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Touching, Seeing, Imagining: Consistency in Unpleasantness Across Haptic, Visual, and Verbal Domains*

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I. Introduction

Imagine the feeling of touching rough sandpaper—would you anticipate the same level of unpleasantness when looking at an image of it or imagine it upon seeing its name? Touch perception involves both discriminative aspects, which help to identify the physical properties like stickiness or roughness, and affective responses, which relate to how pleasant or unpleasant something feels. Previous research has shown that physical material properties such as softness, stickiness, and roughness are represented similarly across haptic, visual [1], [2], [3], and verbal domains [4]. Notably, stickiness and roughness have been found to be quite consistently associated with unpleasantness [5], [6], [7]. However, it remains unclear whether tactile unpleasantness itself is represented consistently across these domains. To address this question, the present study compares the tactile unpleasantness judgments across verbal (Experiment 1), haptic (Experiment 2a), and visual (Experiment 2b) domains, focusing on participants from Germany and the UK. Understanding how tactile unpleasantness is perceived across different sensory domains has broad implications for industries such as online shopping, where consumers might rely on visual or verbal descriptions of materials, or in the field of robotics, where artificial systems may need to infer tactile properties without physical contact.

II. Methods

A. Participants

Experiment 1 was conducted online with 108 participants from Germany (66 females, 41 males, 1 other; M_{age} = 24 years, SD_{age} = 3.7 years, age range: 18-41 years) and 104 participants from the UK (62 females, 39 males, 3 preferred not to say; M_{age} = 30 years, SD_{age} = 13.8 years, age range: 18-71 years). Additional participants from Türkiye (N = 112) and France (N = 296) were recruited, but their data are not reported in this paper.

Experiment 2a was conducted in the lab. Thirty participants (20 females, 9 males, 1 missing; M_{age} = 23 years, SD_{age} = 3.6 years, age range: 19-34 years) were recruited from the UK, and 30 others (25 females, 5 males; Mage = 24 years, SDage = 3.49 years, age range: 20-33) from Germany.

Experiment 2b was conducted in the lab as well. Thirty participants (23 females, 6 males, 1 other; M_{age} = 19 years, SD_{age} = 3.0 years, age range: 18-32 years) were recruited from the UK, and 30 others (17 females, 13 males; Mage= 24 years, SDage = 2.87 years, age range: 20-32) from Germany.

All experiments were approved by ethics committees (approval numbers: 689594 and 2212193 in Aberdeen, 2022-003 in Giessen, and 2024-A01756-41 in Marseille).

B. Setup, materials, design, and procedure

In Experiment 1, participants were presented with 115 material and object names, with a subset of 79 selected for lab testing in Experiments 2a and 2b (e.g., excluding animals and perishable food). To allow comparisons between experiments, we report data only for these 79 materials and objects throughout. The stimuli were everyday materials and objects that vary in stickiness (e.g., honey, slime toy), roughness (e.g., sandpaper, baking paper), softness (e.g., silk, linen), granularity (e.g., salt, flour), and other material properties. The stimuli were presented randomly as material names (in the respective language in all countries) in Experiment 1, as physical samples in Experiment 2a, and as images of the same physical samples in Experiment 2b. Participants rated how (un)pleasant they would find touching the material (Experiments 1 and 2b) and how (un)pleasant touching the material felt to them (Experiment 2a) on a 7-point Likert scale (1-very pleasant, 7-very unpleasant). In Experiment 2a, participants explored the physical samples freely for 4 seconds while wearing noise-cancelling headphones to mask any auditory cues. In Experiment 2b, images of the materials were displayed at the center of the screen (~57cm from participants) for 2 seconds before the rating scale appeared. Participants provided written informed consent before the experiment.

