

Labeled magnitude scales for oral sensations of wetness, dryness, pleasantness and unpleasantness

Steve Guest^{a,*}, Greg Essick^b, Akshya Patel^c, Rajan Prajapati^c, Francis McGlone^{d,1}

^a Center for Neurosensory Disorders, School of Dentistry, 2160 Old Dental Bldg., University of North Carolina, Chapel Hill, NC 27599-7450, United States

^b Department of Prosthodontics, Curriculum in Neurobiology, Center for Neurosensory Disorders, University of North Carolina, Chapel Hill, NC, United States

^c School of Dentistry, University of North Carolina, Chapel Hill, NC, United States

^d Cognitive Neuroscience, CSIG, Unilever Research and Development, Wirral, United Kingdom

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Abstract

Methods for directly comparing the salience of oral sensations between individuals are not available. To this end, we generated labeled magnitude scales for assessing the magnitude of oral sensations of wetness, dryness, pleasantness and unpleasantness. Seventy-three subjects provided magnitude estimates for seven intensity descriptors, randomly interspersed with examples of various nonpainful oral sensations, which were rated also. Twenty of the subjects provided ratings for all four scales twice during four days of testing. Analysis of these subjects' data indicated that the ratings of the intensity descriptors significantly varied ($F_{6,1045} = 688.00, p < 0.001$), but were similar for all four scales ($F_{18,1045} = 0.64, p = 0.87$). Fifty-three of the 73 subjects provided data without replications, or data for only two of the four scales. The complete dataset was divided into separate analyses for wetness/dryness scales (OWDS; $n = 51$ subjects) and for pleasantness/unpleasantness scales (OPUS; $n = 49$). Results did not differ from those of the 20 subjects described above. Additionally, no effects of gender or sensitivity to 6-*n*-propyl-2-thiouracil (PROP) upon the ratings were seen. The mean ratings of the 51 and 49 subjects were used to define label positions on the OWDS and OPUS, respectively. Comparison of the two scales with the LMS [Green, B. G., Shaffer, G., & Gilmore, M. M. (1993). Derivation and evaluation of a semantic scale of oral sensation magnitude with apparent ratio properties. *Chemical Senses* 18, 683–702] and the LAM scale [Schutz, H. G., & Cardello, A. V. (2001). A labeled affective magnitude (LAM) scale for assessing food liking/disliking. *Journal of Sensory Studies* 16, 117–159] indicates that positions of labels for OWDS and OPUS are similar to those for the LAM. The OWDS and OPUS labels are shifted toward the upper end of the scale, considerably so when compared with the LMS. This suggests that using the LMS to rate oral wetness, dryness, pleasantness or unpleasantness would underestimate the intensities of relatively weak sensations.

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1. Introduction

A topic of pervasive interest in psychophysics is how best to obtain and compare judgments of stimulus intensity

from different individuals. This interest has extended to judgments of the intensity of very specific sensations, such as the perceived pleasantness of food (Schutz & Cardello, 2001) or physical exertion during exercise (Borg, 1982). For many years, visual-analogue scales (VAS) and labeled category scales (composed of fixed-interval, ranked categories) were preferred, in large part due to their simplicity. However, the validity of these scales was subsequently challenged by S.S. Stevens' investigations of magnitude

* Corresponding author. Tel.: +1 919 966 2953; fax: +1 919 966 3683.

E-mail address: steve_guest@dentistry.unc.edu (S. Guest).

¹ Department of Neurological Sciences, School of Medicine, Liverpool University, United Kingdom.

estimation (e.g., Stevens & Poulton, 1956). With magnitude estimation (ME) ratings of stimulus intensity are, at least in principle, directly comparable between- and within-observers in terms of their ratios. However, ME has significant disadvantages as compared with VAS and labeled category scales. First, the ME procedure may be more difficult for naïve respondents to comprehend than that of scaling techniques, as reflected in the idiosyncratic numbers used by some subjects (Teghtsoonian, Teghtsoonian, & Baird, 1995). Further, because the numbers produced by subjects during ME have no inherent meaning, it is not possible to directly compare the magnitude estimates produced by different subjects. For example, different subjects commonly use different numbers for the same perceived intensities. Additionally, in some circumstances ME is less sensitive than scaling methods, such as use of the CR100 scale, in discriminating differences in stimuli based on perceived intensity (Borg & Borg, 2002).

