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Standard Guide for Time-Intensity Evaluation of Sensory Attributes[1]

This standard is issued under the fixed designation E1909; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers procedures for conducting and analyzing time-intensity (TI) evaluations of products or other sensory stimuli. Time-intensity is the measurement of the intensity of a single sensory sensation over time in response to a single exposure to a product or other sensory stimulus. Simultaneous evaluations of multiple sensory attributes are possible, although are outside of the scope of this document. See Reference List for more information.

1.2 This guide utilizes a specially trained panel to measure the intensity of a single continuous sensation during the time from initial exposure:

1.2.1 To its extinction,

1.2.2 To a specified intensity, or

1.2.3 To a predetermined limit of time.

1.3 Applications not covered in this guide include measuring:

1.3.1 Multiple sensations,

1.3.2 Multiple exposures within a single measurement, and

1.3.3 Qualitative or hedonic changes in the perceived sensation.

1.4 This guide includes protocols for the selection and training of judges, descriptions and use of physical data collection devices, and methods of data handling, summarization, and statistical analysis. An example, with data handling and analysis approaches, is included in the appendix.

1.5 This guide is not applicable to measure product shelf life or stability.

1.6 *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.*

1.7 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E253 Terminology Relating to Sensory Evaluation of Materials and Products

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:* See Fig. 1.

3.1.1 *area after I_{max}*—post-peak area under the curve.

3.1.2 *area before I_{max}*—pre-peak area under the curve.

3.1.3 *AUC*—area under the curve.

3.1.4 *I_{max} or peak intensity*—maximum observed intensity during the time of measurement.

3.1.5 *perimeter*—measured distance of perimeter of area delineated by TI curve.

3.1.6 *plateau*—duration of peak intensity.

3.1.7 *rate of increase*—rate of intensity increase before peak intensity (slope).

3.1.8 *rate of decrease*—rate of intensity decrease after peak intensity (slope).

3.1.9 *T_{dur} or duration time*—time from onset of sensation until it can no longer be perceived ($T_{ext} - T_{onset}$).

3.1.10 *T_{ext} or time to extinction*—time from initial exposure to the stimulus (T_{init}) until it can no longer be perceived.

3.1.11 *T_{init}*—time of initial exposure to the stimulus, typically when the clock starts.

3.1.12 *T_{max}*—time to reach maximum intensity of the sensation after exposure to the stimulus.

3.1.13 *T_{onset}*—time point when the stimulus is first perceived after initial exposure to the stimulus.

[1] This guide is under the jurisdiction of ASTM Committee E18 on Sensory Evaluation and is the direct responsibility of Subcommittee E18.04 on Test Methods.

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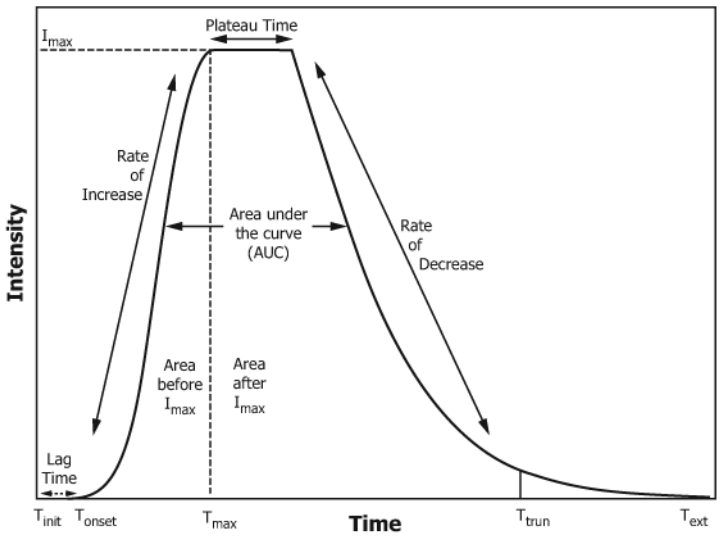
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.