III. Data analyses and Results

To identify systematic differences between haptic, verbal, and visual domains, we used Bland-Altman plots to assess agreement between two domains. These plots show the mean difference in ratings (y-axis) against the average rating across two domains (x-axis). Materials falling outside ±1.96 standard deviations of the mean difference (i.e., limits of

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agreement) were considered to show considerable differences. To ensure comparability across samples and experiments, limits of agreement were normalized using the overall mean and standard deviation (Figure 1). Results suggest that tactile unpleasantness ratings were largely consistent, with only 1 (1.3%; Figure 1E) to 9 (11.4%; Figure 1D) out of 79 materials falling outside the limits. Notably, materials that vary in stickiness were generally rated more extreme in unpleasantness in the haptic and visual domains compared to the verbal domain, with outliers predominantly appearing in the upper part of the plots. To further examine the agreement, we computed Pearson correlations of the mean ratings for the 79 materials in each domain and conducted Fisher's Z test. Verbal-haptic correlations were moderate (Germany: r = .45, UK: r = .47), verbal-visual correlations were slightly stronger (Germany: r = .62, UK: r = .59), and haptic-visual correlations were the highest (Germany: r = .71, UK: r = .76), aligning with the Bland-Altman plots. All correlations were significant at $p < .001$. In the UK, haptic-visual correlations were significantly higher than verbal-haptic (Z = -3.71, $p < .001$) and verbal-visual (Z = -2.32, p = .02), while the latter two did not significantly differ (Z = -1.80, p = .07). In Germany, haptic-visual correlations were significantly higher than verbal-haptic correlations (Z = -3.30, p = .001), and verbal-visual was higher than verbal-haptic (Z = -2.40, p = .02), but no significant difference emerged between haptic-visual and verbal-visual correlations (Z = -1.11, p = .27).

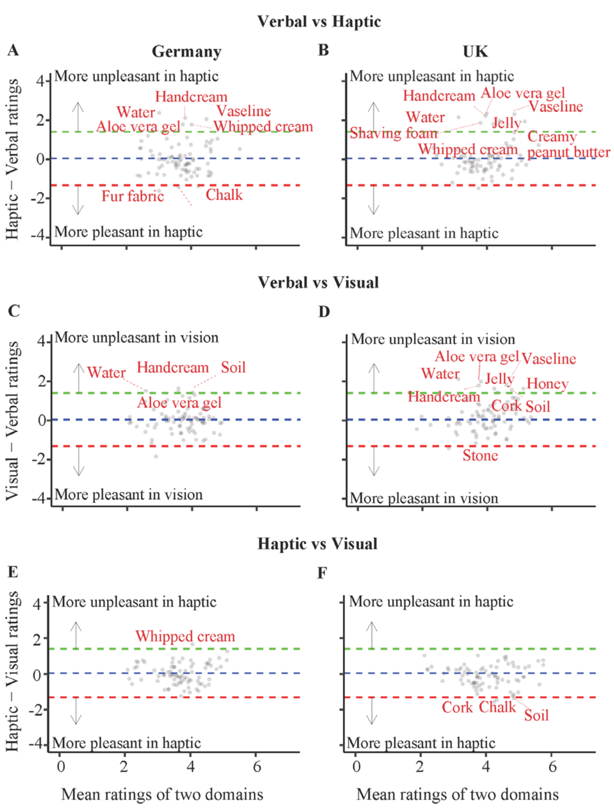

Figure 1. Bland-Altman plots comparing verbal (Experiment 1), haptic (Experiment 2a), and visual (Experiment 2b) ratings in Germany (A, C, and E) and the UK (B, D, and F). Green lines indicate +1.96 SD, blue lines indicate overall mean rating difference, and red lines indicate –1.96 SD. Materials out of ±1.96 SD are annotated in red.

IV. Discussion

Previous research has demonstrated that material properties associated with unpleasantness, such as softness, stickiness, and roughness, are represented similarly across haptic, visual [1], [2], [3], and verbal domains [4]. Our findings build on this by demonstrating directly that tactile unpleasantness ratings are consistent between haptic and visual domains but diverge from verbal ratings, a pattern observed in both Germany and the UK. Interestingly, visual ratings showed stronger agreement with both haptic and verbal ratings than the latter did with each other, suggesting that vision may serve as an "intermediate" modality in inferring tactile unpleasantness. This may be because visual conveys both sensory cues and invites imagined touch, allowing it to tap into both bottom-up and top-down processes. This interpretation is supported by visual neuroscience research showing that mental imagery relies more on top-down processes, while perception engages both bottom-up and top-down pathways [8]. In this context, verbal judgments, which resemble mental imagery, may be primarily top-down, haptic judgments primarily bottom-up, and visual judgments a combination of both—explaining vision's closer agreement with both domains.

Overall, haptic unpleasantness judgments show reasonable agreement between haptic and visual domains. These findings have potential applications in robotics, AI, and online consumer experience—enabling systems/people to infer tactile qualities from images without physical touch.

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