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**Applying Bodily Sensation Maps To Art-Elicited Emotions:
An Explorative Study**

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Abstract

Art is known to give rise to a large range of emotions in people. These emotions are associated with bodily sensations felt in various regions of the body and subjective feelings. The current study applies Bodily Sensation Maps (BSMs, Nummenmaa et al., 2014) as a tool to measure art-elicited emotions by charting bodily sensations onto a body map. Through a web survey, 90 participants viewed 36 new media visual artworks. After each artwork, they were asked (1) to point out the regions of their body in which they felt activity getting stronger or weaker, (2) to select, if appropriate, up to two primary emotion words being anger, disgust, fear, happiness, sadness or surprise, and (3) to rate the intensity of the subjective feeling on a continuous scale. By allowing two primary emotion words for each artwork, participants could report more complex emotions. Among complex emotions, bittersweetness, delight, despair, and repugnance occurred the most, and delight stands as the most frequently used. Results show that BSMs are a resourceful method to investigate simple and complex emotions elicited by art in terms of bodily sensations and subjective feelings. Interestingly, we found that art-elicited emotions were always characterized by increased activity in the head area. This study provides novel insights into the nature of art-elicited emotions and how they are experienced in the body, as well as how they are related to emotions in everyday life.

Keywords: Art, Bodily Sensation Maps, Subjective feelings, Embodiment, Emotions.

Applying Bodily Sensation Maps To Art-Elicited Emotions: An Explorative Study

Emotions

Emotions can be described as affective states that include physical and psychological changes (Ekman, 1970). While physical changes are related to autonomic responses in the body that occur as an emotion arises, psychological changes represent the qualitative experience of the emotion. Following the component process model of emotion, five components can be identified: the cognitive (appraisal), the neurophysiological (bodily sensations), and the motivational (action tendencies) as well as the components of motor expression (facial and vocal expressions) and subjective feeling (Scherer, 2005). The synchronized interplay of these components in response to an external or internal stimulus constitutes an emotion. In the process of emotion, the cognitive or appraisal component refers to the information processing of a stimulus event, and its evaluation. Besides, the stimulus event elicits physiological response patterns, such as feeling shivers, muscles relaxing or trembling and changes in respiration activity. The adaptive action tendencies (motivational component) and motor expression have a strong impact on the action that is chosen (i.e., fight or flight) as well as how the emotion is communicated (i.e., crying), respectively. The subjective feeling or experience is summarized in emotion words, “reflecting a unique experience of mental and bodily changes in the context of being confronted with a particular event” (Scherer, 2005 p.712). Hence, subjective feelings of an emotional episode are underpinned by patterns of the different components listed above.

Ekman (1970) asserts the existence of six psychologically primitive (i.e., basic) emotions: anger, disgust, fear, happiness, sadness, and surprise. They elicit biologically based response patterns, and they can fuse, merge altogether easily taking the shape of new complex emotions¹ (Ortony & Turner, 1990). Emotions elicited by art are no exception (Brown et al., 2011). Therefore, the present study will focus on how the two components of

¹ Nonbasic, or complex, emotions will be discussed further in the Methods section of this study.

the emotion, namely bodily sensations, and subjective feeling, are intertwined with each other in response to art (see Damasio & Carvalho, 2013; Russell, 2003).

Art-elicited emotions

According to Cupchick (2013), emotions in response to art can be divided into two reactions: the dimensional and the categorical. Whereas the former reactions are closely tied to bodily states of arousal elicited by an artwork, the latter pertains to primary emotions and “emphasizes spontaneity or empathetic reaction to art” (Pelowski et al., 2016 p. 13). With regard to the dimensional reaction, most philosophical aestheticians have claimed that visual arts “produce a variety of responses ranging from calm contemplation to “aesthetic emotion” in which physiological arousal is not included” (Konečni, 2015 p. 306). According to philosophical aesthetic theories, ‘refined’ or ‘aesthetic’ emotions are detached affective states that are different from everyday psycho-biological emotions for practical purposes (i.e., utilitarian emotions) (James, 1890; Ribot, 1987; Sully, 1892). Importantly, against this school of thought, we explicitly use the word ‘art-elicited’ instead of ‘aesthetic’ to move away from the traditional assumption that aesthetic emotions are only about beauty and enjoyment for their own sake (Sully, 1892) without accompanying bodily alteration (James, 1890). Whether experiencing artwork elicits a special class of emotions or not remains a matter of debate. Aware of this controversy on the nature of emotions elicited by art, we are open to the possibility that emotions felt during the artistic encounter can account for bodily changes and a wider range of subjective feelings so that emotions as responses to artworks may be merged altogether with emotions that deal with important events in our lives. ‘Art-elicited emotions’ used throughout this paper refers to the emotion provoked by a stimulus that is an artwork, without assuming they lack defining features of emotions such as bodily alterations or, in some cases, negative affect. The inclusion of negative affect marks a pivotal point for art theories. Art is able to evoke adverse reactions such as disgust, queasiness, or anger by mirroring the emotions expressed in an artwork (Freedberg & Gallese, 2007). Cooper and Silvia (2009, p. 113) claim indeed that “people appraise art in ways that evoke

hostile emotions, [...], in short, some art makes some people mad”. Again, Menninghaus et al. (2017) claim that arts do not reduce or erase the negative emotional responses.

The present study considers that all basic emotions, their nuances, and combinations can occur in art encounters, thus seeing the basic-emotion theories as eligible in the context of art (Juslin, 2013a). We made use of these theories in the present study to obtain descriptors for the emotional experience of the participants towards artworks although not inclusive of typical aesthetic feelings (Juslin, 2013b; Marković, 2010). We validated whether emotions arise in the same way in the body either when they are evoked by visual artworks as proposed in the present research, or by different stimuli used in previous studies.