NOTE 1—Based on a figure from Ref (**1**).

FIG. 1 Representative Time-Intensity Curve with Selected Parameters Labeled

3.1.14 *T_{trun} or truncated time*—time until a specified minimum intensity or until a pre-determined time point has been reached.

3.2 The graphical illustration of a typical time-intensity curve is shown in Fig. 1. The time increment may be seconds, minutes, hours, etc., depending upon the characteristic of the particular material under study.

4. Summary of Guide

4.1 This guide describes procedures utilizing specially trained panelists to measure the intensity of a single sensory sensation as it changes with time and the possible approaches to collect and analyze such data. Details on specific procedures are given in Sections 6 – 9 of this guide. An example of a time-related evaluation is included in the appendix.

5. Significance and Use

5.1 The purpose of time-intensity measurements is to establish the pattern of development and decline of a particular sensory characteristic over time. TI evaluations are applicable when measurements at a single time point (an averaging process) are not sufficient to distinguish products that have very different temporal characteristics.

5.2 TI has applications for a variety of products. Examples include: food products, ranging from short-term sweetness in a beverage to long-term elasticity in chewing gum; personal care products, measuring the development and longevity of shampoo lather and the residual skin feel of a skin cream; household care products, monitoring the intensity of scents over time; pharmaceuticals, monitoring skin cooling after application of a topical analgesic. Auditory signals or visual changes in products can also be evaluated by the TI technique.

6. Time-Intensity Panel Selection and Training

6.1 *Screening and Selection of Panelists:*

6.1.1 Time-intensity evaluation is a specialized type of descriptive analysis. Therefore, use of randomly selected, naive panelists is neither appropriate nor recommended. Panelists selected for Time-Intensity studies are screened as recommended for other descriptive methods (see MNL 90 (**1**)).[3] Use of panelists with previous descriptive training facilitates the TI training because these panelists are competent in both recognizing and scaling the intensity of an attribute.

6.1.2 The goal of the selection process is to identify panelists who have the ability to:

6.1.2.1 Continually focus on a single sensory attribute,

6.1.2.2 Accurately identify and quantify a single sensory attribute within a simple or complex sample,

6.1.2.3 Accurately record changes in sensations as they occur,

6.1.2.4 Perform consistently, and

6.1.2.5 Perform all test procedures with appropriate skills (for example, ability to chew gum while manipulating the input device to indicate the intensity of the mint flavor).

6.1.3 Compared to other descriptive methods, TI panelists require more skills to complete the time-intensity task. Due to the complexity of the method and techniques involved, final selection of panelists may not occur until after completion of the training.

6.2 *Time-Intensity Panel Training:*

6.2.1 The purpose of TI training is to instruct how to perform the physical, mental and psychological tasks associated with this method. Training begins with an orientation to the TI method. Orientation to the method involves explanation and demonstration of the temporal nature of sensory properties, utilizing products having diverse temporal profiles. General

[3] The boldface numbers in parentheses refer to a list of references at the end of this standard.

time-intensity concepts may be illustrated by showing examples from alternate sensory modalities. Sound, light, odor, taste, touch/pressure or texture may all display temporal properties.

6.2.2 During training, panelists are thoroughly familiarized with all testing equipment and procedures.

6.2.3 The purpose of training samples is to demonstrate different onset, plateau, or duration characteristics. These are often best presented in contrasting pairs or sets. One example is a set of chewing gums, one with a fast flavor onset, another with a slower onset. Another example is a series of margarine products that demonstrate different textural properties, such as rate of melt.

6.2.4 References are samples that demonstrate an attribute at a given intensity. Use of references to calibrate intensity ratings occurs prior to the test. This is critical because in TI analysis, attribute intensity is recorded without interruption during the test.

6.3 *Panel Performance Monitoring and Feedback*

6.3.1 Monitor panelist performance during the training and evaluation sessions. At the start of the study, determine an acceptable level of individual and group performance. This can include deviation around a scale value at a specified time point or similar indicator. MNL 90 (**1**) provides statistical procedures suitable for monitoring panelist performance.

