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Standard Guide for Selection, Evaluation, and Training of Observers[1]

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1. Scope

1.1 This guide describes criteria and tests for selecting, evaluating, and training human visual-sensory observers for tasks involving the perception and scaling of properties and phenomena relating to appearance.

1.2 Examples of tests requiring the use of trained observers include but are not limited to those described in the following ASTM standards: on color, Test Method D 1535 and Practice E 1360; on color difference, Practice D 1729 and Test Method D 2616; on gloss, Test Method D 4449; on metamerism, Practice D 4086; and on setting tolerances, Practice D 3134.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1535 Test Method for Specifying Color by the Munsell System[2]

D 1729 Practice for Visual Evaluation of Color Differences of Opaque Materials[2]

D 2616 Test Method for Evaluation of Visual Color Difference With a Gray Scale[2]

D 3134 Practice for Establishing Color and Gloss Tolerances[2]

D 4086 Practice for Visual Evaluation of Metamerism[2]

D 4449 Test Method for Visual Evaluation of Gloss Differences Between Surfaces of Similar Appearance[2]

E 284 Terminology of Appearance[2]

E 1360 Practice for Specifying Color by Using the Optical Society of America Uniform Color Scales System[2]

3. Terminology

3.1 *Definitions*—Definitions of appearance terms in Terminology E 284 are applicable to this guide.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *appearance*, *n*—*in psychophysical studies*, perception in which the spectral and geometric aspects of a visual stimulus are integrated with its illuminating and viewing environment.

3.2.2 *observer*, *n*—one who judges visually, qualitatively or quantitatively, the content of one or more appearance attributes in each member of a set of objects or stimuli.

3.2.3 *scale*, *v*—to assess the content of one or more appearance attributes in the members of a set of stimuli.

3.2.3.1 *Discussion*—Alternatively, scales may be determined by assessing the difference in content of an attribute with respect to the differences in that attribute among the members of the set.

4. Summary of Guide

4.1 This guide provides descriptions of techniques and tests for the selection of candidates for observers for use in visual testing, for the evaluation of their capabilities in this field, and for their training to enhance these capabilities.

4.2 Discussion is provided of precautions required for the efficient use of observers in visual tests, including avoidance of overtaxing the observers and the control of test variables.

4.3 Other considerations of test design, including the numbers of observers and observations required and the precision of the visual results, are to be covered elsewhere.

5. Significance and Use

5.1 The term *appearance* (see 3.2.1) implies the essential presence of human visual observations. The results of visual observation involve not only the step of observing, accomplished by the eye, but also the inseparable step of interpretation in the brain. Instrumental test methods currently cannot duplicate this second step, and therefore can now only approximate, but not fully measure, appearance. Such instrumental measures of appearance properties are useful only to the extent that they can be correlated to the results of visual observations by observers of the appearance phenomena being evaluated.

5.2 Almost invariably, too little attention has been paid to ensuring that the essential visual observations have been properly obtained to provide the basis for correlating visual and instrumental test results. (The only recent book devoted to visual measurements **(1)**[3] has no index entry for *observer*.)

[1] This guide is under the jurisdiction of ASTM Committee E-12 on Appearance and is the direct responsibility of Subcommittee E12.11 on Visual Methods.

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[2] *Annual Book of ASTM Standards*, Vol 06.01.

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

5.3 This guide provides the means for assessing observers, by outlining the requirements and tests for their selection, evaluation, and training. This guide should be useful to all experimenters designing or using visual test methods to provide either direct results in terms of the observation of appearance properties, or the experiments correlating such results with instrumental measures approximating the same appearance properties.

6. Selection and Evaluation of Observers

6.1 The process used for selecting observers depends a great deal upon the type of experiment being carried out, but should essentially evaluate the potential capability of the observer to execute a series of visual evaluation tasks **(2, 3)**. When these tasks involve appearance attributes, color or related spectral phenomena are often among the task subjects, and if instead geometric phenomena such as gloss are involved, many of the same considerations apply. Accordingly, the emphasis in this guide is upon selecting observers for color-related measurements. Thus, observers must be screened to rule out those with any color- or task-oriented deficiencies.

6.2 *Color Vision Tests* **(4)**:

6.2.1 *Pseudoisochromatic Plates*—As a preliminary color vision test, a pseudoisochromatic-plate test[4,5,6] should be administered to the candidate observers. The instructions and scoring techniques supplied by the manufacturer should be followed. In particular, the illumination level should be kept well within the photopic range (1000 1x is recommended as a minimum value) and the spectral quality of the illuminating source should be near that of north-sky daylight. Failure to identify correctly the required number of the plates in the test used should be considered grounds for dismissing the candidate observer.

