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Quantifying Pain Location and Intensity with Multimodal Pain Body Diagrams

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Abstract

To quantify an individual's subjective pain severity, standardized pain rating scales such as the numeric rating scale (NRS), visual analog scale (VAS), or McGill pain questionnaire (MPQ) are commonly used to assess pain on a numerical scale. However, these scales are often biased and fail to capture the complexity of pain experiences. In contrast, clinical practice often requires patients to report areas of pain by drawing on a body diagram, which is an effective but qualitative tool. The method presented here extracts quantifiable metrics from pain body diagrams (PBDs) which are validated against the NRS, VAS, and MPQ pain scales. By using a novel pressure-hue transformation on a digital tablet, different drawing pressures applied with a digital stylus can be represented as different hues on a PBD. This produces a visually intuitive diagram of hues ranging from green to blue to red, representing mild to moderate to most painful regions, respectively. To quantify each PBD, novel pain metrics were defined: (1) PBD mean intensity, which equals the sum of each pixel's hue value divided by the number of colored pixels, (2) PBD coverage, which equals the number of colored pixels divided by the total number of pixels on the body, and (3) PBD sum intensity, which equals the sum of all pixels' hue values. Using correlation and information theory analyses, these PBD metrics were shown to have high concordance with standardized pain metrics, including NRS, VAS and MPQ. In conclusion, PBDs can provide novel spatial and quantitative information that can be repeatedly measured and tracked over time to comprehensively characterize a participant's pain experience.

Introduction

Chronic pain is a debilitating neuropsychiatric condition affecting over 50 million adults in the United States[1]. However, common clinical tools to track subjective pain intensity (such as the numeric rating scale [NRS] or visual analog scale [VAS]) are reductionistic and fail to communicate the complex nature of pain symptom intensity spanning somatosensory, cognitive, or affective domains[2,3]. Accurately tracking an individual's pain intensity is critical to the diagnosis of pain syndromes, monitoring disease progression, and assessing the potential efficacy of therapies such as medications or brain stimulation.

The widely used NRS pain intensity tool requires the subject to rate pain intensity as an integer value from 0-10, representing no pain to the worst possible pain. While easy to administer and understand, the NRS is limited by respondent anchoring bias, expectation bias, and variable interpretation of individual values[4,5]; these also limit between-participant comparisons. The VAS, a continuous scale from 0-100, may reduce the impact of anchoring but can still face similar limitations as those of NRS[4]. Several studies have demonstrated a high degree of agreement between the NRS and VAS for chronic lower back pain severity[6,7] and clinical practice[5], but consensus guidelines highlight the many shortcomings of relying on similar scales in clinical pain trial design or interpretation[8,9]. The short-form McGill pain questionnaire 2 (MPQ) further dissects the somatosensory and affective dimensions of pain using ratings of verbal descriptors[10], to aid in distinguishing between sensory and affective pain dimension[11]. Although these pain rating scales are commonly used to track pain intensity[12,13], they fail to capture detailed topographic information such as pain location, or intensity variation across body regions.

Pain body diagrams (PBDs) are an open-ended, free-form pain assessment tool allowing respondents to illustrate a visual representation of pain location and intensity on a schematic human body outline[14,15]. PBDs are an effective communication tool between participants and medical providers which help track pain symptoms longitudinally[16]. PBD's free-form graphical format may decrease anchoring bias. Recent modifications to PBDs, such as the introduction of sex-specific body diagrams, have increased their effectiveness as a communication tool by aligning the visually represented body form with the respondent's anatomy, thereby increasing self-identification and response accuracy[17]. Furthermore, the use of color to signify intensity has been shown to allow effective communication of pain symptoms overcoming cultural and language barriers. For instance, the colors white and red were most commonly selected to indicate no pain and severe pain, respectively, in a Hmong patient population[18]. While PBDs are an effective tool[19,20], they have been limited by their qualitative nature.

The use of PBDs on digital tablets has substantially expanded the tools available for quantifying pain location and intensity. Barbero et al. quantified the pain extent or the number of pixels drawn within a PBD of patients with chronic lower back and neck pain and showed good test-retest reliability and significant correlation with VAS measures[21]. Body diagrams have also been analyzed to create pain frequency maps to show the most to least frequently painful areas of the body[21,22]. While these methods quantify spatial pain

information, so far, no method has incorporated both pain intensity and location into composite metrics.

