Mapping Abstract Visual Feedback to a Dimensional Model of Emotion

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Abstract
Recent HCI research has looked at conveying emotions through non-visual modalities, such as vibrotactile and thermal feedback. However, emotion is primarily conveyed through visual signals, and so this research aims to support the design of emotional visual feedback. We adapt and extend the design of the "pulsing amoeba" [29], and measure the emotion conveyed through the abstract visual designs. It is a first step towards more holistic multimodal affective feedback combining visual, auditory and tactile stimuli. An online survey garnered valence and arousal ratings of 32 stimuli that varied in colour, contour, pulse size and pulse speed. The results support previous research but also provide new findings and highlight the effects of each individual visual parameter on perceived emotion. We present a mapping of all stimulus combinations onto the common two-dimensional valence-arousal model of emotion.

Author Keywords
Emotion; affective feedback; visual feedback.

ACM Classification Keywords
H.5.2. User Interfaces – Graphical user interfaces.

Introduction
Emotion is primarily conveyed through visual signals, particularly facial expression and body movement

[2,8]. However, it is also multimodal: research from psychology has shown how emotion is conveyed through vocal [5,23] (and even musical [17]) auditory bursts. Physical touch is also important in conveying "pro-social" emotions [2,9]. Each channel contributes important, or even necessary, signals. Research in HCI has attempted to use visual [30] and haptic/tactile feedback [20,25–27,35] to convey the emotional state of another but, in general, these channels have been studied individually, with few multimodal approaches. Individual channels currently do not seem capable of conveying a wide range of emotions by themselves. Multimodal detection of emotion is a large research community (see ACM International Conference on Multimodal Interaction) but more research is needed on the use of multiple complimentary output modalities for conveying emotion.

The research in this paper measured the range of emotional states that could be conveyed through abstract visual designs inspired by Valtchanov & Hancock's [29] "pulsing amoeba": a circular coloured shape that changed in size and contour (Figure 1). Circumplex valence and arousal measures [19] were taken after viewing each of 32 visual stimuli that varied in colour, edge contour, pulse size and pulse speed. The data in this paper constitute the first illustration of how visual stimuli that vary in multiple parameters map to the common dimensional model of affect, and so how changing each parameter moves around the model. It forms a first step before we next separately combine these designs with 1) thermal feedback, which has been shown to convey a limited range of emotions [21,22,34] and 2) auditory affective bursts [5,17,23] to understand how to effectively combine multimodal stimuli to convey a wide range of emotions.

Related Research

Psychology research has shown associations between colours, shapes and either emotions or preferences [1,18,28,32], but generally only looking at colour or shapes individually. Wexner [31] looked at associations between colours and a range of affective adjectives and found that red was associated with words such as "exciting" and "stimulating", blue was associated with "comfortable" and "soothing", orange was "disturbing" and black was "strong". Adams and Osgood [1] found consistent associations between emotional words and semantic differential adjectives across multiple cultures: white, blue and green were "good", red was "strong" and "active" and grey was "bad" and "weak". In line with these associations, Jacobs and Suess [12] found that red and yellow produced higher anxiety levels in participants than blue and green.

Utilising Pleasure-Arousal-Dominance measures [15], Valdez and Mehrabian [28] found that blue and green colours were the most pleasant, while yellow colours were the least pleasant. Red was moderately pleasant. Green colours were the most arousing, purple-blue and yellow-red were least arousing, with blue, yellow and red in between. Arousal decreased and pleasure increased as greyscale colours changed from black through grey to white. Research has also identified hedonic perceptions of shape and contour, finding that people have a consistent preference for curved over pointed objects [3,18], possibly due to the inherent "threat" conveyed by sharp objects [4].

Valtchanov & Hancock [29] recently used this research to design abstract visual feedback to convey the affective valence of photography scenes, to help users know if the scene is pleasant (positive) or unpleasant (nega-

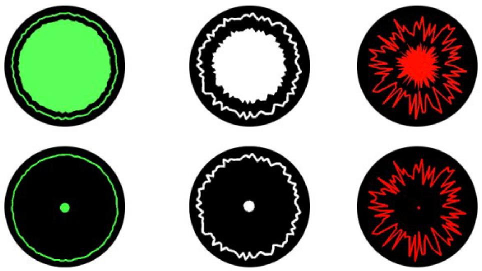

Figure 1: Pulsing amoeba designs from [29], representing positive (left), neutral (middle) and negative (right) visual environments.