Embodiment

Gallese (2001) propose that art can deploy *liberated embodied simulation*, whereby the human brain is assumed to map actions, emotions, and sensations onto the viewer’s sensory-motor and visceromotor neural representations through the immersive state that art can put the viewer into (Gallese, 2017; Rizzolatti et al., 1996). Noticeably, embodied empathetic feelings do not occur exclusively as a response to figurative artworks (Freedberg & Gallese, 2007). Bodily involvement and empathetic movements can be experienced also in nonfigurative artworks, where the viewers engage with the gestures of the artist. Hence, it is considered both figurative and nonfigurative artworks can evoke embodied simulations. Likewise, Johnson claims that “perception, imagination, and feeling are aligned with the bodily dimension” (1987, p. xxv), asserting that whenever a projection of selves and bodies into an artwork occurs, the embodiment follows. Artworks give rise to bodily movements in the viewer (cf. Brinck, 2018; Fuchs & Kochs, 2014) empathizing a relationship between emotional states and levels of physiological arousal of the viewer (Eskine, Kacinik & Prinz, 2012; van Klaveren, Ueding & Cox, 2019). Several studies found that artworks are able to elicit distinct movement patterns in the viewer, such as leaning posture and eye movement which are subtle indicators of people’s attunement to the environment (Buswell, 1935; Ganczarek et al., 2015; Kapoula et al., 2011). These subtle movements are dynamically interrelated with the subjective feeling in response to art. Thus, this interplay is modulated

by cognitive and emotional processes underlying the experience of a work of art (cf. Cova & Deonna, 2014; Leder et al., 2004; Pelowski et al., 2017). Consequently, art-elicited emotions harmonize somatosensory, emotional, and motor systems, and eventually, result in what Esrock (2018) terms ‘transomatizations’. Transomatizations are empathetic embodied processes in which viewers (re-)evaluate the bodily component in light of the artwork. In artistic encounters, not only the viewer’s body and mind are engaged in the emotion felt as in any other emotional event, but also in the artwork. “Viewers can experience themselves, via their bodies, within the artwork, or containing the artwork. Where emotion is understood to have a bodily component, [...] emotions, too, can be felt in these shifts of embodied experience” (Esrock, 2018, p. 189). While looking at art, viewers may fall into a state of consciousness connected to emotion. These moments are not passive nor detached: they occur when the body and mind are engaged in a voluntary effort (Csikszentmihalyi, 1990).

To conclude, emotions provoked by artworks can give rise to an interplay of bodily sensations and a variety of subjective feelings. Art elicits physical changes in the body which are an important defining feature of emotions in general, such as heat in the face, tightness in the jaw or shoulders, shivers down the spine. That is, where and how happiness feels happy, or anger feels angry when looking at an artwork. The self-awareness of internal bodily states can specify sensory information of the affective process (Jung et al., 2017). Therefore, it should not be assumed that art-elicited emotions are only cognitive or detached by nature as suggested by traditional theories of philosophical aesthetics but are perceived and evaluated in the body. Looking at art has the potential to give rise to emotions that are subjective and embodied (see, e.g., Esrock, 2010; Esrock, 2018; Gernot, Pelowski, & Leder, 2018). To grasp the relationship between art and emotions in different facets, we investigated the embodied nature of art-elicited emotions by validating a new way to chart them (Nummenmaa et al., 2014).

Bodily Sensation Maps (BSMs)

Nummenmaa and colleagues (2014) have designed a self-report software called emBODY. This tool allows people to highlight body regions that are activated or deactivated

during emotional arousal on an empty body silhouette. It demonstrates how bodily sensations in emotional contexts are spatially distributed across the body in specific and consistent patterns (Jung et al., 2017). Based on this topographical tool, heatmaps known as Bodily Sensation Maps (BSMs) can be calculated. The BSMs have been used extensively in multiple studies including different scenarios and various populations (Nummenmaa et al., 2018; see also Novembre et al., 2019; Volynets et al., 2019). They can identify a broad spectrum of emotions, ranging from happiness, interest, guilt, disgust to embarrassment, among others. It reinforces the idea of using new biomarkers - such as the BSMs - to detect art's ability to move people figuratively and literally. Therefore, BSMs constitute a research tool that affords the nature of viewers' emotions in response to art. To the best of our knowledge, the topographic tool has not yet been applied to investigate art-elicited emotions. Due to art's particular potential for induction of emotional responses, it can encourage both introspective processes (Pelowski et al. 2017) and interoceptive processes (Esrock, 2018) in viewers. The latter processes help the viewers to read their own bodies as material for transomatization. Interoception plays an important role in the accuracy of "visible presentation [such as BSMs] of affective perception and its link with physiological states" (Jung et al. 2017 p.11).

The present study

The present study investigated whether BSMs constitute a valid instrument to measure a person's emotions in the art domain, without being exclusively limited to positive aesthetic-specific evaluations of pleasure, enjoyment, or fascination. To this end, we used BSMs as a means to detect participants' bodily sensations related to art-elicited emotions while viewing 36 artistic stimuli. After each artwork, participants were asked to point out the regions of their body in which they felt activity getting stronger or weaker using the BSMs (i.e., activations and deactivations), then to express their subjective feelings by selecting up to two primary emotion words (anger, disgust, fear, happiness, sadness, and surprise), and lastly to rate the intensity of the subjective feeling on a continuous scale. Concretely, we addressed the following research questions: (1) To what extent do the artworks give rise to

bodily sensations in the participants? To answer this, we analyzed the counts on the BSMs to assess the location and frequency of activations and deactivations in the body upon viewing the selected new media (i.e.: digital, Quaranta, 2014) paintings. (2) To what extent do the artworks elicit subjective feelings in the participants (emotion words and their rated intensity)? (3) How are bodily sensations and subjective feelings related in art-elicited emotions? Finally, this study explores the application of BSMs in an artistic context by comparing our findings with previous literature (García-Magariño, Chittaro, & Plaza, 2018; Jung et al., 2017; Nummenmaa et al., 2018; Novembre et al., 2019). This leads to a final, exploratory, and qualitative research question: (4) Are the topographical depiction of emotional responses in the body generated in previous studies similar to the ones evoked by new media visual artworks?

Methods

Participants

Ninety-two first-year Psychology students at the University of Groningen participated in the experiment. They were rewarded with course credits upon completion of the survey. Only participants with normal vision (with or without optical adjustments) were invited to participate in the experiment. Participants were asked to perform the experiment without physical (e.g., other people around), physiological (e.g., being hungry or tired) or psychological (e.g., being more emotional than usual) distractions as these might interfere with their emotional state and perception of their body and might have an impact on the performance of the task. Two participants were excluded from the analysis as they responded respectively only to 16.66% and 12.04% of the experiment. The final sample used for the analysis, therefore, consisted of 90 participants (29 males, 61 females) with an average age of 20 years (from a minimum of 17 to a maximum of 24, $SD=1.56$). The study was approved by the Ethics Committee Psychology of the University of Groningen (research code: PSY-1920-S-0250) and was conducted according to the Dutch ethical standards for scientific research.

Materials

Artworks

A careful selection of 36 new media artworks was carried out. The selection was limited to new media figurative paintings as the digital format allows participants to appreciate the artworks as they were meant to be experienced, that is on a screen.

