the best juice. The frequency of choice for each juice by combination order is presented in Table 5.2. Seven of the 16 children (*b, e, g, i, n, o,* and *p*) indicate a significant preference for the Temple. Thus, since more children made significant preference than discrimination judgments, and it is logically impossible to prefer stimuli which are non-discriminable, it may be concluded that the discrimination test failed to detect their power of discriminability. It is noteworthy that not more of the children expressed a preference for the well-flavored Temple concentrate over the insipid and "tinny" canned Valencia juice. Perhaps these 16 children are not as sophisticated in their taste reaction as the former group of children used in Tests 1 and 2.

Bias in selection of the odd juice and preferred juice is apparently inherent in the combination order. Presented in Table 5.3 is the frequency with which each juice was chosen according to its order position. It will be noted that the middle position is most frequently selected, thus bearing out an observation made by Harrison and Elder (1950) regarding bias in the use of the triangular method.

There was no tendency for the children to increase in accuracy of identification of the odd juice as the test progressed. Furthermore, there was no tendency for the children to select as their preferred juice the juice they had previously cited as the one that tasted different.

Test 6

Reconstituted Valencia Orange and Grapefruit Concentrate, Natural and Colored; Modified Paired Comparison Method

The results of Test 5 raised serious doubt as to the efficacy of the triple comparison method for measuring discrimination. The ability to discriminate inferred from the preference phase of the test was greater than revealed

TABLE 5.1

Frequency of Right and Wrong Identification of the Odd Juice by Combination Order. (Reconstituted Temple[1] and Canned Valencia[2])

Child	Combination Order												Total	
	TVT		TVV		VTV		TTV		VTT		VVT			
	R	W	R	W	R	W	R	W	R	W	R	W	R	W
a	1	1	0	3	0	2	2	0	2	0	0	1	5	7
b	2	1	0	3	0	3	2	0	1	0	0	1	5	8
c	1	2	0	3	2	1	1	1	0	2	0	1	4	10
d	0	1	0	0	0	2	0	1	0	0	0	1	0	5
e	3	0	0	3	1	1	2	0	0	1	0	1	6	6
f	1	1	0	2	2	1	0	2	0	1	0	0	3	7
g	2	0	1	2	2	1	2	0	0	1	1	0	8*	4
h	0	2	1	2	0	1	1	0	0	0	0	1	2	6
i	1	0	0	1	0	2	1	0	0	0	0	1	2	4
j	0	2	0	2	0	0	1	0	0	1	0	0	1	5
k	1	1	1	1	0	2	0	2	0	1	0	0	2	7
l	0	2	0	2	1	0	1	0	1	0	0	1	3	5
m	2	0	0	1	3	0	0	2	0	1	1	0	6	4
n	1	1	2	1	3	0	1	1	2	0	1	0	10**	3
o	2	0	0	3	0	3	1	1	1	0	0	0	4	7
p	2	0	0	3	0	1	1	0	1	0	0	1	4	5
Group	19	14	5	32	14	20	16	10	8	8	3	9	65	93

* Significant at the 5% level.
** Significant at the 1% level.

[1] 12.2° Brix, 13.0 ratio.
[2] 8 or 9° Brix, 12 or 16 ratio.

TABLE 5.2
Frequency of Choice for Reconstituted Temple[1] and Canned Valencia,[2] by Combination Order

Child	Combination Order TVT T	TVT V	TVV T	TVV V	VTV T	VTV V	TTV T	TTV V	VTT T	VTT V	VVT T	VVT V	Total T	Total V
a	1	1	3	0	1	1	2	0	2	0	0	1	9	3
b	3	0	3	0	3	0	2	0	1	0	1	0	13**	0
c	1	2	2	1	2	1	1	1	2	0	1	0	9	5
d	0	1	0	0	2	0	0	1	0	0	0	1	2	3
e	3	0	2	1	1	1	2	0	1	0	1	0	10*	2
f	2	0	1	1	0	3	2	0	0	1	0	0	5	5
g	2	0	2	1	3	0	2	0	1	0	1	0	11**	1
h	0	2	2	1	1	0	1	0	0	0	0	1	4	4
i	1	0	1	0	2	0	1	0	0	0	0	1	5*	1
j	1	1	0	2	0	0	0	1	1	0	0	0	2	4
k	2	0	1	1	1	1	2	0	1	0	0	0	7	2
l	2	0	0	2	0	1	1	0	1	0	1	0	5	3
m	1	1	1	0	3	0	2	0	1	0	0	1	8	2
n	1	1	2	1	3	0	2	0	2	0	1	0	11*	2
o	2	0	2	1	3	0	2	0	1	0	0	0	10**	1
p	2	0	3	0	1	0	1	0	1	0	1	0	9**	0
Group	24	9	25	12	26	8	23	3	15	1	7	5	120	38