tive). They gained subjective preferences and opinions about two affective designs: a moving horizontal waveform and a "pulsing amoeba" (Figure 1). Both were coloured green to convey positive/pleasant scenes, white for neutral and red for negative/unpleasant scenes. The waveform changed from rounded, low amplitude and low frequency (pleasant) to jagged, high amplitude and high frequency (unpleasant). The amoeba changed from rounded contour and slow pulse (pleasant) to jagged contour and fast pulse rate (unpleasant). These were compared to more explicitly informative bar-based and glyph-based designs. While the bar-based design was the easiest to use, the amoeba was successful in creating affective responses, as it was considered "captivating" and "responsive", with the jagged shape being "threatening".

More research needs to be done to understand the individual influences of various visual parameters on the perceived emotional content. This will make it easier to combine these visual displays with existing affective thermal, vibrotactile and auditory stimuli to provide potentially more engaging and informative multimodal affective displays. The research in this paper utilises and expands the amoeba design, separating all the individual parameters to look at their respective contributions to the perceived emotion. It is a first step before we combine the visual with audio and tactile feedback.

As we are interested in using the abstract visual designs, and combinations of modalities, to convey the emotional state of another person in HCI, we sought measures of the perceived emotional content being conveyed by the designs. Specifically, we got measures of the perceived valence and arousal of the conveyed emotion to be able to compare to other studies that have measured emotional content in abstract vibrotactile [20,25–27,35] and thermal [21,22,34] signals. With these measures we plotted all the average valence-arousal values within a dimensional model of affect [19], to illustrate how all the different visual designs relate to common discrete emotions. In contrast, previous research has only shown associations between specific shapes/colours and a few affective states.

Visual Designs

In their original pulsing amoeba designs, Valtchanov & Hancock [29] used two set combinations of contour (smooth/jagged), pulse rate (short/long) and colour (green, white, red): smooth+long+green to convey positive environments and jagged+short+red for negative environments. The parameters transitioned from one extreme to the other as the environment changed. They do not give actual values for the pulse rate (i.e. in seconds), so we pilot-tested our designs.

In our designs we also used contour (smooth, jagged) and pulse rate (slow, fast) but we added the parameter of pulse size (small/large) and we used four colours: red and green [29], but also blue and grey (see Colour, below). Whereas Valtchanov & Hancock combined only 1) *smooth* with *small* and *green* and 2) *jagged* with *large* and *red*, we produced every possible combination of contour, pulse rate, pulse size and colour, giving 2 x 2 x 2 x 4 = 32 stimuli. The visual designs were made using HTML5, CSS3 and Javascript (JQuery 1.9.1) for use on a variety of devices (using Apache Cordova for mobile devices). Each 'amoeba' consisted of 100 squares that rotated at slightly different speeds around the centre of the screen and changed in size (pulsed) in unison from one predefined extreme to the other (see "Pulse size").

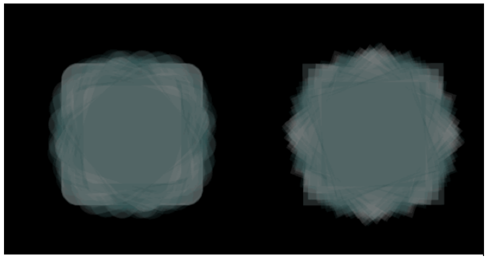

Figure 2: Two contours used in the visual designs: smooth (left) and jagged (right)

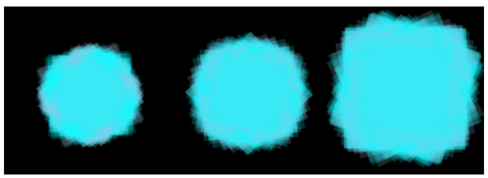

Figure 3: Pulse sizes: starting size (left), small increase (middle) and large increase (right)

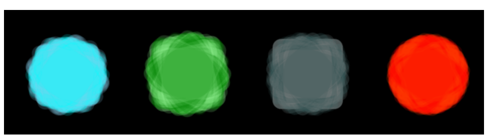

Figure 4: Four colours used in amoeba design (from left): blue, green, grey and red.

Contour
To change the contour, we changed the roundedness of the square corners (the length of a circle arc connecting one side to the other, see Figure 2): right angles (1-pixel arc) were used for the *Jagged* contour and rounded edges (50-pixel arc) for the *Smooth* contour.