Preliminary informal polls and sorting among the authors of the paper have been conducted according to the following criteria: the variety of figurative artistic styles, equal presence of female and male figures, dimension, image aspect ratio, and variety of potential elicited emotions. Firstly, a broad selection of approximately 200 figurative (or representational) artworks has been collected through digital art gallery websites, namely ArtStation (<https://www.artstation.com/>) and DeviantArt (<https://www.deviantart.com/>). Secondly, the collection of stimuli has been narrowed down to 70 stimuli. Ten artworks were chosen for each basic emotion category (anger, disgust, fear, happiness, sadness, surprise); and ten ones aiming at eliciting a neutral state. The use of figurative paintings ensured that the emotions portrayed in the artworks could be read more easily by the participants (Konečni, 2015). Lastly, the stimuli have been filtered by artists and their respective styles (realism, impressionism, comics, surrealism, cartoon, manga). The artists among the collection who featured artworks in different formats (portrait, landscape, and square pictures), displaying diverse emotions and with a variety of figurative content (humans and non-human) were then chosen as the final selection. In fact, ten stimuli of the 36 used in the present study (stimulus 6, 7, 8, 9, 14, 15 17, 18, 21, and 29) represent as main content objects or landscapes (n=6) and monsters (n=4). The remaining stimuli (i.e.: 26 out of 36), on the other hand, depict human bodies and faces. Therefore, artworks with recognizable images and objects were then selected purposely for this study. The understandable and prototypical features of figurative paintings usually induce emotional responses without difficulty in laypersons (O'Hare, 1976; Cupchik & Gebotys, 1988; Martindale, Moore, & Borkum, 1990; Hekkert & van Wieringen, 1996; Millis, 2001). We were thus able to establish a preconceived notion of the general emotion each artwork would convey (Hayn-Leichsenring, 2017;

Wagner et al., 2014). Once the final assortment was decided, the permission of use under the Creative Commons (CC) license for such art pieces was obtained from each of the artists. Six artworks of six different artists each have been randomly used as artistic stimuli for the current study (see Appendix A and online supplemental material for detailed information).

Bodily sensations: body regions and their activity

The experiment was generated online using Qualtrics software so that each participant could take part in the experiment on their computer.

To replicate the emBODY tool by the Nummenmaa Lab (<https://emotion.utu.fi/>), the Heat Map Questions have been set up to gather information on the locations in which people felt activity in their bodies. Body activity was divided into two categories: (1) activations in the body (or activity getting “stronger”, such as heart pounding, flush in the face, muscles tensing, etc.); (2) deactivations in the body (or activity getting “weaker”, for instance, feeling weak limbs, getting pale, light-headed, numb, feeling faint and woozy body parts). These activities can be more or less intense depending on the emotional event. For this reason, participants could click up to ten times to indicate the respective parts of the body. For it to be as close as possible to emBODY, the same human body silhouette image (265 × 620 pixels) and instructions have been used. We adapted the instructions by referring to ‘point’ instead of painting and coloring and specific guidelines for the heat map question were added (i.e., “*You can click up to 10 times. Try to be the more accurate as possible. If necessary, use more clicks to stress a particular zone where the feeling is more intense.*”).

The heat maps provide us with coordinates for each selected click-point. Participants were let free to leave the body silhouettes blank, if appropriate. Moreover, to further investigate bodily patterns of sensation, we defined nine customized regions within the silhouettes (head, face, neck, upper limbs, hands, chest, abdomen, legs, feet) and reported the number of respondents who click on each of them. Nevertheless, during the analysis, following the example of previous literature (see Novembre et al., 2019), we combined the categories into five to facilitate the analysis. The final bodily regions are the head, upper limbs, chest, abdomen, and lower limbs.

Emotion words: To describe the type of subjective feeling and its intensity

In addition to the heatmaps, we assessed participants' subjective feelings by selecting emotion words (happiness, surprise, anger, fear, disgust, or sadness) and rating their intensities in relation to the bodily sensations.

Only these primary universal emotion words were provided to the participants, for three reasons: (i) to use familiar terms commonly used in emotional experiences (Prinz, 2004), (ii) to ease the categorization labeling of the BSMs during the analysis, and (iii) to retrace the theoretical background and methodology used by Nummenmaa et al. (2014). To account for the possibility that participants did not experience a particular subjective feeling regarding a specific artwork, not responding to the question was also an option. In this case, the subjective feeling was interpreted as neutral. Participants could combine up to two basic emotion words indicating a more complex subjective feeling if needed (see Table 1). Four combinations of emotion words that most frequently occurred have been analyzed in this study: bittersweetness, delight, despair, and repugnance. The categories for these emotion words have been based on Plutchik's emotion wheel (1980) and Ekman's universal emotions (1970). However, we adopted an elaboration of Plutchik's emotion wheel revised by TenHouten (2013).

Table 1

Dyads or complex emotions (compositions of two emotion words) (Plutchik, 1991; TenHouten, 2013).

	Anger	Disgust	Fear	Happiness	Sadness	Surprise
Anger	Anger	Contempt	Frozenness	Pride	Envy	Outrage
Disgust	Contempt	Disgust	Repugnance	Morbidness	Remorse	Unbelief
Fear	Frozenness	Repugnance	Fear	Guilt	Despair	Awe
Happiness	Pride	Morbidness	Guilt	Happiness	Bittersweet.	Delight
Sadness	Envy	Remorse	Despair	Bittersweet.	Sadness	Disapproval
Surprise	Outrage	Unbelief	Awe	Delight	Disapproval	Surprise

Note. Bittersweet. = Bittersweetness.

According to Plutchik (1980), the combination of fear and disgust results in shame. This formulation would be fair if one would interpret shame just as a feeling that -per definition- is associated with negative thoughts and discomfort (Tracy & Robins, 2007). Nonetheless, shame brings with it cultural considerations, and, in western cultures, it is usually associated with embarrassment or prudishness (Russell, 1991). We think it would be more appropriate, then, to embrace the idea that the combination of fear and disgust is repugnance (TenHouten, 2013, p. 18), which seems to be also coherent in the context of artistic experiences (García, 2019). By doing so, the study explores art-elicited emotions beyond the traditional categories of pleasure or beauty.

Procedure

From the beginning, the participants were fully informed of the research's purpose. It was explained to them that the study involved questions about the feelings they perceive in their body in response to artworks. Moreover, participants were provided with an information form for further details about the procedure. Importantly, it was clearly stated in the information form and the instructions for the experiment that participants will look at artworks. Therefore, we expected that participants anticipating artworks engaged in artistic experience (Hayn-Leichsenring, 2017). Subsequently, a check to ensure their pre-affective state has been conducted. This go/no-go measure functioned as a screening instrument. Subjects with second thoughts about their emotional pre-condition were asked to participate in the experiment at a more suitable time. Moreover, this brief check also worked as an emotional scan. Doing this before the stimuli display can prevent emotional hijacking (Boyer, 2011). Besides, participants are more self-conscious and convey the emotional attitude they want to convey. Upon agreement to participate, the online experiment started. Demographic questions (age, gender, and whether they are native English speakers or not) were asked first, followed by the task instructions and a step-by-step sample of the trial serving as a tutorial. Once the participant felt ready, the experimental trials started.

