

# Sensory Analysis

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## CONCLUSIONS

1. The subcommittee terminated its work with flavor reference standards. An expanded discussion of this labor-intensive study, essentially completed last year (1), is being prepared for publication.
2. A simplified key has been established by which the sensory test most relevant to a given problem can be determined.
3. The Duo-Trio test is useful for establishing whether a difference exists, especially if it is used in the constant reference mode and with trained assessors.

## RECOMMENDATIONS

1. Adopt Choice of Method and Duo-Trio Test for inclusion in ASBC "Methods of Analysis."
2. Discontinue the current BEER-30, Testing for Taste Differences Between Two Beers (superseded by Triangular test issued in 1981).
3. In collaboration with the organizations listed below, continue the study of method of sensory analysis, notably the sections on general methodology and on the selection and training of assessors.

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Having completed its work with flavor reference standards, the subcommittee's sole remaining charge is to continue to study and write methods of sensory analysis for use in breweries. In this project, the subcommittee will continue to collaborate with the International Organization for Standardization (ISO), the American Society for Testing and Materials (ASTM), the Institute of Food Technologists (IFT), and the European Brewery Convention (EBC).

## FLAVOR REFERENCE STANDARDS

Last year's report of the subcommittee (1) outlined 27 established standards. In addition, around 15 compounds have received insufficient study to permit definitive conclusions. Certain subcommittee members have demonstrated a continuing interest; anyone intending to work on new standards should contact the chairman.

## CHOICE OF METHOD

The choice of a test method for a given problem is not an absolute task but rather a question of optimization, of weighing many factors, such as local limitations of facilities, the number of

assessors available and their training, the statistical efficiency of various tests, and even psychosocial factors such as the degree of bias likely to arise because of the formulation of questions on answer forms. Ultimately the choice must be decided by experience gained in practical testing at the local level. Discussions underway in the organizations listed nevertheless show that a consensus is emerging, as reflected in ISO Draft International Standard 6658 (2) and in two recent papers (3,4).

The text now recommended for inclusion in ASBC "Methods of Analysis" closely follows the ISO text but goes beyond it by providing a simplified key. Although such a key is needed, it may need frequent revision; each laboratory should consider adjustments to suit local conditions.

## DUO-TRIO TEST

This test can be used in two forms: with a balanced reference or with a constant reference. Last year's discussion (1) of the relative merits of the Duo-Trio and Triangular tests pointed out that, although the Triangular test has greater statistical efficiency, its use may involve certain psychological problems that often make the Duo-Trio test the more efficient. This is the case when panels have more than eight and especially 15 or more members, and in the constant reference mode, when trained assessors are used and a product well known to them is the reference.

The following text resembles that of the ISO except for two points. The Duo-Trio is considered a forced-choice test (1), and the subcommittee, in collaboration with the IFT and the ASTM, is challenging the ISO's policy of permitting "no-difference" verdicts in this test. The second deviation is a reference to the test of nonrecognition by Ferdinandus et al (1).

## LITERATURE CITED

1. American Society of Brewing Chemists. Report of Subcommittee on Sensory Analysis. *Journal* 39:108, 1981.
2. International Organization for Standardization. Draft International Standard ISO/DIS 6658: Sensory Analysis-Methodology-General Guidance. ISO: Paris, 1982.
3. Meilgaard, M. C. *Eur. Brew. Conv., Proc. Congr. 18th, Copenhagen, 1981*, p. 383.
4. Meilgaard, M. C., and Siebert, K. J. *Eur. Brew. Conv., Monograph VII, Flavour Symposium, 1981*, p. 33.

## APPENDIX A SENSORY ANALYSIS: CHOICE OF METHOD

In sensory analysis, a given problem frequently requires appreciable thought before an appropriate practical test is selected. This is because the initial conception of the problem may require clarification. It would, for example, be meaningless to carry out a preference test with a large number of assessors without first having shown that a significant difference exists; this can be established with a much smaller number of assessors, using a difference test.

Similarly, where many samples are concerned, it is useful to carry out preliminary tests to establish appropriate orders of magnitude, such as the concentration of a reference standard to be used; the number of samples to be evaluated; and the relevance of the attributes (judged to be representative of the product to be analyzed).