Pulse Size
All amoeba began at a diameter of ~60% of the screen or window, from which it expanded to either a *Small* size (20% increase to ~75% of the screen) or a *Large* size (50% increase to ~90%; see Figure 3). The amoeba moved back and forth between these sizes continuously at one of the "Pulse Rates" below.

Pulse Rate
The amoeba increased/decreased in size from one extreme to the other at one of two different speeds: over 10 seconds (*Slow*) or 1 second (*Fast*).

Colour
We included green (RGB 0,128,0) and red (RGB 255,0,0) as the previous research discussed above show they are reliably perceived as positive/pleasant and negative/unpleasant, respectively. Thermal sensation has inherent links with emotional content and experience [11,13,33] and previous research has shown how thermal feedback might be used to convey a subset of emotions or emotional meanings [21,22,34]. To try and convey a greater range of emotions we plan to combine the visual designs with thermal feedback, which has its own inherent associations with colour: red for hot and blue for cold [10]. Therefore, we included the colour blue/cyan (RGB 0,255,255) to get initial results about the emotional associations of blue shapes of different designs. Grey (RGB 47,79,79) was added as a neutral colour with different associations ("weak") to the other colours [1] (see Figure 4).

Online Survey on Affective Content
Measures were taken using an online survey (Survey Monkey: www.surveymonkey.com). Participants were presented with all 32 of the visual design combinations in a random order and were asked to rate the emotion being conveyed in terms of valence and arousal. At the beginning of the survey the concepts of valence and arousal, and the purpose of the experiment (to measure the conveyed emotion), were described, in the same way as previous research [34]. Each page of the survey showed one of the dynamic visual designs at the top, with the sentence "*Based on the pattern above, rate the emotional state being conveyed*" underneath. Below the design were 7-point valence (unpleasant on the left, pleasant on the right) and arousal (low on the left, high on the right) scales. Participants chose one of the radio buttons within each scale before pressing "Next" to proceed.

37 people completed the survey, recruited through academic email or social media (21 male, 17 female; aged 16 to 53, mean = 23.65). The 7-point scale data was in the format of signed integers from -3 (unpleasant/calm) to 0 (neutral) to 3 (pleasant/excited).

Results
A mixed-method ANOVA was carried out on the valence and arousal data separately, with within-subjects factors of *Colour*, *Contour*, *Pulse Size* and *Pulse Rate*, and a between-subjects factor of *Gender*. Bonferroni-corrected pairwise comparisons were used for *post hoc* tests. Effect sizes are shown with η_p^2. Mean valence and arousal values are shown in Figures 5 and 6.

gure 5: Average valence and arousal ratings for ender and Colour.

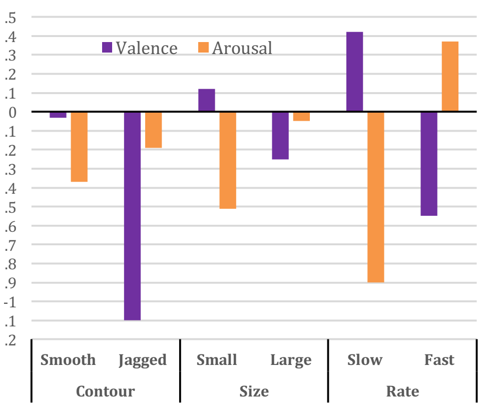

Figure 6: Average valence and arousal ratings for Contour, Pulse Size and Pulse Rate.

Valence

There was no significant main effect of Gender on the Valence ratings, and no interaction effect between Gender and any other factor. Average ratings were 0.03 for women and -0.16 for men. There was a significant main effect of Colour on valence ($F_{(3, 105)}$ = 29.81, p<0.001, $\eta_p{}^2$ = 0.46), with means of 0.55 (blue), 0.18 (green), -0.41 (grey) and -0.59 (red). Blue was rated as significantly more pleasant (higher valence) than all other colours and green was significantly more pleasant than red and grey.