Figure 1*Experimental procedure*

Figure 1 shows step by step the trial's procedure as follows:

- 1) Each new media artwork was randomly displayed on the screen for 15 seconds.
- 2) At the end of each observation, the participant was asked to indicate the regions and intensities of bodily sensations by clicking up to ten times on two empty body silhouettes. They could point out body regions in which activations and deactivations were taking place (in the first and second silhouette, respectively).
- 3) After this task, the participant selected up to two emotion words within the cluster of the six basic emotions to label that bodily sensation. Sliders were used as a more interactive and intuitive way to quantify the intensity of the emotions. Rather than simply picking an emotion word and selecting its intensity on a scale point, respondents could use a slider handle to indicate the intensity level of the emotion. Additional labels about the intensity range of emotions helped participants to find the appropriate answer (see Figure 1). Participants were provided with instructions and information form that cleared out they should choose the closest option of emotion word(s) to label the bodily sensations they reported in the BSMs and that no slider selection was considered as a response of nothing special, hence a neutral state. While

the selection of two sliders was interpreted a posteriori in the analysis as a complex emotion derived from the combination of the two basic emotions (see Table 1). The participants could choose a maximum of 2 sliders to combine emotions. For instance, if an artwork conveyed them a pleasant emotion, they could: use the most appropriate slider for the basic emotion they felt (e.g.: only happiness) and drag the pointer to the desired amount; or drag the pointer of two sliders (e.g.: happiness and surprise, as shown in Figure 1) so that the respondents could create the closer combination to their current subjective feeling (e.g.: delight).

The entire experiment lasted 38.2 minutes on average (SD= 19.7). We excluded only one participant from these descriptive statistics since their response time of 20 hours stands as an outlier. We presume the participant took a break and resumed the experiment the day after it without closing the tab to prevent the loss of progress. At the end of the experiment, participants were thanked for their time and then provided with a debriefing form to emphasize the importance of their participation.

Data preprocessing and analysis

Data preprocessing was carried out using customized 'COUNTIFS' scripts in Excel (Microsoft 365, v. 2016). Based on the raw dataset, we identified patterns of bodily sensations by dividing the body silhouettes' coordinates into five regions of interest (ROIs). Body regions are shown in Figure 2.

They allowed us to use accurate frequencies instead of the cartesian coordinates (i.e., xy-coordinates of all points in the image) for our analysis. Coordinates and frequencies were discerned into 22 discrete emotional categories (namely, the six basic emotions, the neutral state, and the 15 dyadic states) to ease the computation of BSMs.

Figure 2*Regions of interests (ROIs) in the body defined by pixel-point coordinates*

Note. The ROIs identified within the silhouette are (from top to bottom): head, chest, abdomen, upper limbs (shoulders, arms, and hands), lower limbs (legs and feet). For more information, see ‘Bodily Regions COORDINATES.xlsx’ in the online supplemental material.

Art-elicited bodily sensations

First, a frequency table was created to preliminarily evaluate which of the defined body regions were activated or deactivated the most for each artistic stimulus across all 90 participants (see Table 1B and Table 2B in Appendix B). Then, cross-tabulations between the counts of both activations and deactivations of body regions and stimuli were generated. Finally, to formally assess the association between bodily sensations in terms of activations and deactivations and the artworks, a chi-square test was performed to check the statistical significance of such crosstabs.

Art-elicited subjective feelings

We used data counts (see ‘Frequencies (.xlsx)’ file of the online supplemental material accompanying the article for full access to the data) to gain information about the dominant subjective feelings elicited by each artwork. In this way, we could compare the frequencies of reported emotion words and the rated intensity for each artwork. Among the complex emotions only repugnance, despair, bittersweetness, and delight have been further explored.

These combinations had an occurrence rate greater than 5% in the responses given throughout the entire survey. Respectively, they constitute the 7.10%, 7.41%, 5.49%, and 11.85% of all the responses concerning the subjective feelings reported by the participants as reported in Figure 3. The remaining dyads (pride, remorse, unbelief, guilt, disapproval, frozenness, envy, morbidness, outrage, and awe) singularly occurred with a slim rate, ranging from a minimum of 0.65% (pride) to a maximum of 3.53% (contempt).

In this experiment, participants could rate the intensity of basic emotions by positioning a slider on a 0-100 scale. The combination of two basic subjective feelings was interpreted as a new complex one. To assess the intensity of the complex subjective feeling, the square-root function on the sum of two squares has been computed. That is, we calculated the magnitude of the vector in Euclidean coordinates, from (0, 0) to (x, y), where x and y are the intensity scores (i.e.: coordinates) of the two basic subjective feelings as components of a complex emotion. By doing so, the intensity of the subjective feeling of a complex emotion was defined as the length of the resultant vector of the combination.

Figure 3

Percentages of occurrence of combinations of subjective feelings

Note. The chart shows the percentage (on the vertical axis) of the combinations of subjective feelings (on the horizontal axis) across participants among the 36 stimuli. The line sets a threshold under which combinations of subjective feelings were not further examined in the present study due to their very low presence in the experiment.

Finally, we normalized all individual scores so that the magnitude of the subjective feeling could range from 0 to 1. In other words, each intensity score of the subjective feelings has been divided by the square root of the maximum magnitude achievable². A subjective feeling of a primary emotion could reach a maximum of 0.71, and the highest intensity value for a complex emotion was 1. Intensity values were studied through histogram shape analysis (i.e., skewness and kurtosis).

Art-elicited emotions: Combining bodily sensations and subjective feelings

No consistent normal distribution was observed in the data. Hence, non-parametric statistics were used. To assess significant activations and deactivations, in each body region of the emotion-specific BSMs, One-Sample Wilcoxon tests against zero were performed. Moreover, pairwise comparisons between BSMs for each subjective feeling and the neutral state were carried out with the Wilcoxon matched-pair signed-rank test. Counts for each body region in relation to a specific subjective feeling for each stimulus were tested against the counts for the neutral state, adding up to ten comparisons (i.e., five comparisons for activations in the body and five for deactivations) by the final ten selected emotion words excluding the neutral state.

In all the Wilcoxon analyses, family-wise error (FWE) correction was used to handle false positives due to multiple comparisons and repeated testing. Hence, to obtain a corrected type I error of $p < .05$ for the whole body was corrected by exact-significance. Furthermore, to assess the existence of a relationship between bodily sensations and subjective feelings in art-elicited emotions, a chi-square was performed for both body activations and deactivations and emotion words.