There are two main types of problems: those in which the primary aim of the test is to describe the product, and those in which the aim is to distinguish between two or more products. For the second type, it is important to distinguish between the need to know whether there is a difference at all, the magnitude of the

difference, the direction (or quality) of that difference, the effect of that difference, for example with regard to preference, and whether all or only part of a population detects a difference.

**Choice of the Test**

When the nature of the problem has been established, the choice of the appropriate test will also be related to the degree of confidence deemed necessary, the nature of the samples, and the availability and degree of training of the assessors.

The description of each individual test contains guidance as to its relevance. A simplified key is presented in Fig. A-1 by way of an example, which should not be taken as limiting the choice of tests. Note that preliminary tests may be necessary.

The key in some cases offers a choice of three or four tests that may be suitable for a given problem. The individual test descriptions should then be consulted, which may lead to a reformulation of the problem.

Sensory tests have a finite risk of an erroneous result and should

therefore be replicated whenever possible. A statistical plan should always be determined before practical tests begin, and this is especially recommended if the number of samples to be evaluated requires more than one session. Details of statistical plans should be selected from specialized texts.

During one session, usually no more than three or four samples for descriptive tests are assessed, or no more than six for Duo-Trio tests, triangular tests, etc. For visual tests, eg, the evaluation of differences in haze, color, or foam, these numbers may be increased.

Although the use of control samples or reference substances is essential in most cases and especially when the problem is unfamiliar to the assessors, their use naturally limits the number of samples that can be assessed during any given session.

Several tests not listed in Fig. A-1 may be useful and are described in references (2) and (4). Examples are the "A"-or-"not A" test, the two-out-of-five test, the Scheffé paired comparison test, and the multiple paired comparison test.

