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Standard Guide for Screening and Training of Assessors and a General Approach for the Sensory Evaluation of Oral Care Products: Toothpaste and Toothbrushes¹

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1. Scope

1.1 This guide provides guidelines for the selection and training of expert assessors for the sensory evaluation of toothpaste and toothbrushes as well as a basic framework for the sensory evaluation of the same. Sensory evaluation of toothpaste and toothbrushes can be used to define the sensory attributes of the products and then to measure those attributes quantitatively for the purposes of new product development, product optimization, competitive benchmarking, and claims substantiation.

1.2 A general framework for both toothpaste and toothbrush descriptive analysis is provided to guide the reader in the design and execution (including sample preparation and presentation, facility and testing environment, and specific evaluation protocols) for such evaluations.

1.3 This guide provides suggested protocols and approaches to the evaluation of the indicated products/samples and in no way excludes any alternate approaches that may be effective in providing such perceptual evaluations.

1.4 This guide does not address other oral care products including, but not limited to, whitening agents, oral rinses, mouthwashes, dental flosses, denture adhesive, floss picks, or other oral care products.

1.5 *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.*

1.6 *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 guide is under the jurisdiction of ASTM Committee E18 on Sensory Evaluation and is the direct responsibility of Subcommittee E18.07 on Personal Care and Household Evaluation.

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2. Referenced Documents

2.1 *ASTM Standards:*²

E253 Terminology Relating to Sensory Evaluation of Materials and Products

E1490 Guide for Two Sensory Descriptive Analysis Approaches for Skin Creams and Lotions

E2082 Guide for Descriptive Analysis of Shampoo Performance

3. Terminology

3.1 *Definitions*—Refer to Terminology E253 for common sensory terms that may be applied to the evaluation of toothpaste.

3.2 *Definitions of Terms Specific to Toothpaste:*

3.2.1 This list is in no means meant to be an exhaustive list of sensory attributes common to toothpaste but rather a list of example attributes that are commonly perceived in the use of toothpaste.

Flavor Attributes

3.2.2 *anisellicorice, n*—aromatics associated with sweet, spicy herbs containing anethole, for example, licorice gum and licorice candy.

3.2.3 *brown spice, n*—bark, buds, flowers, roots, fruit, and secretions of plants used to create pungency, bite, or character in foods and aromatics associated with a range of earthy, musty, woody, sweet, warm, citrus, terpeney, sassafras, brown spices that can include bitter and numbing, for example, cinnamon, cardamom, clove, mace, coriander, and nutmeg, 0.1 % allspice solution, and strong cinnamon chewing gum.

3.2.4 *chalky flavor, n*—aromatics associated with mineral salts such as chalk along with some cement-like and dusty notes, for example, chalk dust, milk of magnesia, calcium carbonate, and calcium oxide.

3.2.5 *earthy, adj*—aromatic associated with mushrooms, potatoes, and potting soil.

² 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.

3.2.6 *green (viney)*, *n*—aromatic associated with plants, particularly with plant stems, for example, the aromatic associated with tulip stems.

3.2.7 *mint complex*, *n*—sum of the combination of several aromatics associated with mint such as wintergreen, spearmint, and peppermint.

3.2.7.1 *Discussion*—Other attributes associated with mint complex may include basic tastes and feeling factors such as: sweet, bitter, cooling, pungency, and menthol, all of which are rated separately.

3.2.8 *peroxide*, *n*—aromatic associated with hydrogen peroxide and can include astringency, soapy, prickly, vinyl impression, soured, and metallic taste and aftertaste, for example, 1:4 dilution hydrogen peroxide.

3.2.9 *soapy aromatic*, *adj*—aromatics associated with lipolyzed milk solids, hydrolyzed vegetable fat, tallow notes, or hydrolyzed animal fat, or combinations thereof.

3.2.10 *spearmint*, *n*—aromatics associated with spearmint.