Topographical depictions of art-elicited emotions

We adapted Nummenmaa and colleagues' methodology (2014) to our dataset by recreating BSMs based on the data collected during the web survey. The xy-coordinates of all points per emotion were plotted into the original silhouette image via Power Map, a 3-D

² The highest value on the intensity scale is 100. To normalize the intensity scores, we divided each of them and the vector units of complex subjective feelings by $\sqrt{100^2 + 100^2}$

spatial visualization add-in fully integrated into all versions of Excel 2016 for Windows. We also reproduced the color scales used in the emBODY software. In the case of highly intense agglomerations of point, the extreme colors turn to white. Click-points outside the body silhouette were masked out as per protocol (Nummenmaa et al., 2014). This way we attained a visual representation at the population level for subjective feelings of primary and complex emotions as well as of the neutral state. This was especially helpful in gaining insights into how emotions were embodied across artworks. Coordinates and their topographical representations are available as online supplemental material in a dedicated folder entitled 'BSMs'.

Hierarchical Clustering

Chi-square values between sets of frequencies body activity for each art-elicited emotion were plotted into a proximity matrix, proceeded by hierarchical cluster analysis.

This agglomerative procedure with complete linkage ('Furthest Neighbor' method in SPSS) was run to test how similar or different the art-elicited emotions in terms of their bodily responses were. It provided us with a dendrogram to compare with the one obtained by Nummenmaa et al. in their original paper (2014). In our sample, we aimed at replicating their results and relate them to testing commonalities across BSMs' clusters of emotion.

Results

Relationship between bodily sensations and artworks

We first investigated the potential association between bodily sensations in terms of activations and deactivations and artistic stimuli presented in the experiment. To achieve that, a cross-tabulation analysis was used (see Table 1B and Table 2B in Appendix B). Considerably more points were collected from the activation maps (9998 points) compared to the deactivation maps (6852 points). Conceivably, this indicates that activity getting stronger in the body is perceived more easily than activity getting weaker. Interestingly, both activation and deactivation occurred with a certain region-specificity. The former was mostly observed in the head, whereas the latter was generally limited to the lower limbs (see Table 2).

Table 2*Summary table for frequencies of activations and deactivations in the body*

Type of body	Body Regions					Total
activity	Head	Chest	Abdomen	Lower Limbs	Upper Limbs	Counts
Activation	3128	2340	1640	879	2011	9998
Deactivation	553	758	892	2806	1843	6852

The highest frequency of activations and deactivations were recorded for Stimulus 23 (347 points) and 18 (226 points), respectively, whereas the lowest frequency of activations and deactivations were detected for Stimulus 9 (198 points) and Stimulus 7 (139 points), respectively. Two chi-square tests were performed testing against the following null hypotheses: (1) *Stimuli* are not associated with *Activations* of body regions, and (2) *Stimuli* are not associated with *Deactivations* of body regions (see Table 1C and Table 3C in Appendix C). Stimuli and activations of body regions showed a significant ($\chi^2(4) = 1223.288, p < .001$), although rather weak association according to Cramer's V test of the strength of association ($V = 0.175$). Thus, the first null hypothesis can be safely rejected. The second null hypothesis can also be rejected as the association with deactivations of body regions is again weak ($V = 0.117$) but reliable ($\chi^2(4) = 377.392, p < .001$).

Relationship between subjective feelings and artworks

A preliminary analysis was performed to determine the frequencies of specific subjective feelings evoked by the artworks in the 3240 trials of our experiment (36 stimuli for each of the 90 participants) (see Table 3B and Table 4B of Appendix B). *Delight* was the most frequent emotion word as it was selected 384 times, whereas the least chosen was *Anger* (55 times). In general, participants chose more frequently to combine emotion words rather than pick only one, suggesting that visual art provokes subjective feelings of complex emotions in people. Additionally, *Delight* was elicited in 35 (out of 36) stimuli, whereas *Happiness* (the second most selected emotion words) occurred only in 28 stimuli. Stimulus 7 (see Appendix A) generated *Repugnance* in 40% of the participants (36 out of 90), which indicates that certain artworks consistently evoke the same subjective feelings.

Figure 4

Histograms of standardized intensity scores for each subjective feeling

Note. The x-axis marks and labels with the standardized intensity values from the dataset, while the y-axis for counting data values.

Nevertheless, only eight stimuli had a rate of agreement greater than 30%, implying that there was a certain degree of subjectivity of the art-elicited emotions in terms of subjective feelings. As Figure 4 shows, the reported intensity also varied across people (see also Table 5B of Appendix B).

Overall, it never exceeded a mean value of 0.36, thereby being always rather weak. However, the values range is fairly wide, spanning from a minimum of 0.001 for *Sadness* to a maximum of 0.749 for *Delight*. According to the mean intensity, *Delight* was the most intense emotion in terms of subjective feeling, whereas *Anger* was the least intense one.

An exploratory data analysis (EDA, Komorowski et al., 2016) has been conducted to yield information about the distributions of intensities using skewness and kurtosis constraints (Nuzzo, 2019).

Data observed for subjective feelings of primary and complex emotions are characterized by non-symmetric and non-identical distributions (see Table 3). *Bittersweetness*, *Delight*, and *Surprise* have a closer-to-normal distribution of intensities and outliers within it.

Table 3

Descriptive statistics of each emotion, the last column shows the overall values

		Anger	Disgust	Fear	Happ.	Sad.	Surp.	Bitter.	Delight	Despair	Repug.	Overall
N	Valid	18	30	25	28	28	33	28	35	29	27	281
Median		.140	.180	.200	.215	.225	.230	.315	.380	.350	.370	.259
Std.												
Deviation		.0962	.107	.153	.103	.149	.120	.120	.125	.103	.128	.139
Skewness		.450	1.305	1.057	.212	.874	.826	.294	.617	-.265	-.058	.455
Std. Error of												
Skewness		.536	.427	.464	.441	.441	.409	.441	.398	.434	.448	.145
Kurtosis		-1.157	3.120	1.203	-.462	.403	1.359	.141	.818	-.919	-.922	-.120
Std. Error of												
Kurtosis		1.038	.833	.902	.858	.858	.798	.858	.778	.845	.872	.290

Note. Happ. = Happiness; Sad. = Sadness; Surp. = Surprise; Bitter. = Bittersweetness.

