



Designation: E2610 – 18

Standard Test Method for Sensory Analysis—Duo-Trio Test¹

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1. Scope

1.1 This test method covers a procedure for determining whether a perceptible sensory difference exists between samples of two products.

1.2 This test method applies whether a difference may exist in a single sensory attribute or in several.

1.3 This test method is applicable when the nature of the difference between the samples is unknown. It does not determine the size or the direction of the difference. The attribute(s) responsible for the difference are not identified.

1.4 Compared to the triangle test, the duo-trio test is statistically less efficient, but easier to perform by the assessors. For details on how the duo-trio test compares to other three-sample tests, see Refs (1-4).²

1.5 This test method is applicable only if the products are homogeneous. If two samples of the same product can often be distinguished, then another method, for example, descriptive analysis, may be more appropriate.

1.6 This test method is applicable only when the products do not cause excessive sensory fatigue, carryover or adaptation.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

¹ This test method is under the jurisdiction of ASTM Committee E18 on Sensory Evaluation and is the direct responsibility of Subcommittee E18.04 on Fundamentals of Sensory.

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² The boldface numbers in parentheses refer to the list of references at the end of this standard.

2. Referenced Documents

2.1 ASTM Standards:³

E253 Terminology Relating to Sensory Evaluation of Materials and Products

E456 Terminology Relating to Quality and Statistics

E1871 Guide for Serving Protocol for Sensory Evaluation of Foods and Beverages

E1885 Test Method for Sensory Analysis—Triangle Test

E2262 Practice for Estimating Thurstonian Discriminal Distances

2.2 ISO Standards:⁴

ISO 4120 Sensory Analysis—Methodology—Triangle Test

ISO 10399 Sensory Analysis—Methodology—Duo-Trio Test

3. Terminology

3.1 *Definitions*—For definition of terms relating to sensory analysis, see Terminology E253, and for terms relating to statistics, see Terminology E456.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 α (alpha) risk—probability of concluding that a perceptible difference exists when, in reality, one does not. (Also known as Type I Error or significance level.)

3.2.2 β (beta) risk—probability of concluding that no perceptible difference exists when, in reality, one does. (Also known as Type II Error.)

3.2.3 p_c —probability of a correct response.

3.2.4 p_d (proportion of discriminators)—proportion of the population represented by the assessors that can distinguish between the two products.

3.2.5 *product*—material to be evaluated.

3.2.6 *sample*—unit of product prepared, presented, and evaluated in the test.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

3.2.7 *sensitivity*—general term used to summarize the performance characteristics of the test. The sensitivity of the test is rigorously defined, in statistical terms, by the values selected for α , β , and p_d .

3.2.8 δ —Thurstonian measure of sensory difference (effect size) relative to perceptual noise (standard deviation) (see Practice E2262).

3.2.9 *triad*—three samples given to an assessor in the duo-trio test; one sample is labeled as a reference the other two samples are labeled with different codes. One of the coded samples is the same product as the reference. The other coded sample is different.

4. Summary of Test Method

4.1 Clearly define the test objective in writing.

4.2 Choose the number of assessors based on the level of sensitivity desired for the test. The sensitivity of the test is, in part, a function of two competing risks: the risk of declaring the samples different when they are not (that is, α -risk) and the risk of not declaring the samples different when they are (that is, β -risk). Acceptable values of α and β vary depending on the test objective and should be determined before the test (see for example Appendix X1 and Appendix X2).