The following protocol demonstrates a method for obtaining novel, visually intuitive, colored PBDs and extracting three quantitative metrics that together reflect a composite of pain intensity and location information. To do this, five participants undergoing a research trial of deep brain stimulation (DBS) for refractory chronic neuropathic pain were selected to test the current approach, using a N-of-1 study design[23]. Participants were instructed to report the intensity of their momentary pain symptoms by applying varying levels of pen pressure on a tablet illustration application to produce color hues that corresponded to varying pain intensities at different body locations. PBD-derived metrics of coverage, sum intensity, and mean intensity were compared to more common validated pain metrics (i.e., NRS, VAS and MPQ) using statistical and mutual information (MI) analyses.

Over a 10-day inpatient hospital stay, patients undergoing evaluation completed PBDs (mean ± standard deviation (SD) = 121.8 ± 34.3 PBDs per patient; range 84-177; 609 PBDs total) in addition to validated pain scales such as the NRS, VAS, and MPQ multiple times daily. PBDs were collected via a tablet application and uploaded as time-stamped files to secured research servers when completed. Pain intensity NRS, VAS and MPQ were acquired using REDCap survey tools, a secure web application. Both surveys and PBDs were administered in person by research assistants to ensure patients received the needed assistance to complete their evaluations accurately. The following steps detail PBD setup, participant instruction, data collection, and PBD analysis used to reliably quantify pain **(Figure 1)**.

Protocol

This PBD protocol was implemented in a parent clinical trial protocol (NCT03029884), approved by UCSF Human Research Protection Program and FDA. Each participant (3 female and 2 male, age range: 51-67 years) signed written informed consent; they were recruited from the UCSF pain management center or referred by physicians in the United States.

1. Pain body diagram setup

1. Patient inclusion criteria: Include participants with the following pain diagnoses: several neuropathic pain etiologies, including central post-stroke pain (2 patients) and neurodegenerative spine disease with radicular pain (1 patient), complex regional pain syndrome (1 patient), and spinal cord injury (1 patient). All participants have completed post-high school education.
2. Import a gender-appropriate PBD template (**Supplementary Figure 1**), displaying both front and back body surfaces, into an illustration application that contains a pressure-sensitive drawing tool on a touch-sensitive digital tablet. Download the PBD template to the tablet's photo library, then click the **Import** button.
3. Create a new layer on top of the PBD template by clicking the **Layers** icon followed by the **+** button for the participant to draw on. This results in two layers, one with the PBD and one to be drawn in with colors indicating pain.
4. Create a new brush with a x=y pressure-to-hue transformation curve by first clicking the **Brush Library** icon, then **+** to open the brush studio.

5. Click on the button labeled **Color Dynamics**, then scroll down to the color pressure section. For the hue slider, click the **Numeric Percentage** to ensure the pressure transformation graph visualizes a straight 45° line.
   NOTE: Double-clicking the graph will provide the option to reset the graph to the straight x=y graph.
6. To define the hue gradient range from green to blue to red, adjust the hue slider under the color pressure section by clicking the **Percentage Number Listed** and inputting a numeric value of 81%.
   NOTE: Another way of doing this is to enter hexadecimal limits of #008000 to #FF0000 if the application allows for manual entry of hexacodes.
7. Select a pen size that accommodates the needs of study participants by adjusting the pen tool slider. A pen size of 30% is a good starting size for most participants.

2. Instructions for the participants

1. Describe the PBD anatomy and orientation of the body templates in portrait mode, the drawing and erasing tools, the tactile pinch-to-zoom and the panning functionality to the patient.
2. Explain the pressure-to-hue linear transformation to participants in the following manner: inform participants that increased pressure applied to the stylus will result in hues that shift from green to blue to red which should be colored into the diagram to represent mild to moderate to severe pain intensity at any given location, respectively.
3. Using the teach-back method[24], confirm the participant's understanding of the PBD task by asking them to explain how to fill in the diagram using their own words.
4. Allow participants at least 15 min of practice time to draw multiple PBDs on a flat surface to ensure accurate representation of pain location and intensity. Allow for any adjustments to be made to maximize usability. Review the PBDs immediately afterwards with each participant to ensure consistency and that colors are drawn as intended.