Repug. = Repugnance

Anger's negative kurtosis value shows a platykurtic distribution, that is slightly flatter than normal. Both *Fear* and *Disgust* are characterized by a tall right-skewed distribution, outside the range of normality (Hair et al., 2017). Besides, they both also show a skewness greater than 1, which reveals the presence of a wide left shoulder in the distribution indicating a large portion of weak intensity values. Furthermore, an EDA was performed using the medians as a measure of central tendency. The positional averages of *Delight* and *Repugnance* are very close (see Table 4), with the highest values of average intensity. Conversely, *Anger* showed the lowest values of both average intensity and standard deviation, indicating a small dispersion of values. Instead, *Sadness* was characterized by the highest level of dispersion in intensity. A close-to-normal distribution can be observed when averaging the intensity of emotions across all affective states and stimuli. Such distribution has a low propensity for producing outliers, according to the cutoff values of skewness and kurtosis described by Westfall (2014).

Art-elicited emotion-specific bodily sensation maps

The characteristics of art-elicited emotions in terms of bodily sensations have been first explored using a chi-square test of independence. Specifically, this test investigates the

relation between art-elicited emotions and (de)activated body regions (see Table 5C and Table 7C in Appendix C).

Emotion showed a significant relation with both *Activations* (χ^2 (40, N = 7336) = 305.370, $p < .001$) and *Deactivations* (χ^2 (40, N = 4896) = 176.176, $p < .001$), indicating that unique patterns of bodily sensations are associated with specific art-elicited emotions.

Table 4

Color-coded table summary of the p-values (2-tailed) obtained by Wilcoxon tests against the neutral state with exact significance correction.

Subjective feeling	Body activity	Body Regions				
		Head	Chest	Abdomen	L_Limbs	U_Limbs
<i>Anger</i>	Activation	0.138	0.061	0.079	0.688	0.288
	Deactiv.	0.922	0.567	0.648	0.010	0.019
<i>Disgust</i>	Activation	0.409	0.087	0.672	0.724	0.626
	Deactiv.	0.946	0.448	0.615	0.053	0.280
<i>Fear</i>	Activation	0.752	0.625	0.547	0.129	0.618
	Deactiv.	0.616	0.697	0.561	0.615	0.209
<i>Happiness</i>	Activation	0.072	0.002	0.001	0.005	0.005
	Deactiv.	0.003	0.054	0.032	0.019	0.026
<i>Sadness</i>	Activation	0.975	0.143	0.306	0.598	0.304
	Deactiv.	0.127	0.358	0.087	0.271	0.709
<i>Surprise</i>	Activation	0.273	0.142	0.841	0.267	0.175
	Deactiv.	0.069	0.034	0.111	0.624	0.576
<i>Bittersweetness</i>	Activation	0.808	0.214	0.025	0.167	0.361
	Deactiv.	0.284	0.898	0.389	0.395	0.288
<i>Delight</i>	Activation	0.001	0.000	0.000	0.007	0.001
	Deactiv.	0.075	0.065	0.001	0.000	0.000
<i>Despair</i>	Activation	0.180	0.006	0.012	0.001	0.002
	Deactiv.	0.070	0.011	0.010	0.076	0.077
<i>Repugnance</i>	Activation	0.904	0.382	0.027	0.058	0.212
	Deactiv.	0.048	0.058	0.028	0.517	0.292

Note. The green (light gray) cells indicate statistically significant different body activity from the neutral state, while red (dark gray) cells show no statistically significant differences.

L_Limbs = Lower Limbs; U_Limbs = Upper Limbs; Deactiv. = Deactivations.

A closer examination of the body regions that are (de)activated showed that activation arises mainly on the head and often on the chest, whereas deactivation is more likely to occur on the lower and upper limbs. In the light of this finding, a control analysis of frequencies has been conducted to ensure the prominent activations in the head and chest are not related to what is depicted in the stimuli selection (human figures or miscellaneous contents, see Appendix F for detailed information). It revealed that activations at the level of the head are not typical only of stimuli picturing human faces or body parts as it can be similarly found in responses to stimuli containing food, landscapes, and monsters. Nonetheless, stimuli depicting humans (especially half-length portraits) seem to elicit more distinguishable bodily activations in the upper part of the body and better discerned from the deactivations in the lower limbs, possibly suggesting a mirroring of embodied sensations (Gallese, 2006).

Figure 5

Dendrogram of Emotions using Complete Linkage

Note. The dendrogram shows a hierarchical structure of the similarity between bodily topographies of art-elicited emotions. Each emotion took into analysis constitutes its own cluster (N=11) numbered from 1 (case of Anger) to 11 (case of Surprise). See Appendix E for detailed information.

Disgust, *Fear*, and *Sadness* were the only art-elicited emotions that did not show a statistically significant difference from the neutral state in any of the body regions, as analyzed with a Wilcoxon test (see Appendix D). *Anger* is characterized by a significant difference in the upper and lower limbs. However, this might be due to the smaller sample size of *Anger* compared to *Neutral*. On the other hand, *Despair*, *Happiness*, and *Delight* showed significant differences in most of the body regions, pointing out that their related bodily sensations can easily be distinguished from neutral states. *Surprise* and *Bittersweetness* differ from the neutral state only in the deactivation of the chest area for the former, and in the activation in the abdomen for the latter. Finally, *Repugnance* exhibited significant differences in the activation of the abdomen and the deactivation in the head region. Subsequently, art-elicited emotions have been clustered based on their counts using hierarchical clustering. The resulting dendrogram is shown in Figure 5 and allows the assessment of the grade of similarity among the counts of activations and deactivations in the BSMs. In analogy with the work by Nummenmaa et al. (2014), an agglomerative procedure with complete linkage (maximum distance) has been performed. This method is also known as “furthest neighbor” since it defines the distance between two groups as the distance between their two farthest-apart members. The clusters obtained are well separated and compact (see Appendix E) the observed distances are automatically rescaled by SPSS to fall into the range from 1 to 25 as shown in figure 5. This means the actual distances cannot be observed but “the ratio of the rescaled distances within the dendrogram is the same as the ratio of the original distances” (Norusis, 2012, p. 384). The smallest rescaled distance is the one between Bittersweetness and Delight. According to the dendrogram, these two emotions are the closest in terms of the features considered. An arbitrary cutoff value has been determined at a distance of 12.5. All art-elicited emotions can join a cluster upon the threshold. At this point, four main clusters can be identified: one composed of Bittersweetness, Delight, and Happiness; another including Sadness, Despair, and Neutral; a third one grouping Disgust and Surprise, and the last cluster that contains Anger,

Repugnance, and Fear. Ultimately, we can distinguish two big clusters, one for Anger, Repugnance, and Fear and the other comprising all the remaining art-elicited emotions.

Discussion

The main objective of this study was to assess the suitability of BSMs for quantifying the emotions elicited by 36 new media artworks. To this end, the interrelations between three factors were considered: (i) perceived bodily sensations, (ii) experienced subjective feelings, and (iii) artistic stimuli.