3.2.10.1 *Discussion*—Other associated characteristics with spearmint typically include sweet, bitter, green notes, and cooling (though typically not as intense as peppermint), all of which are rated separately, with slightly less burn than peppermint.

3.2.11 *thymol-eucalyptol*, *n*—aromatics associated with the aroma of eucalyptus trees that include piney/rosemary and phenolic/medicinal.

3.2.12 *unripe (green) fruit*, *n*—aromatic associated with underdeveloped fruit, for example, green bananas.

3.2.13 *warming*, *v*—perception of chemical heat associated with substances such as brown spice and low levels of capsaicin.

3.2.14 *wintergreen*, *n*—combination of several sweet aromatics associated with the mint family having some green and menthol aromatics along with a methyl salicylate aromatic sensation.

3.2.14.1 *Discussion*—Other associated characteristics with wintergreen typically include warming, low-level burning, and cooling, which are rated separately. Non-category examples: wintergreen breath mints and typical bismuth subsalicylate stomach remedies.

Texture/Mouthfeel and Holistic Attributes

3.2.15 *baking soda complex*, *n*—metallic, salty, mouth coating with radiating burn feeling, including mouth slip, for example, 0.1 % baking soda solution and unflavored seltzer water.

3.2.15.1 *Discussion*—The study designer may choose to separate this complex attribute into more granular attribute measures.

3.2.16 *bicarbonate feeling factor*, *n*—additionally can be recognized as the chemical feeling factor associated with sodium bicarbonate.

3.2.17 *chalky feel*, *n*—textural perception of small particulates.

3.2.18 *foam*, *n*—characteristics of the bubbles produced during the use of the product and this may specifically include

more granular measures such as: foam amount, foam uniformity, and denseness of bubbles produced.

3.2.19 *gritty*, *adj*—sensation of coarse, hard particles perceived in the mouth, for example, quick-dissolving antacid (calcium carbonate) tablets and granulated sugar.

3.2.20 *menthol*, *n*—“green” aromatic with associated nasal pungency and cooling feeling factor (and burning at higher levels) while in the mouth, for example, menthol and eucalyptus cough drop and mentholated topical cough suppressant ointment.

3.2.21 *overall impact*, *n*—sum total of the sensory impressions (sensations) of the sample in the mouth that includes aromatics, basic tastes, and feeling factors.

3.2.22 *peppermint*, *n*—aromatics associated with peppermint leaves.

3.2.22.1 *Discussion*—Other associated characteristics with peppermint typically include sweet, mint, cooling, green notes, bitter, and pungency, all of which are rated separately. Non-category examples of peppermint include peppermint gum and candies.

3.2.23 *pins and needles/numbing/stinging*, *n*—feeling factor associated with a sharp, stinging sensation that can be intense and includes a decrease or loss of sensation (numbing) often as a result of intense carbonation and a reaction to strong flavoring oil, essence, or extracts, for example, rinsing the oral cavity with hydrogen peroxide and then expectorating.

3.2.24 *slick*, *adj*—measure of the lack of resistance to tongue movement across the surface of the teeth.

3.2.25 *soapy mouthfeel*, *adj*—alkaline and slippery feel on the soft tissues of the mouth.

3.2.26 *toothpaste*, *n*—powder, paste, gel, or liquid for cleaning the teeth with the primary clinical benefit being the prevention of dental caries.

3.2.26.1 *Discussion*—Toothpaste products may or may not contain a form of fluoride as the common active ingredient and are generally intended for application with a toothbrush or similar device.

3.3 Definitions of Terms Common to the Perception of Toothbrushes:

3.3.1 *bristle*, *n*—short, hair-like structure, usually made of synthetic material with varying degrees of stiffness (or firmness).

3.3.1.1 *Discussion*—Other bristle attributes associated with toothbrushes can include: deformation of bristles over time, bristle length, and bristle density.

3.3.2 *handle*, *n*—part of an instrument or thing by which it is held, carried, or controlled.