3. Data collection and pre-processing

1. Ask participants to complete PBDs during baseline or at various time points after some treatment or intervention. Allow for an open-ended amount of time for the completion of each PBD so that each map can be completed to the participant's satisfaction.
2. Save completed PBDs with a standardized filename containing patient ID as well as date and time when PBD was completed.
   NOTE: These files are saved temporarily on the tablet device.
3. Bulk export completed PBDs in either portable document format (.PDF) or photoshop document (.PSD) file format that retains image layers for pre-processing. To bulk export, first click the **Select** icon to choose the desired images, then click **Share** to open a menu of image formats for export. Click the format file of choice.
   NOTE: Exported files are uploaded to a secure research server.
4. Download PBDs and open in a raster-based image editor.
5. Isolate the colored pixels of interest from the top layer of the PBD file by adding two mask layers: one completely black layer below the colored-in layer and one black mask layer to exclude pixels outside the template body outline above the colored-in layer. This will result in

processed PBDs that only contain the colored pixels within the body outline on a black background (**Figure 1**).

6. Export the processed PBDs as portable network graphics (.png) files by clicking and selecting the following sequence of buttons: **File > Export > Export As > PNG > Export**.

4. PBD Quantification

1. Convert each pixel value in the PBD from RGB (red, green, blue) color space into HSV (hue, saturation, value) color space using OpenCV2[25], a publicly available Python package. Extract the hue value for each pixel by running the python scripts titled rgba2hsv(filename) (**Supplementary Coding File 1**) and measure_SAnoblur(filename, sigma-1.0) (**Figure 1**).
   NOTE: These scripts quantify and adjust hue values to create a continuous hue scale from 0-139.5. The HSV values on OpenCV2 range from 0-179. The lightest green, which represents the least pain intensity, corresponds to the hue value of 39.5. Some red hues correspond to values between 0-10. Yellow and orange colors which correspond to hue values between 10-39.5 are not used by the pen tool. The red hue values from 0-10 are reassigned to 179 to correctly represent the most pain intensity. The hue scale ranges from 39.5-179 after this adjustment. Then, 39.5 is subtracted from each hue value so that the final scale ranges from 0-139.5.
2. Calculate and normalize the three PBD metrics by running the Python script titled quantifypain(filename) (**Supplementary Coding File 1**).
   1. The script calculates each metric as described below.
      1. PBD coverage: Divide the number of colored pixels by the total number of pixels available within the body diagram. The range for the number of colored pixels for females is 0 to 820,452 pixels (total pixels) and the range for males is 0 to 724,608 pixels (total pixels).
      2. PBD sum intensity: Add the hue values for all pixels in the body diagram. The range for the sum of hue values for females is 0 to 114,453,054 and the range for males is 0 to 101,082,816.
      3. PBD mean intensity: Divide the sum of all hue values by the total number of colored pixels.
   2. Use the script to normalize all PBD measures on a 0 to 100 scale by following calculations described below.
      1. PBD coverage: Multiply PBD coverage by 100.
      2. PBD sum: Divide PBD sum intensity by the maximum PBD sum intensity and multiply by 100. The maximum PBD sum intensity equals the total number of pixels in the body diagram multiplied by 139.5 (i.e., for females, it is 820,452 pixels multiplied by 139.5 which equals 114,453,054; for males, it is 724,608 pixels multiplied by 139.5 which equals 101,082,816).
      3. PBD mean: Divide PBD mean intensity by the maximum hue value of 139.5 and multiply by 100.
3. Repeat steps 4.1 and 4.2 to process each PBD (with extension .png) file. Compile the outputs in a spreadsheet to run further analyses.

Representative Results

The PBD mean, sum, and coverage uniquely provide information about pain responses not captured in other standardized pain scales. Between the two PBDs (**Figure 2A,B**), the mean pain intensity is identical (PBD mean = 79.6). An increased coverage and sum, however, reveals the greater spatial spread of pain and total pain intensity, respectively, that differentiate the two PBDs (**Figure 2B**). To accurately quantify pain using these metrics, researchers should avoid the following common PBD setup mistakes (**Figure 2C**). Excessively large pen thickness and extraneous elements outside the body outline, such as circling body regions or written descriptors will not be captured in the PBD processing. Similarly, a white pen used to remove color rather than the eraser tool will skew PBD metrics. Practice and reinforced instruction will empower patients to create accurate and quantifiable PBDs that reveal variability in pain intensity and distribution.

The PBD metrics were validated against the NRS, VAS, and MPQ (**Figure 3B**; **Supplementary Figure 2**) and scored high in usability (**Supplementary Figure 1** and **Supplementary Figure 2**).