There was a significant effect of Pulse Size on valence ($F_{(1, 35)}$ = 14.51, p=0.001, $\eta_p{}^2$ = 0.29), with the small size (mean = 0.12) being significantly more pleasant than the large size (mean = -0.25). There was also a significant main effect of Pulse Rate on valence ($F_{(1, 35)}$ = 105.99, p<0.001, $\eta_p{}^2$ = 0.75): the slow rate (mean = 0.42) was significantly more pleasant than the fast rate (-0.55). There was no significant main effect of Contour, with means of -0.03 for smooth and -1.1 for jagged. Finally, there was a significant Pulse Size * Pulse Speed interaction effect ($F_{(1, 35)}$ = 12.01, p= 0.001, $\eta_p{}^2$ = 0.26). The combination of the large Size and fast Speed led to a greater reduction in valence.

Arousal

There was no significant main effect of Gender on the Arousal ratings, with means of -0.16 for women and -0.4 for men. There was a weak significant interaction effect between Gender and Colour ($F_{(3, 105)}$ = 2.87, p=0.04, $\eta_p{}^2$ = 0.08): men rated all colours as conveying "calm" (negative arousal) but, while women also rated green and grey as conveying calm, they rated blue (mean = 0.27) and red (mean = 0.14) as conveying positive arousal. There was also a significant interaction between gender and Speed ($F_{(1, 35)}$ = 6.34, p=0.017, $\eta_p{}^2$ = 0.15). Both genders rated the slow Speed as calm (approximately -0.9) but men rated the fast Speed as less aroused (0.11) than women (0.62).

There was a significant main effect of Colour on arousal ($F_{(3, 105)}$ = 13.89, p<0.001, $\eta_p{}^2$ = 0.28), with means of -0.07 (blue), -0.33 (green), -0.76 (grey) and 0.03 (red). grey was rated as significantly calmer (lower arousal) than all other colours. There was a weak significant main effect of Contour ($F_{(1, 35)}$ = 4.53, p=0.04, $\eta_p{}^2$ = 0.11), with the smooth edge being calmer (-0.37) than the jagged edge (-0.19). There was a significant effect of Pulse Size on arousal ($F_{(1, 35)}$ = 59.62, p<0.001, $\eta_p{}^2$ = 0.39), with the small size (mean = -0.51) being significantly calmer than the large size (mean = -0.05). There was also a significant main effect of Pulse Rate on arousal ($F_{(1, 35)}$ = 154.24, p<0.001, $\eta_p{}^2$ = 0.81): the slow rate (mean = -0.9) was significantly calmer than the fast rate (0.37). Finally, there was a significant Pulse Size * Pulse Speed interaction effect ($F_{(1, 35)}$ = 4.74, p=0.036, $\eta_p{}^2$ = 0.12).

Mapping to the dimensional model of emotion

Figure 7 shows the average valence-arousal ratings for all the stimuli placed on the two dimensional model. From this we can see the influence of all the different colour-shape combinations on the perceived emotional content. Most stimuli sit within the bottom-right (high valence, low arousal; e.g., calm, contented) and top-left (low valence, high arousal; e.g., anger, fear) quadrants. A small number sit in the bottom-left quadrant (low valence, low arousal; e.g., sad) and only one stimulus in the top-right quadrant (high valence, high arousal; e.g., happy, excited).