In more recent years, a type of scale has been developed that aims to provide the advantages of ME, VAS and labeled category scales, namely the labeled magnitude (aka category-ratio) scale. In general, labeled magnitude scales consist of a VAS-like scale upon which intensity descriptor labels, similar to those of a labeled category scale, have been added at locations experimentally-determined using ME. All labeled magnitude scales include an upper anchor at or beyond the most intense end of the scale, to provide the context in which all responses are made (e.g., Borg, 1982; Borg, 1998; Borg & Borg, 2002). Although researchers in the 1970s experimentally defined the relative intensities for a range of intensity descriptors (e.g., for pain, Gracely, McGrath, & Dubner, 1978a) that could, in principle, be used to produce labeled magnitude scales, the earliest such scale entering common use was that reported by Borg (1982). The Borg CR-10 scale was developed primarily for the rating of perceived exertion (RPE), and a version of this scale is in wide use at the time of writing (e.g., Noakes, 2002), including its use for rating the intensity of sensations for which it was not designed (e.g., Johansson, Kjellberg, Kilbom, & Hägg, 1999). Even for such non-intended applications the scale has been shown to perform well when compared with other psychophysical methods (Marks, Borg, & Westerlund, 1992), although it does not always produce the same ratios of perceived intensity between stimuli as ME (Marks, Borg, & Ljunggren, 1983). This indicates that using the CR-10 for non-intended applications can lead to intensity ratings that are not ratio scaled.

In recent years, the most widely used labeled magnitude scale, and indeed the first such scale to be explicitly named a 'labeled magnitude scale' (LMS) is that developed by Green, Shaffer, and Gilmore (1993). The LMS was originally developed for rating the intensity of general oral stimuli, with the top anchor of the scale representing the most intense oral sensation imaginable, including painful sensations. This scale has been shown to be more sensitive than other methods, such as labeled category scaling, in discriminating

between different subgroups of subjects, such as in the classification of individuals based on their perception of bitter tastes (Bartoshuk, 2000).

The LMS, like the Borg scale, has been applied outside of its original intended use, such as in the rating of tactile roughness (Diamond & Lawless, 2001). This might not be optimal for several reasons. First, the original LMS only produces data equivalent to magnitude estimation for scales that include painful sensations within the most intense sensation label (Green et al., 1996). For example, the LMS does not produce the same ratio of sensory intensities as magnitude estimation when used for rating the intensity of sweetness. Second, the intensity descriptor labels themselves may not be appropriate for certain oral or indeed non-oral sensations. This is essentially an issue of face validity and usability. For example, one is unlikely to refer to pleasant oral sensations as 'strong'; the adjective strong might be better phrased as 'very', or some other adjective of similar intensity appropriate for hedonic applications. Third, and perhaps most importantly, the relative positions of the intensity descriptor labels may be different when comparing the LMS with scales that are produced to assess specific sensations such as oral pleasantness, wetness, roughness and so forth.

In recognition of these concerns, Schutz, Cardello and colleagues developed separate (sets of) labeled magnitude scales for rating the pleasantness and unpleasantness of foods (the LAM scale, Schutz & Cardello, 2001), for rating satiety and hunger (the SLIM scale, Cardello, Schutz, Leshner, & Merrill, 2005) and for rating the comfort of clothing (the CALM scale, Cardello, Winterhalter, & Schutz, 2003). The development of each of these scales included a wide range of appropriate labels to describe sensation intensity. The scales generated show a small amount of asymmetry in descriptor label locations for the positive versus negative hedonic or intensive labels. Similar to the LMS, the LAM was shown by the authors to be relatively sensitive, in particular more sensitive than the Natick 9-point hedonic scale (Peryam & Pilgrim, 1957), a labeled category scale frequently used to obtain affective ratings of foods. Similarly, the CALM scale has been shown to be more sensitive than a VAS satiety scale (Cardello et al., 2003). To our knowledge, the LAM scale is the only labeled magnitude scale that has been generated for specific experiences obtained in the context of non-noxious oral stimulation.

Following on from the work of Schutz and Cardello, we developed scales for the oral sensations of wetness and dryness, and for the pleasantness and unpleasantness of liquids in the mouth. We anticipated that the locations of semantic intensity descriptors would differ from those of the LMS, given that the four sensations we studied did not include pain within their sensory range. Additionally, we expected our oral pleasantness and unpleasantness scales to agree more closely with the LAM of Schutz and Cardello than the LMS, given the conceptual similarities between our consideration of general oral pleasantness/unpleasantness

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