PBD metrics correlated to standard pain metrics

The PBD metrics were correlated with the NRS, VAS, and MPQ for most patients (**Figure 3A**, **Supplementary Figure 1A,B**). In four of five patients, the PBD sum, coverage, and mean were correlated to their VAS and NRS (Spearman's correlation, r_s = 0.33-0.72, p < 0.004, **Supplementary Table 1**). For three out of five participants, PBD metrics were also significantly correlated with MPQ scores (Spearman's correlation, r_s = 0.38-0.53, p < 0.004, **Supplementary Table 1**). However, patient 4 did not show significant correlations between the PBD metrics and standard pain scores. We further characterized non-linear relationships between PBD and standard metrics using information theory analyses (**Supplementary Figure 2**).

PBD metrics avoid response anchoring and share mutual information with standard pain metrics

PBD metrics contained more information (i.e., entropy) than the NRS. Across patients, NRS contained less information (2.32 ± 0.37 bits) compared to VAS intensity, VAS unpleasantness, MPQ total, PBD sum, PBD coverage, and PBD mean (3.21 ± 0.49 bits, 3.20 ± 0.31 bits, 3.16 ± 0.23 bits, 3.06 ± 0.32 bits, 3.34 ± 0.16 bits, 3.22 ± 0.39 bits, respectively; **Supplementary Figure 2**). This was confirmed with a one-way repeated measures ANOVA ($F(4,1) = 12.10$, p < 0.05) and a Tukey's t-test for individual comparisons (all p < 0.05). This shows PBD metrics had less response anchoring than the NRS.

The PBD was further validated against established metrics by mutual information analyses (permutation testing, α=0.05). In four of five patients, PBD metrics significantly shared MI with the NRS, VAS intensity, VAS unpleasantness, and the MPQ (p < 0.05, **Figure 3B**). In contrast, patient 4's PBD metrics did not significantly share MI with established metrics. Since their NRS contained the least information across patients' (**Supplementary Figure 2**), this suggests the NRS failed to capture nuances in pain experience that were captured by the PBD. In all patients, the NRS shared significant MI with VAS intensity, VAS unpleasantness, and MPQ while the PBD sum shared MI with PBD coverage and PBD mean (p < 0.05, **Figure 3B**). Altogether, for most patients, the PBD metrics shared MI with established pain metrics.

PBDs were easy to use for most participants

In the study, four of the five patients found the PBD easy to use and to accurately reflect their pain (**Supplementary Table 2**). However, patient 4 reported that the PBD was difficult to use (5 on a 5-point Likert Scale). This is primarily because they have deep, visceral pain-which is not well-captured in a 2-dimensional (2D) PBD. While patients varied in their familiarity with PBDs (2.8 ± 1.2, range 1-4, 5-point Likert Scale), they all used comparable electronics daily (5.0 ± 0.0, 5-point Likert Scale) and found the PBD to be user-friendly (5.2 ± 0.4, range 5-6, 6-point Likert Scale).