3.3.2.1 *Discussion*—Attributes to consider regarding handle may be comfort, ability to control, length, roughness, slipperiness, circumference, diameter, shape, and feel of composition material.

3.3.3 *toothbrush*, *n*—oral hygiene instrument used to clean the teeth, tongue, and gums and the instrument consists of a head of tightly clustered bristles embedded in a handle that facilitates the cleansing of teeth surfaces and soft tissues of the mouth.

3.3.3.1 *Discussion*—The toothbrush is typically used in conjunction with a teeth-cleaning agent such as toothpaste or tooth powders. These agents may be contained within the brush or applied directly to the brush head before use.

4. Summary of Guide

4.1 The development of expert descriptive sensory capability for the evaluation of toothbrushes and toothpaste requires a very specific and deliberate approach to not only the evaluation of the product itself but also to the recruitment and training of potential evaluators for the evaluation of toothbrushes and toothpaste. This guide provides approaches for the recruitment, screening, training, and final selection of panelists to evaluate the intensity and time course of the sensory physical characteristics of toothbrushes and toothpaste.

4.2 Additionally, several approaches to the expert descriptive analysis of consumer products have been developed, each with its own particular strengths and drawbacks. Two of the most common approaches are the common application and use of toothbrushes and toothpaste through the typical toothbrushing process using a toothbrush.

4.3 An alternate approach to the evaluation of some attributes of toothpaste specifically that has been published in the sensory literature is the sampling of the product from a spoon.³ This approach provides a mechanism for flavor, chemical feeling factor, and some mouthfeel characteristics without the concomitant irritation of the oral tissues that can accompany the use of a bristled toothbrush. This approach would not be appropriate in the evaluation of toothbrush sensory characteristics nor for toothpaste characteristics that require the mechanics of brushing to be perceived, such as those associated with foam, or for those that require full contact of all oral tissues with the toothpaste or generated foam or both such as cooling.

4.4 Specifics around the approaches for toothbrush and toothpaste evaluation are left to the reader as varied and equally valid descriptive analysis protocols can be developed.

5. Significance and Use

5.1 The approaches to the evaluation of toothbrushes and toothpaste recommended in this guide can be used to assess the sensory characteristics of toothpaste in use and after use (or a series of uses). This guide is meant to address the evaluation of standalone toothbrush and toothpaste products and does not address packaging, product/package interaction, dispensing, or overall clinical effect or benefit of the product. The procedures outlined in this guide are to be used by assessors that have been specifically screened for sensory and descriptive ability and trained in the evaluation of toothbrushes or toothpaste or both. The procedures described in this guide can be used to guide product development within a manufacturer and communicate information regarding the product to the consumer through the media or on product packaging.

5.2 Additionally, language and ideas from two additional ASTM International sensory guides (Guides **E1490** and

E2082) as well as the *Lexicon for Sensory Evaluation: Aroma, Flavor, Texture, and Appearance (DS72-2ND)*⁴ are used throughout this guide.

6. Panel Selection and Training – Toothbrush and Toothpaste Sensory Assessors

6.1 *Objective*—To select and train a panel of 10 to 15 judges to evaluate sensory properties before, during, and after usage of toothbrushes and toothpaste using descriptive analysis methods that quantify sensory attributes over time. For any particular study or evaluation, a smaller subset of these panelists may be used to generate data depending on project needs or objectives or both.

6.2 *Assessor Selection*—The following paragraphs will cover points specific to toothbrush and toothpaste assessors. For more general considerations in the recruitment of a descriptive analysis panel, reference *ASTM STP 758*.⁵

6.2.1 Assessors are recruited from within a company or the local community. The choice to use employees allows a company to have the assessors on site and keep proprietary information confidential. Candidates from within the company are contacted by interoffice memo, e-mail, company newsletter, or notices posted on regular and electronic bulletin boards. Management encouragement and support is critical. The use of local community residents broadens the potential panelist pool and also provides panelists that do not have a vested interest in the success of any product or product proposition. However, the use of panelists from the surrounding community provides a risk of panelist attrition both on a daily basis and longer term as the panelists are not employees of the company. A large group of candidates are recruited from the local community by contacting community groups, posting on bulletin boards, websites, placing newspaper ads, or other such ways to communicate such as exploring social media.