4.3 Each assessor receives a triad where one sample is labeled as the reference and the other two samples are labeled with different codes. The assessors are informed that one of the coded samples is the same as the reference and that one is different. The assessors report which of the coded samples they believe to be the same as (or different from) the reference.⁵

4.4 Results are tallied and significance determined by reference to a statistical table.

5. Significance and Use

5.1 The test method is effective for the following test objectives:

5.1.1 To determine whether a perceivable difference results or a perceivable difference does not result, for example, when a change is made in ingredients, processing, packaging, handling or storage; or

5.1.2 To select, train and monitor assessors.

5.2 The test method itself does not change whether the purpose of the duo-trio test is to determine that two products are perceivably different versus that the products are not perceivably different. Only the selected values of p_d , α , and β change. If the objective of the test is to determine if there is a perceivable difference between two products, then the value

selected for α is typically smaller than the value selected for β . If the objective is to determine if the two products are sufficiently similar to be used interchangeably, then the value selected for β is typically smaller than the value selected for α and the value of p_d is selected to define “sufficiently similar.”

5.3 The test method may change based on the test objective or the assessors’ familiarity with the product. The balanced-reference technique (see 9.1.1) typically is used when neither product is more familiar than the other. The constant-reference technique (see 9.1.2) frequently is used when one product is a control/current product or is familiar to the assessors.

6. Apparatus

6.1 Carry out the test under conditions that prevent contact between assessors until the evaluations have been completed, for example, using booths that comply with Ref (5).

6.2 Sample preparation and serving sizes should comply with Guide E1871. See Refs (6) or (7).

7. Assessors

7.1 All assessors must be familiar with the mechanics of the duo-trio test (the format, the task, and the procedure of evaluation). Experience and familiarity with the product and test method may increase the sensitivity of an assessor and may therefore increase the likelihood of finding a significant difference. Monitoring the performance of assessors over time may be useful.

7.2 Choose assessors in accordance with test objectives. For example, to project results to a general consumer population, assessors with unknown sensitivity might be selected. To increase protection of product quality, assessors with demonstrated acuity should be selected.

7.3 The decision to use trained or untrained assessors should be addressed prior to testing. Training may include a preliminary presentation on the nature of the samples and the problem concerned. If the test concerns the detection of a particular taint, consider the inclusion of samples during training that demonstrate its presence and absence. Such demonstration will increase the panel’s acuity for the taint but may detract from other differences. See Ref (8) for details. Allow adequate time between the exposure to the training samples and the actual duo-trio test to avoid carryover.

7.4 During the test sessions, avoid giving information about product identity, expected treatment effects or individual performance until all testing is complete.

7.5 Avoid replicate evaluations by the same assessor whenever possible. However, if replications are needed to produce a sufficient number of total evaluations, every effort should be made to have each assessor perform the same number of replicate evaluations.

⁵ Organizations differ in the instructions they give their assessors. Some organizations instruct their assessors to select the sample that is most similar to the reference. Others instruct their assessors to select the sample that is most different from the reference. Either approach is acceptable.

8. Number of Assessors

8.1 Choose the number of assessors to yield the level of sensitivity called for by the test objectives. The sensitivity of the test is a function of three values: the α -risk, and the β -risk, and the maximum allowable proportion of distinguishers, p_d .⁶

8.2 Prior to conducting the test, select values for α , β and p_d . The following can be considered as general guidelines.

8.2.1 For α -risk—A statistically significant result at:

- 10 to 5 % (0.10 to 0.05) indicates “slight” evidence that a difference was apparent
- 5 to 1 % (0.05 to 0.01) indicates “moderate” evidence that a difference was apparent
- 1 to 0.1 % (0.01 to 0.001) indicates “strong” evidence that a difference was apparent
- Below 0.1 % (<0.001) indicates “very strong” evidence that a difference was apparent

8.2.2 For β -risk—The strength of the evidence that a difference was not apparent is assessed using the same criteria as above (substituting “was not apparent” for “was apparent”).

8.2.3 For p_d —The maximum allowable proportion of distinguishers, p_d , falls into three ranges:

- $p_d < 25$ % represent small values
- $25\% < p_d < 35$ % represent medium sized values
- $p_d > 35$ % represent large values

8.3 Having defined the required level of sensitivity for the test using 8.2, use Table A1.1 to determine the number of assessors necessary. Enter Table A1.1 in the section corresponding to the selected value of p_d and the column corresponding to the selected value of β . The minimum required number of assessors is found in the row corresponding to the selected value of α . Alternatively, Table A1.1 can be used to develop a set of values for p_d , α and β that provide acceptable sensitivity while maintaining the number of assessors within practical limits. The approach is presented in detail in Ref (9).