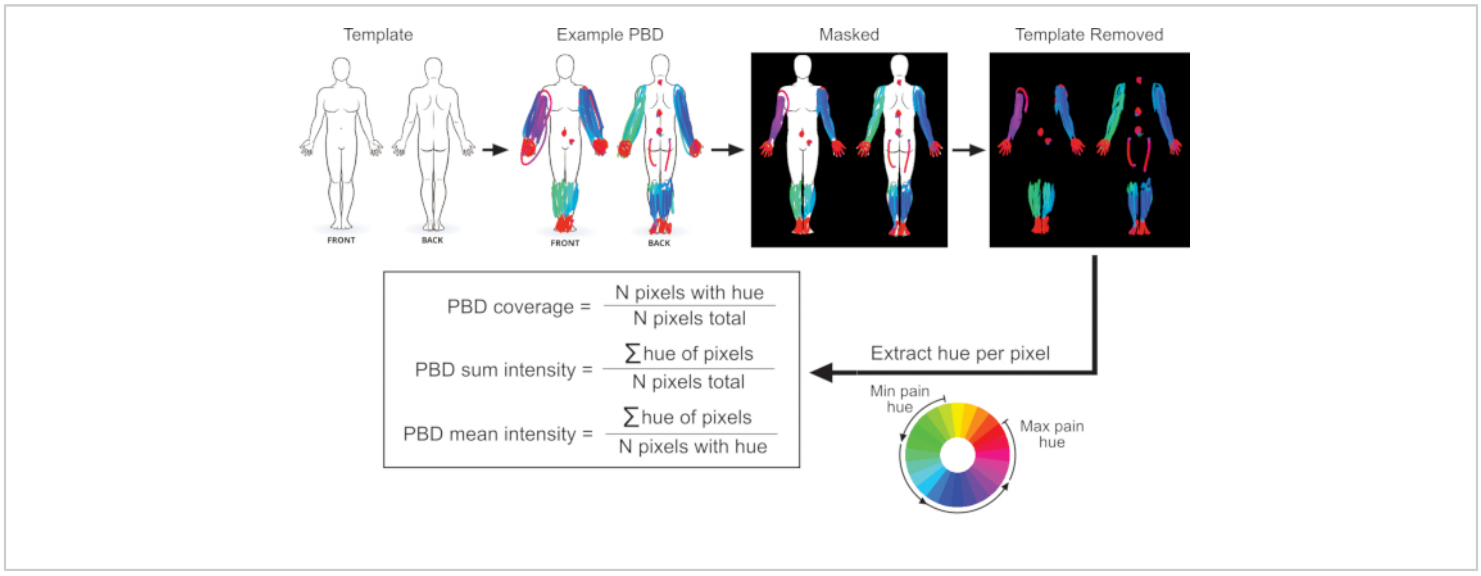

Figure 1. Pain body diagram (PBD) analysis workflow. Patients drew on blank PBD templates to represent the pain's location and intensity. Completed PBDs contained hues that ranged from green to blue to red, representing mild to moderate to severe pain regions, respectively. PBDs were masked to include only pixels within the body outline and then the template was removed to isolate only pixels containing hues. From the PBDs, PBD coverage (%), sum intensity (normalized to 0-100), and mean intensity (normalized to 0-100) were calculated. For PBD coverage, the number of colored pixels were first divided by the total number of pixels within the diagram (820,452 pixels for females, 724,608 pixels for males), then multiplied by 100. For PBD sum intensity, the hue values for all pixels in the body diagram were first summed (female range: 0-114,453,054; male range: 0-101,082,816). The sum was then divided by the maximum PBD sum intensity (females: 820,452 pixels multiplied by maximum hue value 139.5, males: 724,608 pixels by 139.5) and multiplied by 100. For PBD mean intensity, the sum of all hue values was divided by the total number of colored pixels, then normalized by dividing by the maximum hue value of 139.5. Please click here to view a larger version of this figure.