A degree of association between bodily sensations and artworks was observed. Notably, whenever the bodily sensation involved an activation, more points were collected in comparison to deactivation. This led to the conclusion that when the activity in the body is getting stronger, it is better perceived by viewers. Accordingly, Lyons et al. (2020) conducted a study where depressed and healthy adults were asked to self-report via BSMs their feelings towards emotion stimuli taken from the International Affective Picture System (IAPS). They reported that the percentage of deactivations in the total area painted by healthy individuals was 24% throughout their entire experiment, while we can infer that the remaining 76% has been painted as in corresponding to activations in the body. BSMs painted by depressed individuals, on the other hand, showed less activation overall (percentage of deactivation was 38.76%). These results suggested that, regardless of the stimuli used, the overall number of deactivations is usually less than the activations reported. As recommended by previous literature (Blazhenkova & Dogerlioglu-Demir, 2020; Nummenmaa et al., 2018; Torregrossa et al., 2018; Volynets et al., 2019), the number of deactivations could be subtracted by the activations and for each body part without a loss of information in the analysis, thus proposing the use of activations as might be more accurate and applicable to future measurements in artistic encounters.

Figure 6 displays the bodily sensations in art-elicited emotions, mapping the patterns of bodily sensations within the ROIs. Results show that each art-elicited emotion is characterized by a unique pattern even within the same region. For instance, although both *Sadness* and *Happiness* show activation in the head, the former has a distinctive activation

pattern on the eyes while the latter on the mouth. Conceivably, one might parallel this finding to the tears shed during a sad feeling or the smile when experiencing happiness. These reports of activation of the head and upper chest can possibly be connected to physiological responses, such as facial musculature micromovements and heart rate variation (Levenson, 2003). They could derive from the mirroring of emotions and sensations detected by our perception (Gallese, 2006). One's experience of emotions can be affected by what one sees and it can result in simulating and embodying a shared body state. Hence, the high amount of activations in the upper body found in the present study could reflect a mimicry of the artworks' contents (namely, faces, full-body, or half-bust pictures). Although Nummenmaa and colleagues (2014) suggested BSMs can report the effects of the autonomic nervous system too (2014, p. 4). Thus, people indicating feelings getting stronger in the head could be related to brain activation that derives either from mirroring the emotion expressed in the artwork (Wicker et al., 2003) or from triggering emotional imagery (Costa, 2010). Supporting the latter, Figure 6 shows that also the neutral state is related to activation of the head. This outcome conceivably results from the type of stimuli employed (visual artworks). Nummenmaa et al. (2014) used short stories and videoclips to collect emotion-induced BSMs. In their experiment with emotional movies, participants were presented with short 10-second movies without sound and depicting humans involved in either emotional or non-emotional activities (Nummenmaa et al., 2014). The emotion-induced BSMs resulting from such an experiment reported head activation in every emotion, with the exception of the neutral condition, strikingly contrasting our findings. Even if both the videoclips and the artworks used in the present study displayed human bodies and faces, they evoked different responses when it came to the neutral state. This may suggest that BSMs as a response to viewing human figures do not unequivocally result in mirrored bodily feelings. Interestingly, Nummenmaa and colleagues' (2014) results about emotion-induced BSMs after reading emotional stories are much more similar to the present findings displayed in Figure 6. The text-driven emotion induction triggered an activation at the level of the head in each of the basic emotions, even the neutral state. Therefore, it has been

inferred that guided mental imagery based on reading short stories can be the source of reporting head increased activity. This is in accordance with our findings concerning visual artworks, suggesting that visual art, as well as narrative, potentially generates some level of cognitive, associative activation represented by the increased activity of the head region as a common thread in every emotion-induced BSMs.

In the BSM created for the emotion of delight, a generalized activation can be clearly observed throughout the whole silhouette aside from lower limbs. Specifically, one could see a pattern of activation mostly focused along the spine and deactivations imbuing the lower limbs, which might resemble the concept of ‘chills’ of pleasure representative of a condition of enjoyment (cf. Wassiliwizky et al., 2015). It is well known that positive emotions that bring pleasure, as delight here might constitute an example here, are traditionally the most associated with encounters between audience and artworks (for a comprehensive overview see Pelowski et al., 2016). Future studies could elucidate further the somatotopic responses to such an emotion. Although delight was the most chosen emotion throughout this study, art also triggered negative emotions. For instance, the combination of fear and sadness (i.e., despair) was the fourth emotion that occurred the most, followed by repugnance, and sadness (see Figure 3). This finding confirms that artworks can elicit various and complex emotions, ranging from highly positive to extremely negative (Cooper & Silvia, 2009). In contrast to Cooper & Silvia (2009), anger was observed less frequently than expected, indicating either that it is not common to experience anger in artistic encounters or that the chosen stimuli were not appropriate to elicit it. Hence, artwork selection is crucial for a comprehensive analysis of a range of art-elicited emotions. To investigate this further, a stimuli validation step could be implemented in future research. This could be done by performing a preliminary survey on a broad collection of stimuli, similar to the one performed by Novembre et al. (2019) in their study. Then, only the top hits in terms of intensity and agreement of dominant emotion would be used for the experiment. The artworks used in the present study did not appear to trigger intense emotions, leading to lower accuracy of the counts. This can also be seen with the rate of agreement of the

emotions per stimulus, as it is often rather low ($\leq 40\%$). In addition, the responses obtained seemed unbalanced, some art-elicited emotions were experienced more often than others. This resulted in unequal counts rendering some BSMs less reliable than others as is in the case of anger. Due to the individual differences underlying an emotional experience, studies could make use of analysis that accounts for individual-level and group-level variation.

Nevertheless, the collection of stimuli used in this study evoked both basic and complex emotions, constituting likely a starting point to create an open database of new media artworks. Future studies could approach the limitations of the present experimental design, and provide new attempts to design a standardized set of visual art stimuli for studying art-elicited emotions. The range of artworks could be extended to include artworks able to elicit a broader spectrum of emotions and intensities and to increase the applicability of BSMs as a research tool that overcomes language constraints.

All art-elicited emotions examined in the present research seem to follow similar sensation patterns in the body. A general deactivation of lower limbs and increased activity in the head and hands are common defining features across the art-elicited emotions experienced as a response to the artworks selected for this study. One might appreciate that all the body regions that are less prone to activation are instead more susceptible to deactivation. Interestingly, anger stands out from this pattern showing almost the same activation level in the head as much as in the upper limbs, especially the hands. Bias due to its low occurrence is plausible. Additionally, happiness is the only art-elicited emotion in which the chest obtained a score higher than the head. In this study, we confirmed that specific topographical distribution of bodily sensations can be tested in emotional categories, as previously described by Nummenmaa et al. (2014). Similar conclusions were drawn in previous studies (García- Magariño, Chittaro, & Plaza, 2018; Jung et al., 2017; Novembre et al., 2019), which corroborate the idea that BSMs are “the most accurate description available to date of subjective emotion-related bodily sensations” (Nummenmaa et al., 2014, p. 3).