6.2.2 No matter the recruiting approach, before any prescreening or screening of panelist candidates, candidates should be informed of the time commitment for training, potential duration of the panel, use of the panel, and expectation of each panelist relative to the responsibilities of the panel. A prescreening questionnaire is recommended for determining current product usage, oral care habits, availability, interest, and their ability to articulate perceptions.

6.3 *Prescreening Questionnaire*—The prescreening questionnaire should cover the following topics:

6.3.1 *Screening Questions Specific to External Panelists: Availability*—Available for all mandatory training and 80 % or more of practice sessions. Be clear on what exactly is the time commitment. If performing an external recruit, carefully consider exclusion of sensitive industry/competition, as well as household members of current/former company employees or other sensory panel members.

6.3.2 *Clarification to the Candidate of the Scope and Expectation of the Role*—This is a standalone job/role with no

³ Hightower, C. A. and Chambers, E., “Descriptive Analysis of Toothpaste Flavor and Texture Using Two Sampling Methods: Brushing Versus Spoon Tasting,” *Journal of Sensory Studies*, Vol 24, No. 3, 2009, pp. 301-316.

⁴ *Lexicon for Sensory Evaluation: Aroma, Flavor, Texture and Appearance, DS72-2ND*, ASTM International, West Conshohocken, PA, 2011.

⁵ *Guidelines for the Selection and Training of Sensory Panel Members, STP 758*, ASTM International, West Conshohocken, PA. 1981.

expected addition to further company employment (if recruited externally). This is a part-time role without expectation to an increase in hours (if recruited externally). Additionally, hours are based on study needs and are not guaranteed. Working in a group dynamic and group environment is essential. In regard to training, practice, validation, and long-term commitment, willingness to step outside of the oral comfort zone (trying things that they would not normally try, unusual flavors, sensation, textures, and strengths) is critical.

6.3.2.1 If products or materials used in training contain alcohol, caffeine, animal products, processed foods, or other materials that may be prohibited because of a potential panelist's cultural or religious background, it is recommended that this be disclosed to potential panelists early in the recruitment process.

6.3.3 *Questions to Ascertain General Health and Condition*—Generally, exclude potential panelists with food allergies, diabetes, hypertension not managed by medication (less than 140/90), on medications that noticeably affect their ability to smell/taste, have serious chronic medical conditions (for example, cancer), are pregnant, or are lactating. Further medical history and current medication assessment can be conducted in cooperation with safety, regulatory, and legal partners. If the candidate's medical history is collected, ensure that this is acceptable from a Human Resources (HR) perspective and not subject to the Health Insurance Portability and Accountability Act of 1996 (HIPAA) (or similar) restrictions.

6.3.4 *Oral Health and Condition*—Health and condition of mouth and teeth, the presence or absence of dentures or partials, and age may be considered when recruiting assessors for a toothpaste or toothbrush product panel. Unless the product is formulated to address denture wearers, it is recommended that denture wearers not be included in sensory toothpaste or toothbrush evaluations.

6.3.4.1 It is also recommended that individuals who have chronic oral conditions, periodontal disease, excessive fillings, orthodontia, fewer than 80 % of their natural teeth, sensitivity to ingredients commonly included in toothpaste, and the presence of veneers be excluded. Issues such as tooth sensitivity, recent dental or oral surgery, tobacco use, and bridgework should also be considered when selecting assessors.

6.3.5 *Commitment: Training, Practice, and Ongoing (Overall Length of Commitment)*—The amount of time invested in the candidate should balance with the amount of time the candidate delivers.