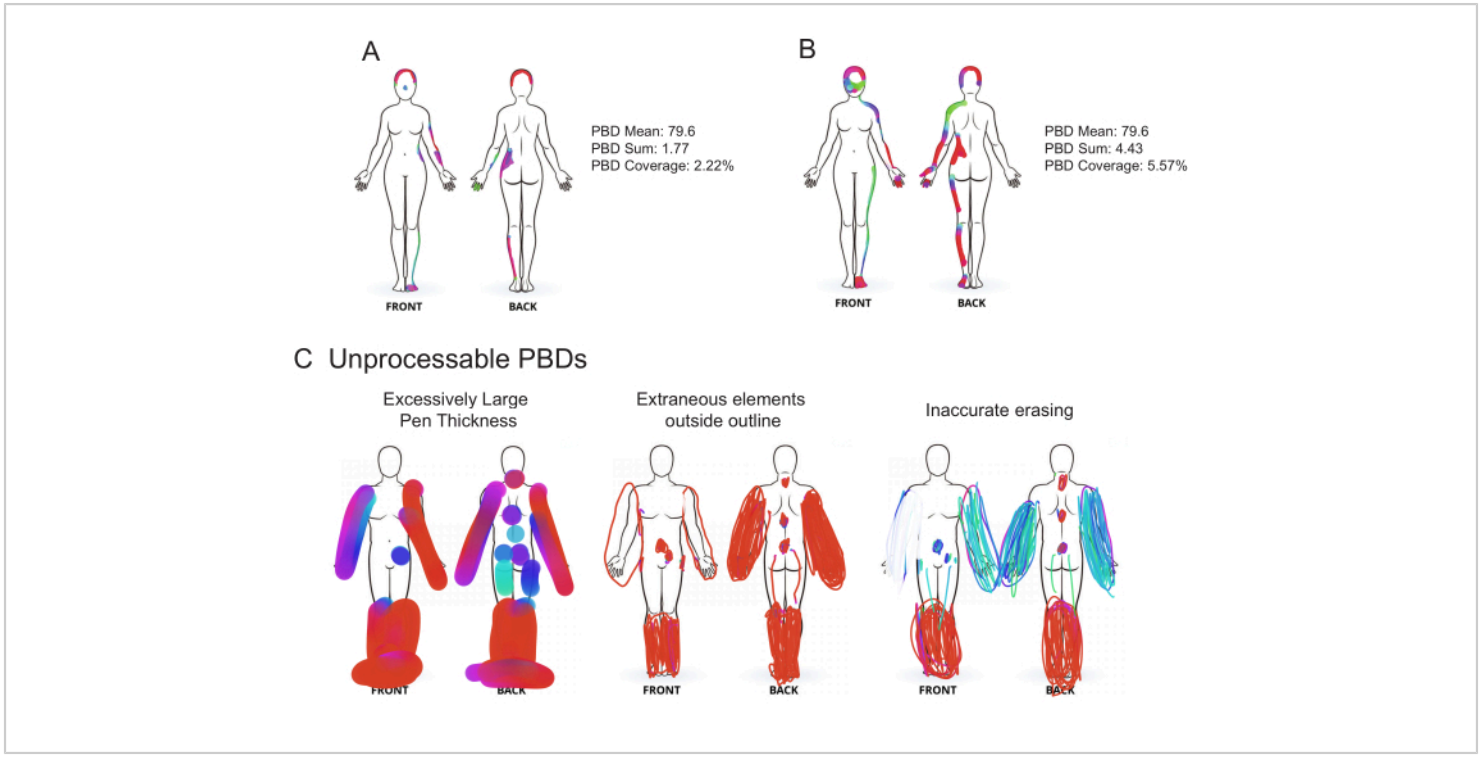

Figure 2. Representative PBDs showing examples of good and bad PBDs. (**A,B**) Good PBDs show the utility of calculating 3 pain metrics. (**C**) Bad PBD examples include excessively thick pen size, extraneous elements outside the body diagram, and inaccurate erasing. Please click here to view a larger version of this figure.