Figure 6

BSMs of basic and complex emotions associated with the new media visual artworks in this study.

Note. The topographical depictions of basic emotions are on the first row, while the complex ones and the neutral state are on the bottom row.

Brighter colors indicate a higher density of point-clicks.

However, their application in representing art-elicited emotions shows some specific features compared to the ones found in other contexts. In our study, complex emotions show a higher degree of bodily sensations compared to basic emotions. The patterns visible in complex emotions correspond to the combination of their respective basic emotions. For instance, the superimposition of the silhouette of fear and sadness is remarkably like the one of despair. This supports Plutchik's theory (1980), which considers complex emotions as a combination of basic ones. However, according to his theory, the fusion of basic emotions may lead to a phenomenally different emotion. On the contrary, our findings may suggest a method of combination similar to the one described by Izard (1997), which is a mixture of basic emotions that preserves the phenomenal qualities of the derived emotion.

In line with Nummenmaa et al. (2014), the cluster analysis provided a cluster for positive emotions (see Figure 5). However, Nummenmaa et al. (2014) discovered four groups for negative emotions while in this study only one group was observed, comprising neutral, despair, and sadness. Possibly, this can be due to the higher number of emotions that were analyzed by Nummenmaa et al. (2014). Besides, in our study, the group composed of fear, anger, and repugnance was found to be clustered independently from other emotions. Finally, Nummenmaa et al. (2014) clustered surprise separately from other emotions, while we grouped it with disgust. According to the localization of bodily sensations, disgust and surprise seem to be close to each other. This considerably differs from what was previously observed, as surprise was not characterized by the activation of the abdomen (Nummenmaa et al., 2018). An interesting relationship was found between disgust and delight in many stimuli. For instance, in Stimulus 5 (see Appendix A) they were the first and second most chosen emotions, respectively. Delight is a combination of happiness and surprise, hence the similarity in the sensation pattern between surprise and disgust may be involved in this relation. Stimulus 10 represents the only stimulus in which disgust was the most prominent emotion without any apparent delightful implication. Investigating such linkages could be subject to future studies.

All in all, BSMs appear to reflect the consciously accessible bodily sensations of art-elicited emotions. Thus, they can be adopted for future studies as they can report a complex pattern of results of both complex and simple emotions in an intuitive and reliable way. However, they first need further validation in the field of psychology of art. The present study constitutes a first exploration in which BSMs were labeled with a series of fixed-response alternatives to ensure the methodological efficiency of the data. Nevertheless, it represents a limitation of this paper. Although in the present study participants were asked to respond with the closest alternative to label their bodily sensations, there is a possibility they wanted to opt for a category that was not provided during the experiment and that this led them not to answer the question instead, establishing a constraint in the present design. Future studies could provide a residual “other” category as well as a “neutral” (or “none”) one, such as in the case of the Geneva Emotion Wheel (GEW, Tinio & Garts, 2018). This would confirm the neutral option is deliberately chosen by the participants.

Furthermore, particular care must be given to the selection of new media artworks since they are pivotal for determining the quality of elicited emotions. The artwork collection employed here prevented a full validation for the full emotional spectrum as some emotions were less represented than others. Connections between physiological and emotional activation were confirmed using BSMs. Yet relying on self-awareness (i.e., introspective and interoceptive processes) exclusively may not be sufficient for complete exploration. However, validating the application of BSMs as a new research methodology in the art domain could constitute a step to bridge phenomenology and cognitive science, introspection and embedded cognition, strengthening or perhaps challenging existing models developed on the nature of emotions provoked by art (see Menninghaus et al., 2019; see also Skov & Nadal, 2019). In this regard, it is important to mention that emotion theories, including Ekman's (1970; 2016) and Plutchik's (1980; 1982; 1991) models on basic and complex emotions applied in the current study, are not set to be definitive guidelines as the present research aims at providing evidence for using BSMs to explore this complex matter. Arrangements around the categorization labeling and reference models are still tentative and wait for

confirmation or disproof upon various kinds of studies of self-reported bodily sensations of emotions elicited by art potentially through the use of BSMs.

BSMs can be used in the future to additionally study different aspects of human-art interaction, such as differences among the embodied emotional engagement of the artists and audience, or the individual relationship with specific artworks investigating, for instance, the impact of artistic style on viewers. In fact, the findings provided by this research are not to be generalized to all kinds of visual art encounters. In this paper, we focused our stimuli selection on figurative art, which is more likely to reflect the depicted emotion in the viewer (Kandel, 2016). Abstract art, on the other hand, is known to offer the viewers space for their own imagery and emotions. BSMs may be useful to map the emotions perceived in the sight of both these styles and investigate whether bodily sensations are perceived differently. Indeed, different styles and content of visual artworks may elicit different reactions. While we can infer figurative art may activate stereotypical answers, mirroring what we see in the work of art (for instance, activations in the head to indicate a smile seen on the depicted character), the way abstract art elicits emotions in people represents more of a mystery. Would it be able to elicit the same patterns of bodily sensations as the figurative one? Additionally, the use of BSMs can be extended to art forms outside the visual arts (e.g.: plastic arts, performing arts, music, and so on). Further fine-tuning in this direction will further corroborate this methodology as a powerful biomarker for bodily sensations in artistic encounters too.

Thanks to the body maps with regards to art-elicited emotions provided by this study, BSMs may be used to infer the subjective feeling evoked by artworks without directly asking for it. We may rely instead on the BSMs and look at how the body responds to art by the individual's conceptualization of physiological reactions.

Conclusion

We explored art-elicited emotions as a key output of the human-art interaction by applying Bodily Sensation Maps (BSMs) to link perceived bodily sensations to subjective feelings.

We observed that subjective feelings and bodily sensations activity are intertwined with artistic stimuli, confirming that BSMs are a reliable and easy-to-use method to gather emotion-related information. Nevertheless, the selection of artworks as stimuli is critical for acquiring balanced data for each emotion. Therefore, an additional stimuli validation step prior to the experiment would be suitable in future research.

The patterns of activation and deactivation points obtained were unique for each emotion and similar to the ones found by Nummenmaa et al. (2014). This indicated that emotions evoked by new media visual art appraisal are akin to emotions experienced in other contexts. Notably, every emotion-specific BSM was characterized by increased activity on the head, which indicates the cognitive effort in response to new media visual art. Such activity can also be appreciated when an artwork did not trigger any specific emotion.

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