6.2.2 *Color Rule Test*—When the anticipated experiment involves observing in the object mode, the candidate observer should be asked to find a (metameric) match on a Color Rule.[5] A standard light source should be used, similar to that specified in the majority of tests for which the observer is being trained. It should be remembered that normal trichromats will report match points that are dependent on age **(5)**, but any abnormal match point should be considered grounds for dismissing the candidate observer.

NOTE 1—An abnormal match point may be considered one that fails to fall within the main groupings of observer match points for the light source used on either Fig. 3 of Ref **(5)** or the figure of Ref **(6)**. Note, however, that this criterion is specific to the original D & H Color Rule and does not apply to the currently available MatchPoint Rule.[7]

6.2.3 *Farnsworth-Munsell 100 Hue Test*—The Farnsworth-Munsell 100 Hue Test[5,8] **(7)** should next be administered to the candidate. While the pseudoisochromatic-plate tests isolate certain factors of color deficiency, the Farnsworth-Munsell 100 Hue Test measures color discrimination directly and in detail. This test was not designed strictly for pass-fail categorization of observers but is recommended as an adjunct test for the analysis of color defectives. (It is also useful as an observer evaluation test; see 6.3.1.) In the Farnsworth-Munsell 100 Hue Test, abnormal color vision is indicated by the observer's failure to place the test chips in correct order. The chips consist of 85 colored papers varying in hue at approximately constant value and chroma, and the observer's failure is usually by wide margins in one or more limited regions of the hue circle. The presence of such abnormal results of the test should be grounds for dismissing the candidate observer.

6.3 *Visual Acuity and Discrimination Tests*—Having determined that the candidate observers have normal color vision, it is next necessary to test their level of discrimination of small differences in color or another appearance attribute of interest.

6.3.1 *Farnsworth-Munsell 100 Hue Test*—Use of the Farnsworth-Munsell 100 Hue Test as a color-discrimination test does not require readministration of the test, but merely reexamination of the test results. For the purposes of assessing color (more precisely, hue) discrimination, the test results are examined for the presence of an approximately constant but significant error level in the arrangement of the test chips throughout the hue circle. This may be interpreted as an inability to discriminate the small color differences between neighboring chips. While a weakness of this type might, for example, interfere with an observer's ability to participate in threshold scaling experiments, the observer might still be competent to perform magnitude scaling of larger differences among specimens.

6.3.2 *Triangle Test*—This test is part of a series known as the Japanese Color Aptitude Test.[5,9] The candidate observers are shown, one at a time, a series of 20 sets of three colored chips each. In each set, two of the chips are identical and the third is slightly different in color. The observer is asked to identify which one is different, the differences being so small that there is considerable uncertainty in the judgment. A lower than average score in this test indicates that the observer does not differentiate small differences well.

6.3.3 *HVC (Hue, Value, and Chroma) Color Vision Skill Test*—The HVC Color Vision Skill Test[5,10] is designed to

[4] The sole source of supply of the Dvorine Pseudo-Isochromatic Plates, known to the committee at this time is The Psychological Corp., Harcourt Brace Jovanovich, 555 Academic Court, San Antonio, TX 78204.

[5] If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[6] The sole source of supply of the H-R-R Pseudoisochromatic plates, Ishihara Color-Blindness Tests, known to the committee at this time is Richmond Products Inc., 1021 S. Rogers Circle, Suite 6, Boco Raton, FL 33484.

[7] *D & H Color Rule* (no longer available); *MatchPoint Rule* (available 1990 but not equivalent to the D& H Rule), available from Munsell Laboratory, Macbeth Division, Kollmorgen Instruments Corp., 405 Little Britain Road, New Windsor, NY 12553-6148.

[8] The sole source of supply of the Farnsworth-Munsell 100 Hue Test, known to the committee at this time is Munsell Laboratory, Macbeth Division, Kollmorgen Instruments Corp., 405 Little Britain Rd., New Windson, NY 12553-6148.

[9] The sole source of supply of the Japanese Color Aptitude Test (1994 edition), known to the committee at this time is Japan Color Research Institute, 3-1-19 Nishiazabu, Minato-ku, Tokyo 106, Japan.

[10] The sole source of supply of the HVC Color Vision Skill Test, known to the committee at this time is Lou Graham and Associates, Inc., 1207 Colonial Ave., Greensboro, NC 27408.