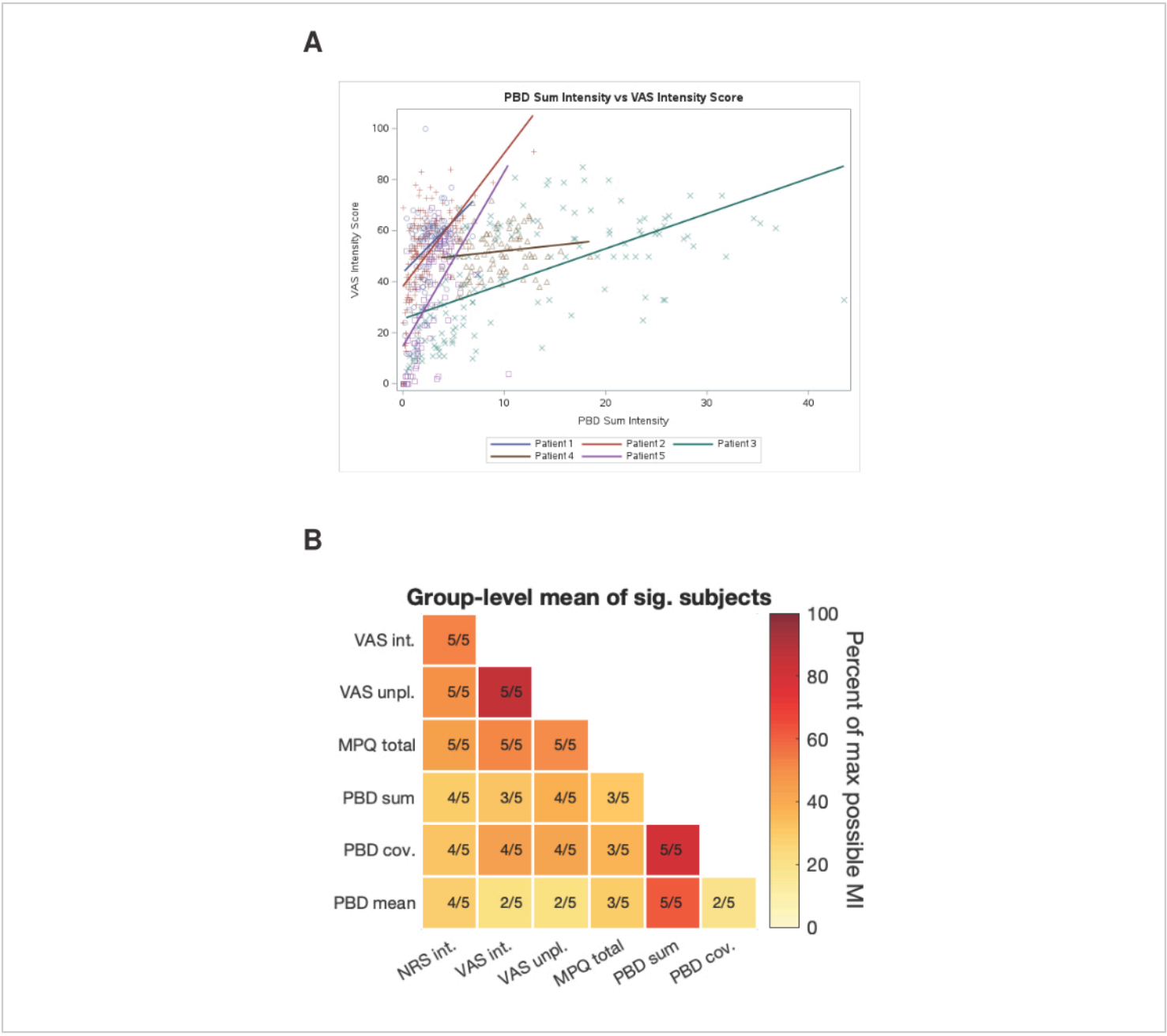

Figure 3. PBD metrics were validated against standard pain metrics via Spearman's correlation and mutual information analyses. (**A**) VAS intensity and PBD sum plotted with linear best-fit lines drawn for each patient. (**B**) Group-level data showing the mean mutual information (MI) between each pain metric, with MI indicated by color bar on the right. The text in each box represents the number of patients with statistically significant MI for a given pairwise comparison (e.g., 3/5 indicates 3 patients with significant values). MI is presented by the observed MI divided by the theoretical max MI. Abbreviations: NRS=numeric rating scale; VAS intensity = visual analog scale intensity; VAS unpl. = visual analog scale pain

unpleasantness, MPQ=short form McGill pain questionnaire 2; PBD=pain body diagram; PBD cov. = PBD coverage, MI = mutual information, sig. = significant. Please click here to view a larger version of this figure.

Supplementary Figure 1. PBD mean (**A**) and PBD coverage (**B**) plotted against VAS intensity with linear best-fit lines drawn for each patient. Abbreviations: VAS=visual analog scale; PBD=pain body diagram. Please click here to download this File.

Supplementary Figure 2. Entropy per pain metric across patients. On the group-level, NRS intensity had lower entropy than every other pain metric as shown by a repeated measures one-way ANOVA followed by Tukey's test post-hoc for specific comparisons * = $p < 0.05$, ** = $p < 0.001$. Abbreviations: NRS=numeric rating scale; VAS=visual analog scale; MPQ=McGill pain questionnaire; PBD=pain body diagram. Please click here to download this File.

Supplementary Table 1. Spearman's correlations between PBD metrics and self-reported standard pain measures. Spearman's correlation coefficients (rho) for three extracted PBD metrics against NRS, VAS, and MPQ pain measures. Abbreviations: NRS=numeric rating scale; VAS=visual analog scale; MPQ=McGill pain questionnaire; PBD=pain body diagram. Please click here to download this File.

Supplementary Table 2. Patient impressions of completing a PBD were revealed through PBD-specific and system usability scale-modified questions. The modified usability scale questions alternated in positive and negative statements and were ranked on a 5-point scale (1=strongly agree, 5=strongly disagree). Abbreviation: PBD=pain body diagram. Please click here to download this File.

Supplementary Coding File 1: Python script for PBD metrics. The annotated python code processes a pain body diagram PNG file and outputs PBD mean, coverage, and sum values for each file. The script also includes import statements to download the required packages for the program to run. Please click here to download this File.

Supplementary File 1: Supplementary file for methodological details. Please click here to download this File.

Discussion

Critical steps within the protocol

The key steps include: PBD setup, patient instruction, and pre-processing. For PBD setup, each gender specific PBD should visualize a front and back view[26], and be overlaid with an empty layer on an illustration application to isolate hue values. Furthermore, pen size must meet patients' illustration needs and hue gradients must be defined to quantitatively analyze PBDs. Patient instruction and understanding of the tool are fundamental for reliable data. Sufficient time should be allotted for participants to practice implementing the tool on the PBD. Use the teach-back method to confirm participant's understanding of tasks and surveys periodically during testing, approximately once every 10 PBDs. In order to keep track of individual PBDs, it is also a good idea to name each file with a unique title and timestamp after completion. Following data collection, each PBD metric could be extracted using Python[27] scripts (see **Supplementary Coding File 1**). The measures of PBD coverage, sum intensity, and mean intensity can be repeated before and after any treatment or intervention to track pain responses within patient. To extract these metrics, one researcher not directly involved in

data collection, should overlay black mask layers to isolate only colors drawn inside the body outline, then compute HSV pixel values using custom software code provided as **Supplementary File 1**.