6.3.2 Panelists must be able to demonstrate reasonable consistency in their evaluations. One approach is to measure reproducibility in selected curve parameters, for example, I_{max}, T_{max}, and T_{ext}. However, consistency with other panelists is less likely than with general descriptive analysis, as each panelist tends to produce distinctive curve shapes. In TI analysis, within-panelist consistency, particularly in their ability to communicate relative differences among samples, is more important than panelist-to-panelist agreement. See discussion in Section 9.

6.3.3 One parameter that should show some degree of agreement among the panelists is I_{max}, particularly if reference standards for intensity are being utilized. The I_{max} value can be used to compare panelist performance with an appropriate means-separation test, percent standard deviation, or other analysis methods commonly used in monitoring descriptive evaluations.

7. Test Protocol

7.1 Specifics of the actual management of a time-intensity panel are highly dependent upon study objectives. The following topics represent major steps or considerations in the design and execution of time-intensity panels. It is assumed that basic panel training on the product of interest and selection of the appropriate data collection device have been completed (see Sections 6 and 8, respectively).

7.1.1 *Design Considerations*—Before a TI study is conducted, the following sample, experimental design, and set-up issues are resolved:

7.1.1.1 The first consideration in designing a time-intensity test is to determine the length of time for data collection. It can be relatively short, like the meltdown of a pat of butter when placed in the mouth, or relatively long, like the longevity of mint flavor in a chewing gum.

7.1.1.2 Knowing the expected duration, and designing the study to cover critical changes in a product is prerequisite to other design considerations. The number of sampling points and the time interval between points is set to capture the changes in an attribute at the time it occurs. Factors which may affect the duration of the attribute to be measured include: sample form (crystalline versus dilute solution of sugar), sample size (larger amount of sample versus smaller amount of sample), evaluation technique (dissolving versus chewing a hard candy), and other product characteristics (water hardness for soaps and shampoos).

7.1.2 The number of samples evaluated in a panel session is primarily dependent upon the duration of the time-intensity sensation. If the evaluation of a chewing gum is designed to measure mint flavor intensity changes over a 20 min period, one to two samples may be the maximum number panelists can evaluate without excessive physical or mental fatigue. Conversely, 5 to 6 potato chips may be evaluated for duration of crisp/crunchy attributes before fatigue sets in.

7.1.3 If the test is designed to measure the perception of an attribute to extinction, there is generally no need for lengthy waiting periods between samples. However, a longer waiting period is required when the perception of an attribute is affected by a preceding sample. Examples include: allowing mouth temperature to return to normal after ice cream evaluations, and recovery from mouthfeel effects due to menthol or capsaicin.

7.1.4 Sample presentation order may be randomized, fixed, balanced, or presented as an incomplete block, depending on study objectives. Typically, samples are presented in a balanced order to minimize position bias, context effects, etc. as recommended for most sensory evaluations. During training, samples may be presented in fixed order (that is, all panelists see the same samples in the same order of presentation), to facilitate discussion and learning.

7.1.5 Panelists may be presented with replicate samples. Presenting replicates allows the researcher to assess the performance of the individual panelists.

7.2 *Sample Preparation*—As with any sensory evaluation, sample preparation and presentation for TI analysis need to be controlled to eliminate extraneous effects. Recommended guidelines are to be followed (Manual 26) (**2**).

7.2.1 *Reference Samples*—If appropriate in the test design, use of reference samples is recommended. References are evaluated prior to test samples, so that test sample evaluation is conducted without interruption. References are evaluated by the same technique as the test samples and may be used to specify an attribute's intensity at a specific point in time.

7.2.2 *Conditioning Sample*—Use of a conditioning sample, presented prior to the actual test sample, can be used to calibrate panelists to the same sensation, and to some extent, to control first position bias or context effects. Consideration should be given to adaptation, carryover, and fatigue in deciding whether to use a conditioning sample.