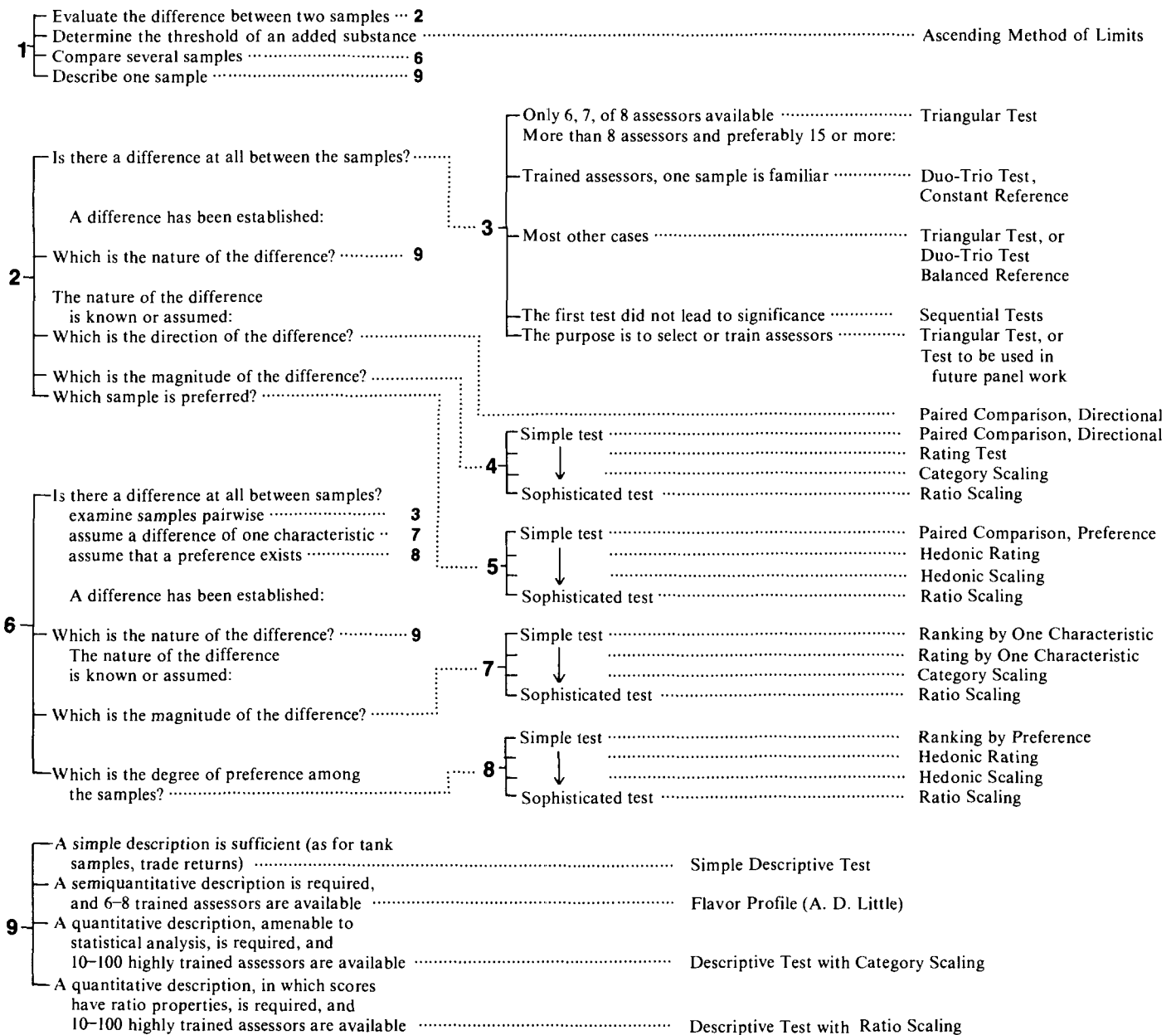


Fig. A-1. Simplified key for the choice of a test relevant to a given problem. For a description of tests not defined in "Methods of Analysis," see references (3) and (4).

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2. International Organization for Standardization. Draft International Standard ISO/DIS 6658: Sensory Analysis-Methodology-General Guidance. ISO: Paris, 1982.
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APPENDIX B  
SENSORY ANALYSIS: DUO-TRIO TEST

Scope

Use this test to determine whether a sensory difference is apparent between two samples (see Note). The test uses a forced-choice, unilateral test situation.

Field of Application

Apply the test to any two samples of beer, wort, water, etc., whether the differences to be expected involve all sensory attributes or one specific attribute (odor, sweetness, etc.).

Two forms of the test exist: the balanced reference and constant reference modes. The latter is especially suitable with trained assessors whenever a product well known to them can be used as the reference, for example, a beer of regular production. If both samples are unknown or if untrained assessors are used the reference sample is alternated between the two test samples being served.

If there are pronounced aftertastes, the Duo-Trio test is less suitable than the paired comparison test.

Principle of the Test

The assessors are first presented the identified reference sample. This is followed by two coded samples, one of which is identical to the reference sample. The assessor is asked to identify the odd sample.

General Test Requirements

*Test Room.* Conduct the test in a room that complies with the requirements in SENSORY ANALYSIS-2: Test Room Equipment, Conduct of Test.

*Assessors.* Choose the number of assessors with reference to the degree of difference expected between the samples, the aptitude of the assessors, and the risk of error that can be accepted. The

minimum is nine assessors, but between nine and 15 the  $\beta$ -error is high. Discrimination is much improved if 20, 40, or a larger number can be employed.

*Preliminary Discussion and Test.* Ascertain that assessors are fully familiar with any particular characteristic studied and with the mechanics of the test. If necessary, arrange a preliminary general discussion concerning the test problem and nature of samples. Direct such discussion in a manner that cannot influence future judgments.

Present and discuss a few samples typical of the series to be analyzed. Limit the number to two or three. If the test concerns the detection of off-flavors, include in the preliminary test a sample free from any off-flavors, or a demonstration of the off-flavor to be detected.

In general, the inclusion of controls (reference substances) may be advisable.

Procedure

*Preparation of Samples.* Take care that assessors cannot draw conclusions about the nature of samples from the way in which they are presented. Use colored glasses. Serve samples at uniform temperature; 12°C is suitable for full perception of flavor. Ascertain that the temperature of each sample in a test is identical, as well as that of samples offered in succession. This applies not only at the time of presentation but throughout the tests. Code glasses using three-digit random numbers or key the placement of the glasses in advance.