6.3.6 *Descriptive Ability (Gauged from Written Questions)*—The objective should not be called out to the panelist. If prescreening is done online, be very careful not to include questions in an online screener that can be answered through an internet search. Be very careful of how the question is asked and ensure that the answer will meet the objective to identify that the candidate has an innate ability to communicate well.

6.3.7 *Ability to Scale/Use a Scale*—Questions can be done using visual stimuli (such as a series of differentially partially filled beakers, for example).

6.4 *Screening Considerations Specific to Internal Panelists:*

6.4.1 Potential panelists should thoroughly examine their ability to commit based on business travel, other business commitments, and so forth.

6.4.2 People cannot be on the panel who are directly involved with the project/product category (for example, all oral care product development should be excluded). They should be from a mix of other project categories to minimize response bias.

6.4.3 Do not recruit from areas of the building/facility that would compromise objective evaluation, for example, those individuals that work in a food setting or a product-making area as odors from their work may be carried with them to the testing site and compromise sample evaluations.

6.4.4 Panelists need to be completely blinded/shielded from the samples in their daily work for the entire testing period.

6.4.5 Based on the results of the prescreening questionnaire, candidates are selected to participate in the acuity screening phase. Candidates meeting prescreening criteria are invited to an onsite session(s) for the assessment of sensory acuity, ability to perform the task, and ability to work independently and in a group.

6.4.6 If internal panelist acuity data has been collected for previous studies, acuity should be reverified for the current project if the previous acuity screen does not apply to toothpaste or toothbrush evaluation or both.

6.5 *On-Site Screening:*

6.5.1 Candidates meeting the prescreening criteria are invited to an onsite session(s) for assessment of underlying sensory abilities. Sensory acuity screening should include, but is not limited to, tests of olfactory ability, gustatory ability, and texture sensitivity.

6.5.2 During the sensory screening process, assessors should demonstrate the ability to both evaluate products independently (without being a distraction to or being distracted by others) and participate in group discussions. For example, candidates may participate in a mock evaluation session of a toothbrush or toothpaste product or both for observation of their ability to work both independently and in a group.

6.5.3 It is recommended that a one-on-one interview be conducted for determination of fit to the role at the end of the screening process before the final selection of assessors.

6.5.4 Questions that may be asked during the one-on-one interview may include, but are not limited to:

6.5.4.1 If you were in a discussion in the group and everyone else on the panel disagreed with your position, what would you do?

6.5.4.2 If you took this job, how would it fit into your life/schedule/routine?

6.5.4.3 What questions do you have that have not been answered thus far?

6.5.5 *Acuity Screening*—Types of sensory acuity screening tests (minimum recruiting criteria is generally 75 % to 80 % correct for identification).

6.6 *Olfactory Ability:*

6.6.1 Odor identification test (commercially available or self-developed odorants).

6.6.2 Rank three different intensities of a single odorant/odor class (within the categories of mint, spice, sweet aromatic, and floral).

6.6.3 Consider detection/identification threshold if active/excipients have a particularly sensitizing effect.

6.6.4 In context identification of odor sensations in toothpaste or a reasonable proxy, for example, gum, breath mint, and mouthwash.

6.7 *Gustatory Ability:*

6.7.1 *Taste Identification Test (Five Basic Tastes)*—Bitter and sour reversals may be considered appropriate. Accurate identification and naming can be trained later.

6.7.1.1 Rank three different intensities of a single tastant.

6.7.2 *Screen for Differential Perception of High-Potency Sweeteners*—Ask for the type of sweetener commonly used in foods/beverages.

6.7.2.1 *Watch out*—Rebiana, Acesulfame K, saccharin, sucralose, and aspartame users are generally not as sensitive to the difference in taste of high-potency sweeteners as sucrose or high-fructose corn sweetener/syrup (HFCS) users. Also, people have developed a decreased sensitivity/acclimation to the sweetness. However, as most toothpaste products are indeed artificially sweetened, this is unlikely to be a major issue.

(1) In context identification/ranking of taste sensations within a toothpaste application or reasonable proxy (gum, breath mint, and mouthwash).