8.4 If one wishes to use Thurstonian δ as a measure of sensory effect size, use Tables A2.1 and A2.2 to convert between p_d and δ . See Ref (10) for further discussion on the relationship between Thurstonian δ and p_d .

8.5 Often in practice, the number of assessors is determined by material conditions (for example, duration of the experiment, number of available assessors, quantity of product). However, increasing the number of assessors increases the likelihood of detecting small proportions of distinguishers. Thus, one should expect to use larger numbers of assessors when trying to demonstrate that products are similar compared to when one is trying to prove they are different. Often 20 to 36 assessors are used when testing for a difference. For comparable sensitivity when testing for similarity, 40 to 78 assessors are needed.

9. Procedure

9.1 If neither product is more familiar than the other, use the balanced reference technique (9.1.1). If the product is familiar

to the assessors (for example, a control sample from the production line), use the constant reference technique (9.1.2).

9.1.1 *Balanced-Reference Technique*—Prepare worksheets and scoresheets (see Appendix X1) in advance of the test so as to utilize an equal number of the four possible sequences of two products, A and B:

A_RAB	A_RBA
B_RAB	B_RBA

9.1.1.1 Distribute these at random among the assessors so that serving order is balanced.

9.1.2 *Constant-Reference Technique*—Prepare worksheets and scoresheets (see Appendix X2) in advance of the test so as to utilize an equal number of the two possible sequences of two products, A and B:

A_RAB	A_RBA
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9.1.2.1 Distribute these at random among the assessors so that serving order is balanced.

9.2 Present each triad simultaneously if possible, following the same spatial arrangement for each assessor (on a line to be sampled always from left to right, in a triangular array, etc.). Within the triad, assessors are typically allowed to make repeated evaluations of each sample as desired. If the conditions of the test require the prevention of repeat evaluations for example, if samples are bulky, leave an aftertaste, or show slight differences in appearance that cannot be masked, present the samples sequentially and do not allow repeated evaluations. In addition, if the samples change over time, for example, chewing gum or cereal with milk, samples should be tested sequentially.

9.3 Instruct the assessors to evaluate the reference sample first and then evaluate the two coded samples in the order in which they were presented. The assessor should then indicate which of the two coded samples is the same as the reference.

9.4 Each scoresheet should provide for a single triad of samples. If a different set of products is to be evaluated by an assessor in a single session, the completed scoresheet and any remaining product should be returned to the test administrator prior to receiving the subsequent triad. The assessor cannot go back to any of the previous samples or change the verdict on any previous test.

9.5 Do not ask questions about preference, acceptance, or degree of difference after the initial selection of the sample that matches the reference. The selection the assessor has just made may bias the reply to any additional questions. Responses to such questions may be obtained through separate tests for preference, acceptance, degree of difference, etc. (see Ref (11)). A comment section asking why the choice was made may be included for the assessor’s remarks.

9.6 The duo-trio test is a forced-choice procedure; assessors are not allowed the option of reporting “no difference.” An assessor who detects no difference between the samples and requests to report “no difference” should be instructed to randomly select one of the coded samples as being the same as the reference. In such situations the assessor can indicate that the selection was only a guess in the comments section of the scoresheet.

⁶ In this test method, the probability of a correct response, p_c , is modeled as $p_c = 1 \cdot p_d + (1/2) \cdot (1 - p_d)$, where p_d is the proportion of the entire population of assessors who can distinguish between the two products. It is a strictly statistical “guessing model” of the assessor’s behavior. It is not a psychometric model of the assessor’s decision process, such as the Thurstone-Ura model that could also be applied in discrimination testing.