TABLE B-1  
Unilateral Test<sup>a</sup> ( $P = 0.50$  with  $n$  Replies)

Number of Replies	Minimum Number of Correct Replies for a Significance Level of $\alpha \leq$		
	0.05	0.01	0.001
7	7	7	...
8	7	8	...
9	8	9	...
10	9	10	10
11	9	10	11
12	10	11	12
13	10	12	13
14	11	12	13
15	12	13	14
16	12	14	15
17	13	14	16
18	13	15	16
19	14	15	17
20	15	16	18
21	15	17	18
22	16	17	19
23	16	18	20
24	17	19	20
25	18	19	21
30	20	22	24
35	23	25	27
40	26	28	31
45	29	31	34
50	32	34	37
60	37	40	43
70	43	46	49
80	48	51	55
90	54	57	61
100	59	63	66

<sup>a</sup>The values in this table were calculated from the exact formula: binomial law for parameter  $P=0.50$  with  $n$  repetitions (replies). When the number of replies is larger than 100, numbers of correct replies may be obtained from the following formula based on the approximation binomial law by the normal law, with a maximum error equal to one unit:  $X = (n + 1) / 2 + k\sqrt{n}$  where  $k = 0.82$  for  $\alpha \leq 0.05$ ;  $k = 1.16$  for  $\alpha \leq 0.01$ ; and  $k = 1.55$  for  $\alpha \leq 0.001$ . Tables for significance levels other than those listed here may be found in references 2 and 4.

NAME .....	DATE .....
(year/month/day)	
PRODUCT SUBMITTED TO TEST .....	
PROBLEM: The sample on the left is a control. Of the other two samples, one is the same as the control and the other is different. Indicate the different sample.	
SET OF THREE SAMPLES	
<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
Comments	

Fig. B-1. Specimen answer form for the Duo-Trio test.

**Test Portion.** A suitable quantity is 50–100 ml in a 250-ml (8-oz) glass.

**Test Technique.** Offer the reference and the two samples simultaneously for testing. Prepare equal numbers of the combinations, and allocate them at random among the assessors. Instruct the assessors to examine sets in a specified order (eg, always from left to right) leaving the opportunity of making repeated tests of any sample while tasting of a set is in progress.

An example of an answer form is shown in Fig. B-1. Space for several duo-trio sets may be provided on the form, but do not add supplementary questions (eg, asking the degree or type of difference or the assessor's preference), as these may introduce bias. Choose the appropriate separate test for each separate question.

#### Expression and Interpretation of Results

Tabulate the number of correct replies and refer to Table B-I. A significant difference is established if the number in question is equal to or larger than that shown in the table.

Any "no-difference" verdicts should be considered invalid. The Duo-Trio test is a forced-choice technique; assessors should guess if necessary and should be informed that a proportion of incorrect replies is normal, and that this proportion is what the test attempts to determine.

#### Examples

**Balanced Reference.** Sample "A" is an untreated sample, "B" is a treated sample, and the test supervisor wishes to know if a sensory difference is apparent between them. A 1% risk of error is accepted, and 24 assessors are available. Thirty-six glasses of "A" and 36 of "B" are prepared, and 12 of each are used as reference samples ( $R_A$  and  $R_B$ ). The following sets are distributed at random among the assessors:  $R_AAB$ ,  $R_BBA$ ,  $R_ABA$ , and  $R_BAB$ . Eighteen assessors correctly identify the sample that is different. Table B-I shows that proof was not obtained that a difference is apparent between "A" and "B."

**Constant Reference.** Sample "A" is the company's regular beer packaged in the usual can. Sample "B" is the same beer packaged in

a new type of can, and the test supervisor wishes to know if it can be distinguished from sample "A." An appropriate number of completely randomized sets are served,  $R_AAB$  and  $R_ABA$ .

#### Note

The present test determines either that the assessors can distinguish a difference, or that proof was not obtained that they can. If the purpose is to prove similarity between two samples, the test does not apply. A test of nonrecognition is required (2).

#### Expression of Results

Make reference to this method and give the following information:

- (a) Test problem
- (b) Full identification of samples
- (c) Test parameters adopted, whether balanced or constant reference, and the number of duo-trio sets presented
- (d) Whether reference substances were used
- (e) Any other recommendation given during the test (eg, information relating to the type of beer)
- (f) Number of tests and number of trained or untrained assessors
- (g) Any test conditions differing from the recommendations given in this method
- (h) The results, with their significance levels
- (i) Date and time of test
- (j) Name of test supervisor

#### REFERENCES

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2. Ferdinandus, A., Oosterom-Kleijngeld, I., and Runneboom, A. J. M. *Tech. Q. Master Brew. Assoc. Am.* 7:210, 1970.
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