6.7.3 *Chemical Feeling Factor*—Differentiation of varied chemical feeling factors. Do not get burdened on sensation identification. Ensure the potential panelists can differentiate the following sensations (accurate identification and naming can be trained later): burning, cooling, and tingling.

6.7.4 *In-Mouth Texture Sensitivity*—Differentiation of varied textures as experienced in the oral cavity. Again, do not get burdened on the specific identification of these textures. Ensure that the potential assessor can distinguish between varied textures (accurate identification and naming can be trained later).

6.7.4.1 *Manual texture sensitivity*—Differentiation of varied textures and tactile sensations as experienced in the hand. Again, do not get burdened on the specific identification of these textures. Ensure that the potential assessor can distinguish between varied textures (accurate identification and naming can be trained later).

6.7.4.2 *Grit/Particle Differentiation:*

- (1) Size and
- (2) Amount.

6.7.4.3 Product breakdown in mouth (in a toothpaste context or a reasonable proxy).

6.7.5 *Visual Acuity*—Differentiation of stimuli that differ on visual sensory dimensions. Again, do not get burdened on the specific identification of these dimensions. Ensure that the potential assessor can distinguish between varied experiences (accurate identification and naming can be trained later):

- 6.7.5.1 Color discrimination (for example, standard color blindness tests),
- 6.7.5.2 Opacity, and
- 6.7.5.3 Shine.

6.7.6 Panel leaders should keep in mind that early attrition of selected assessors may be high once training has begun and the potential panelists develop clarity on the role and the responsibilities associated with the role; thus, over-recruiting/over selection is advised.

6.8 *Training and Validation of Toothpaste/Toothbrush Panel:*

6.8.1 *Panel Orientation:*

6.8.1.1 To begin training of the 10 to 15 selected assessors, the panel trainer shall orient assessors first to the general concepts such as the definition, components, and applications of descriptive analysis testing.

6.8.1.2 Three key areas to be covered during assessor orientation are:

- (1) Attribute development and definition (see Section 3 for a list of attributes that represent a foundation for toothpaste and toothbrush sensory evaluation),
- (2) Standard brushing procedure, and
- (3) Scaling.

6.8.1.3 Discussion and demonstration of each attribute are conducted for each category: appearance, aroma, flavor, texture, and residual. This establishes the overall structure of the descriptive analysis of sample properties. Assessors are encouraged to discuss each term, its definition, the protocol for evaluation, and the corresponding rating scale after they are demonstrated by the panel trainer.

6.8.1.4 Appropriate references and examples should be served to the assessors to ensure the same understanding of the attributes and to demonstrate the intensity ranges. This may take 4 to 5 h.

6.8.2 *Panel Practice*—The assessors should be practicing on a number of samples in a fashion that focuses on gross differences to start and moves towards discrimination of finer differences between samples. Assessors shall be able to discriminate toothpaste and toothbrush attributes, identify them, scale the intensities, replicate themselves consistently, and identify blind controls/duplicate samples as having very similar profiles. This is iterative or repeated exposure training depending upon the difficulty of the attributes. This may need to happen in shorter but more frequent sessions to avoid fatigue or overload, especially for toothpaste products that carry a very high sensate load. Visual cues to toothpaste can be difficult to control in the training environment leading to the possibility that the panelists may learn to use appearance attributes (striping, colors, and so forth) to guide their flavor and texture evaluations, and this is even a bigger challenge for toothbrush sensory training in which blinding the panelist to the toothbrush brand may be nearly impossible. When practical, appropriate steps should be taken to prevent such bias. For example, one approach would be to use red light technology to negate potential color cues in both toothbrushes and toothpaste (but this would have little effect on masking branding for toothbrushes). If a name or brand is embossed or debossed on a toothbrush itself, the researcher may consider chemically or physically removing the identifying branding. This should be done with extreme caution as this process changes the physical properties of the brush and the brush under descriptive evaluation is no longer the brush either in (or destined for) the