

Comparison of Sensory Odour Intensity Scales for Inexperienced Assessors

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Abstract

Odours discharged from various human activities may cause severe damage to local residents. Odour intensity is one of main odour characterization parameters. For ordinary environmental odour monitoring by neighborhood and routine odour management at emission sources, reliable and user-friendly sensory odour intensity scale even for inexperienced assessors is desired. In this study, four odour intensity scales, including conventional six-point scale, 1-butanol reference scale, line segment scale and metronome scale, were applied to odour intensity measurement of 1-butanol and ethyl acetate solutions by inexperienced assessors. As a result, the line segment scale seemed to be the most appropriate for discriminating odour intensity. On the other hand, the improvement of the odour intensity evaluation procedure using metronome scale was thought to be necessary.

Keywords: odour intensity, inexperienced assessor, line segment scale, metronome scale.

1. Introduction

Odours discharged from various human activities may cause severe damage to local residents. For appropriate evaluation of environmental odours, it is necessary to develop a reliable odour measurement scale. Since environmental odours consist of a variety of different odorous compounds, comprehensive evaluation of odours using human sense of smell as well as instrumental analysis of individual chemicals is indispensable. Odour intensity is one of main odour characterization parameters (Naddeo et al., 2013), and remarkably common and important sensory indicator of environmental odours. Odour intensity reflects people's perception of odours and contributes to effective odour management.

For ordinary environmental odour monitoring by neighborhood and routine odour management at emission sources, reliable and user-friendly sensory odour intensity scale even for inexperienced assessors is desired. In this study, four odour intensity scales, including conventional six-point scale, 1-butanol reference scale, line segment scale and metronome scale, were applied to odour intensity measurement of 1-butanol and ethyl acetate solutions by inexperienced

assessors. Then, discrimination rates of odour intensity scales were evaluated and characteristics of each scale were discussed.

2. Materials and Methods

2.1. Odour intensity scales

Six-point odour intensity scale shown in Table 1 is the most popular odour intensity scale in Japan. It was developed more than 40 years ago, and the regulation standards based on the Offensive Odour Control Law were set equivalent to the odour intensity that ranges from 2.5 to 3.5 on this scale (Higuchi and Nishida, 1995). In the measurement, six or more assessors sniff a testing odour directly and classify their impressions in accordance with the scale in 0.5 segments.

In order to ensure equal intervals between odour intensity levels, conventional six-point odour intensity scale was reconsidered and 1-butanol reference scale was proposed as shown in Table 2 (Higuchi et al., 2018). In the measurement, six polyethylene bottles with a capacity of 400 mL are prepared and reference solutions of 1-butanol shown in Table 2 are placed into them. The volume of each solution is 200 mL and the top of the bottle is tightly capped. Then, assessors gently shake bottles to ensure equilibrium, open the caps and sniff one by one to memorize odour intensity impressions. After taking a break of 3 minutes, assessors sniff a testing odour and judge odour intensity.

Line segment scale is a kind of cross-modality matching scale. In the measurement, assessors sniff a testing odour and evaluate perceived odour intensity by placing a magnetic strip on a line segment with a length of 250 mm on a whiteboard. The lowest and upper limits of the line segment designate "no odour" and "the most intense odour imaginable," respectively. After the evaluation, the distance between the lowest limit of the line segment and a magnetic strip is measured.

Metronome scale is another kind of cross-modality matching scale. In the measurement, assessors sniff a testing odour and close their eyes. Then, an

experimenter starts up the metronome application in a smart phone and gradually increase beats per minute (BPM) in 5 segments. Assessors evaluate perceived odour intensity by raising their hands at the BPM they perceive the same sensory impact as a testing odour.

Table 1. Six-point odour intensity scale

| Level | Odour intensity |
|-------|--|
| 0 | No odour |
| 1 | Barely perceivable (Detection threshold) |
| 2 | Faint but identifiable (Recognition threshold) |
| 3 | Easily perceivable |
| 4 | Strong |
| 5 | Extremely strong |

Table 2. 1-butanol odour intensity reference scale

| Level | 1-butanol concentration in water (ppm (vol/vol)) | Odour intensity |
|-------|--|--------------------|
| 0 | 0 | No odour |
| 1 | 10 | Faint |
| 2 | 600 | Easily perceivable |
| 3 | 2600 | Slightly strong |
| 4 | 9000 | Strong |
| 5 | 22500 | Very strong |

2.2. Testing odour solutions

Six sample solutions (200 mL each) with a concentration of 600, 2600 and 9000 ppm for 1-butanol and 350, 700 and 5000 ppm for ethyl acetate were prepared in Erlenmeyer flasks with a capacity of 500 mL.

2.3. Experimental procedure

A total of 65 inexperienced assessors who ranged from 19 to 23 years of age joined the experiment. All assessors evaluated odour intensity of six odour solutions using six-point odour intensity scale and 1-butanol reference scale. However, only 35 and 30 assessors evaluated odour intensity using line segment scale and metronome scale, respectively.

3. Results and Discussion

3.1. Comparison between six-point odour intensity scale, 1-butanol reference scale and line segment scale

Experimental results were evaluated by calculating a discrimination rate (a percentage of the number of assessors who completely recognized the order of odour intensity). Among six-point odour intensity scale, 1-butanol reference scale and line segment scale, the line segment scale showed the highest discrimination rate of 44% and 71% for 1-butanol and ethyl acetate solutions, respectively. However, mean odour intensity of line segment scale for 1-butanol solutions did not indicate a linear increase (Figure 1). It implies the inconsistent understanding of the upper limit of the line segment “the most intense odour imaginable” among assessors.

3.2. Comparison between six-point odour intensity scale, 1-butanol reference scale and metronome scale

Among six-point odour intensity scale, 1-butanol reference scale and metronome scale, the metronome scale showed the lowest discrimination rate of 43% and 33% for 1-butanol and ethyl acetate solutions, respectively. It was observed that a lot of assessors answered the same odour intensity for different concentration of testing odour solutions. BPM values were controlled by the experimenter in 5 segments in this experiment. Therefore, it is necessary to improve the evaluation procedure in odour intensity measurement using metronome scale.

3.3. Characteristics of odour intensity scales

Experimental results imply inconsistent impression of explanatory labels of odour intensity 2 and 3 in six-point odour intensity scale among inexperienced assessors. Among four sensory odour intensity scales, the line segment scale seems to be the most appropriate for discriminating odour intensity. The investigations using real environmental odours, however, would be necessary to discuss the applicability of these scales more clearly.

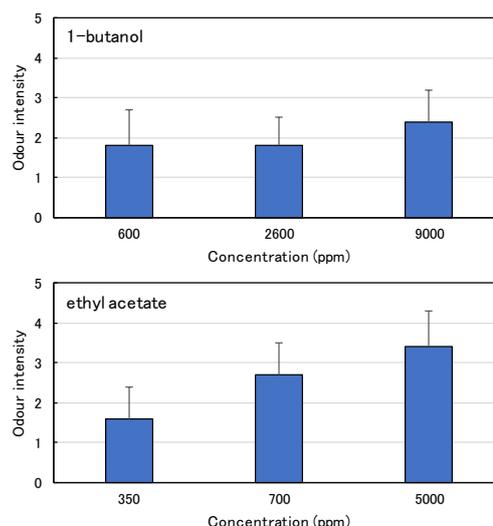


Figure 1. Odour intensities of 1-butanol (upper) and ethyl acetate (bottom) solutions measured by using line segment scale. Columns and bars represent mean values and standard deviations, respectively.

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