* Significant at the 5% level.
** Significant at the 1% level.
[1] See Table 5.1.
[2] See Table 5.1.

from the discrimination test *per se*. Until a more reliable discrimination test is discovered for use with this group of children, it would appear more satisfactory to approach the child through preference tests and infer discrimination than to attempt a direct measure of discrimination. This approach, of course, leaves indeterminate the question of discriminability when the preference is non-significant; that is, is the children's lack of preference for one stimulus to the other due to lack of discriminability or lack of preference? This question, raised in Test 3 in regard to orange and tangerine juices remains unanswered.

The failure of this group of children to show a greater sensitivity to the difference between the full-flavored Temple orange concentrate and the off-flavored canned Valencia orange, however, raised serious doubt as to the children's taste acuity. This was checked by returning to the similar juices and method used in Test 1. The results are presented in Table 6.

The juices were presented on alternate days in the Grapefruit-Orange (G_1O_2) order 10 times, and in the reverse order (O_1G_2) the other 10 days. The unanimity of the response of all 16 children save child *h* whose choices are significant at the 1% level in favor of orange is noteworthy. As a group they were more homogeneous in their choice, and expressed it with convincing evidence. Their taste acuity, at least in regard to these two juices, is no longer in doubt.

Since the color and not taste differences between the two juices may have been the basis for choice, food color was added to the grapefruit to bring its color equal to that of the or-

TABLE 5.3
Frequency of "Odd" and "Preferred" Juice by Its Order Position, by Combination Order (Reconstituted Temple[1] and Canned Valencia[2])

Order Position	Combination Order TVT	TVV	VTV	TTV	VTT	VVT	Summary T	V	Total
			Odd Juice						
1st	T: 4	T: 5	V: 8	T: 4	V: 8	V: 3	13	19	32
2nd	V: 19	V: 25	T: 14	T: 6	T: 7	V: 6	27	50	77
3rd	T: 10	V: 7	V: 12	V: 16	T: 1	T: 3	14	35	49
Total	33	37	34	26	16	12	54	104	158
			Preferred Juice						
1st	T: 12	T: 25	V: 8	T: 14	V: 1	V: 2	51	6	57
2nd	V: 9	V: 8	T: 26	T: 9	T: 13	V: 3	48	20	68
3rd	T: 12	V: 4	V: 5	V: 3	T: 2	T: 7	21	12	33
Total	33	37	34	26	16	12	120	38	158

[1] See Table 5.1.
[2] See Table 5.1.

ange during the last 4 days of the test period. Typical of the children's comments the first day were: "Oh, we have two orange juices today," and "Why are we having both the same?" The scant evidence presented in Table 6 shows no indication of a change in their preference for orange. The investigator noted on the work sheet: "The first two days every child noticed the color—either by word or look. The last two days they paid no attention to it." Color was of interest, but it was the difference in taste of the juices apparently which guided their choice.

The age level at which children can make preference decisions and the direction of these preferences by age level of the child is another aspect of this over-all study. The youngest group of children at the nursery school, aged 3 to 4, were included in this test to explore their ability with the paired comparison test which had proven so successful with the oldest group.

The results of this younger group of children (*aa . . . 11*) are presented in Table 6. Only one child in this group failed to prefer orange to grapefruit enough times for his choice to be considered significant at the 5% level, two children's choices were significant at the 2% level and the remainder significant at the 1% level. Their choices like those of the older group were not unduly disturbed by the color equalization. It should be noted that this was the first test in which these children had participated whereas children *a-p* had participated most of the school year in the taste tests and had had experience with other test situations which are part of their school program. No child showed an order preference.

Conclusions

All conclusions are applicable only to the group of children tested and until further evidence is supplied should not be generalized as applying to all pre-school children.