Modifications and troubleshooting in the technique

Methodological steps were refined during the data collection of patient 1. These include allowing more time for patients to familiarize themselves with controlling the pressure sensitivity of the pen, correctly setting up body diagram layers for later masking and analysis, limiting the use of symbols or words on PBDs, and adjusting absolute pen pressure sensitivity according to each participant's strength and dexterity (though the transformation between relative pressure and hue remained constant). Patients were allowed to select their pen size to best represent their pain; however, selecting one fixed size may allow for better future inter-patient comparisons. In future iterations, prototyping a method that uses one color channel (e.g., red, green, or blue) and varying the lightness of the color based on pen pressure can minimize possible loss of precision when converting from RGB to HSV color space.

Limitations of the technique

PBDs require patients to have sufficient baseline motor strength and dexterity in at least one upper extremity with good fine motor ability in the fingers at a minimum to complete diagrams independently and to accurately translate their pain experience via pressure. While standard pain metrics such as NRS and MPQ can be entered on paper or a keyboard by an assistant through verbal communication, this modification with PBDs is not yet validated. PBDs also lack depth as a two-dimensional illustration. The level of detail in a three-dimensional body diagram has been qualitatively demonstrated to expand the communication of pain information[17]. Further characterizing the depth of pain can capture novel pain information not examined in scales such as the NRS, VAS, and MPQ. Body diagrams are not currently designed to capture more abstract somatization or deeper forms of pain. For instance, patient 4 self-reported that the pain location and pain intensity were not well characterized by the body diagram in the usability survey, as he felt they did not capture his internal neuropathic pain. Patient 5 often drew dotted lines in body diagrams to indicate heaviness within their body, which can confound metric calculations. Future PBDs iterations could be expanded to represent the somatization of pain or visceral pain in a quantifiable method. Finally, PBDs were analyzed in an N-of-1 framework, where nearly 100 separate PBDs were generated for each participant. Group-level analyses were not possible due to the small number of overall participants. Therefore, test-retest reliability could not be determined in this study since the responses to NRS scales face anchoring bias, suggesting the same NRS scores may not be equivalent to the same PBDs tested after the trial. Future research will be needed to evaluate PBD metrics in a group-wise analysis setting and the method's test-retest reliability in a larger sample.

Significance of the method with respect to existing methods

PBDs have been widely used in clinical and research settings to demonstrate a participant's pain intensity across their body[14, 15], yet this tool remained largely limited by its qualitative nature. While digital pain mapping has been used to longitudinally track chronic pain[16], patients lacked the ability to represent pain intensity and location in a combined, precise technique. This novel pressure-hue transformation incorporated with PBDs provides composite spatial and quantitative pain metrics that can be repeatedly measured and tracked across time to capture a participant's

pain experience. Here, three extracted PBD metrics that differentially reflected pain intensity and location within a patient, i.e., PBD coverage, sum intensity, and mean intensity, were demonstrated to carry high validity and concordance with standardized pain measures such as NRS intensity, VAS intensity, VAS unpleasantness, and MPQ. All PBD measures were correlated to the VAS and NRS scores in four out of five patients and significantly correlated to the MPQ in three out of five. Additionally, the information theory approach[28,29,30,31] revealed non-linear relationships that were not detected with more common statistical methods. In the study, four of five patients had significant MI between PBD measures and NRS, VAS intensity, VAS unpleasantness, and MPQ, demonstrating significant, but not total, overlap in information content. Thus, the PBD measures were highly concordant with standardized pain measures, yet PBD mean appeared to reflect a combination of intensity and location information that was not present in conventional pain metrics.

Future applications of this technique

The present results demonstrate that PBDs may be especially appropriate for patients who experience and quantify their pain on a non-linear scale. Similar to how verbal descriptors can provide another dimension for participants to evaluate pain, the PBDs provide a unique graphical and pressure-based interpretation of their pain. By implementing a novel pressure-hue transformation, body diagrams provide information on the location, spread, and regional variation in the intensity of pain, which to our knowledge, has not been demonstrated before. Together with neural data collected during any DBS trial, PBD metrics can be a powerful tool in localizing pain in different body regions to different brain regions and help inform mechanistic studies on pain signaling pathways. The pressure-hue transformation implemented in PBDs can be used in many clinical and research settings to analyze pain relief in response to treatment or compare pain over time. This method not only produces unique, visually intuitive diagrams to assess pain but also accurately captures a patient's experience beyond a singular numerical score.

Disclosures

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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