TABLE 6

Frequency of Choice for Reconstituted Valencia Orange[1] and Grapefruit[2] Juices, Natural and Colored

Child	Natural						Colored		Total	
	Orange-Grapefruit Order		Grapefruit-Orange Order		Summary		Summary			
	O[1]	G[2]	O[2]	G[1]	O	G	O	G	O	G
a	4	0	6	0	10**	0	3	0	13**	0
b	5	0	4	0	9**	0	4	0	13**	0
c	8	0	7	0	15**	0	4	0	19**	0
d	8	0	9	0	17**	0	4	0	21**	0
e	10	0	9	0	19**	0	3	0	22**	0
f	6	0	6	0	12**	0	2	0	14**	0
g	9	0	10	0	19**	0	4	0	23**	0
h	6	1	8	2	14*	3	4	0	18**	3
i	7	0	9	0	16**	0	4	0	20**	0
j	6	0	3	0	9**	0	0	0	9**	0
k	7	0	7	0	14**	0	4	0	18**	0
l	9	0	8	0	17**	0	1	0	18**	0
m	7	0	7	0	14**	0	0	0	14**	0
n	8	0	8	0	16**	0	4	0	20**	0
o	10	0	10	0	20**	0	3	0	23**	0
p	6	0	7	0	13**	0	3	0	16**	0
Group	116	1	118	2	234	3	47	0	281	3
aa	9	0	8	0	17**	0	3	1	20**	1
bb	7	0	9	1	16**	1	3	1	19**	2
cc	7	0	6	0	13**	0	3	0	16**	0
dd	9	0	5	4	14*	4	4	0	18**	4
ee	6	0	5	2	11*	2	3	1	14*	3
ff	6	3	8	1	14*	4	3	1	17*	5
gg	7	1	9	1	16**	2	3	1	19**	3
hh	9	0	10	0	19**	0	4	0	23**	0
ii	3	3	7	3	10	6	4	0	14	6
jj	7	0	7	0	14**	0	1	0	15**	0
kk	6	0	7	1	13**	1	4	0	17**	1
ll	7	0	10	0	17**	0	1	0	18**	0
Group	83	7	91	13	174	20	36	5	210	25
Both Groups	199	8	209	15	408	23	83	5	491	28

* Significant at the 5% level.
** Significant at the 1% level.
[1] 12° Brix, 14 ratio.
[2] 12° Brix, 7.6 ratio.

1. Children of pre-school age may be satisfactory experimental subjects if suitable taste test methods are employed. The minimum age level of children capable of yielding reliable results is yet to be determined.

2. The modified paired comparison test is a satisfactory test for this age of child for preference determination and inferences as to discrimination. The triple comparison tests for determining discrimination levels directly appear to be unsatisfactory. Possible reasons for their failure may rest in their requirement of memory span and communication, and lack of reward.

3. Children are not homogeneous in their preferences, and preference position of the minority might easily be overlooked if data were analyzed in terms of total group reactions.

4. These children preferred orange to grapefruit juice, although one child showed conclusive evidence of the opposite preference. Their choice appears to be based on the taste difference and not color difference of the juices. Indications are that tangerine holds at least an equal if not a higher preference position among those who decidedly preferred orange to grapefruit. The children tested were not as sensitive to the difference between off-flavored canned Valencia and well-flavored Temple concentrate as they were between orange and grapefruit.

5. Much more work of this type should be carried forward to answer the many questions this initial research brings into focus: Is it the flavor characteristic of the fruit, or is it the sweetness and/or acidity level of the juices which is of greater importance? Are children less sensitive to "tinniness" and "off-flavor" than may be generally presumed? At what age level can children discriminate and make preference judgments between such stimuli, and how is this ability related to chronological development of the child and other physical and mental attributes of the child's personality? What relation if any is there between the child's preference position and that of his siblings and parents, and what is the influence of home juice consumption patterns?

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Ornamental Section

NOTES ON SOME ECTOPARASITIC NEMATODES FOUND ATTACKING LAWNS IN THE TAMPA BAY AREA

E. G. KELSHEIMER AND AMEGDA J. OVERMAN

Gulf Coast Experiment Station

Bradenton

As in other sections of Florida, severe chinch bug infestation has become widespread in the lawns of the Tampa Bay area. The incipient symptom of chinch bug attack is a slight yellowing of the grass blades in spots in St. Augustine grass lawns. This yellowing as it becomes more pronounced may be accompanied by wilting. As the infestation becomes chronic, the yellow areas increase rapidly in size while the grass in the center turns brown and dies. In some examinations of damaged lawns not a single chinch bug was found, yet the grass showed typical infestation symptoms. Regular circular patterns of yellow blades appeared, turned brown, and died. All the symptoms occurred during a period of hot dry weather, but even heavy artificial watering failed to revive the grass. Additions of insecticide, fungicide and fertilizer containing minor elements did