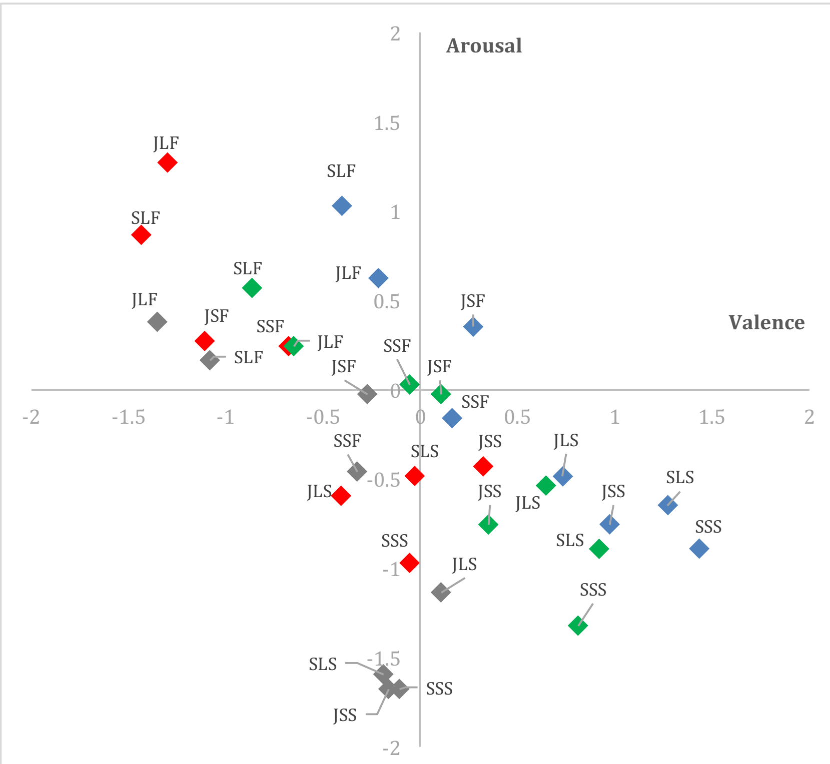

Figure 7: Distribution of average valence-arousal values for all visual stimuli. Colour indicated by marker colour (Blue, Green, Grey, Red). Stimulus details indicated by letters in the order Contour (Jagged/ Smooth) - Size (Small/Large) - Speed (Slow/Fast). E.g., SSS = Smooth, Small, Slow; JLF = Jagged, Large, Fast.

As the results showed, blue and green stimuli are generally higher in valence (towards the right side) while red and grey are lower (towards the left side). More stimuli sit within the bottom half of the model, as most arousal ratings were near or below 0.

Discussion

The main contributions are 1) showing the contributions of each visual parameter individually and 2) showing the dimensional distribution of all stimuli (Figure 7). The study both confirmed earlier findings and provided new results: like others, blue and green were found to be more pleasant than red and grey, and higher pulse speed led to higher arousal and lower valence. However, we also showed strong effects of pulse size, with larger pulses conveying lower valence and higher arousal. Unlike previous research [3,18,29] contour did not influence valence ratings, possibly because the differences between our contours were less obvious than others [29].

The distribution in Figure 7 shows the emotional content conveyed by all stimuli, and the effect of changing an individual parameter can be seen by comparing points that vary by one letter (or colour). The distribution is not a circular or even distribution, but this is common [6,7,34,35]. While valence and arousal are commonly seen as the primary axes along which emotional experience varies, Bradley & Lang [6,14] have proposed more of a 'vector' model of emotion, where emotions lie along one of two vectors originating at low arousal and middle valence (a resting state). One vector moves towards high arousal, low valence ("defensive") and the other to high arousal, high valence ("appetitive"). Our distribution looks to conform to the defensive vector but is missing stimuli from the appetitive vector. As appetitive motivation is concerned with sustenance and procreation, it may be that the stimuli we used did not relate strongly enough to these actions, whereas they had stronger associations with danger (e.g., sharp [4], fast moving). This is likely a limitation of using abstract stimuli to convey emotions, as other tactile channels have failed to represent a full range of emotions [16,22,24,34,35].

Conclusions and Future Work

This research has measured the perceived emotional content being conveyed through abstract visual feedback designs based on the "pulsing amoeba" [29]. The resulting distribution shows the change in perceived emotion after changing an individual parameter: Colour, Contour, Pulse Size and Pulse Rate. This provides designers with more information about conveying more nuanced variations in affectivity. We will use this distribution and combine visual stimuli with thermal and auditory stimuli that have been rated in similar and contradictory positions on the model, to see if the limited distributions observed in individual modalities are expanded by combining modalities.

References

1. Francis Adams and Charles Osgood. 1973. A Cross-Cultural Study of the Affective Meanings of Color. *Journal of Cross-Cultural Psychology* 4, 2: 135–156. http://doi.org/0803973233
2. Betsy App, Daniel N McIntosh, Catherine L Reed, and Matthew J Hertenstein. 2011. Nonverbal channel use in communication of emotion: how may depend on why. *Emotion* 11, 3: 603–617. http://doi.org/10.1037/a0023164
3. Moshe Bar and Maital Neta. 2006. Humans prefer curved visual objects. *Psychological Science* 17, 8: 645–648. http://doi.org/10.1111/j.1467-9280.2006.01759.x
4. Moshe Bar and Maital Neta. 2007. Visual elements of subjective preference modulate amygdala activation. *Neuropsychologia* 45, 10: 2191–200. http://doi.org/10.1016/j.neuropsychologia.2007.03.008
5. Pascal Belin, Sarah Fillion-Bilodeau, and Frédéric Gosselin. 2008. The Montreal Affective Voices: a validated set of nonverbal affect bursts for research on auditory affective processing. *Behavior research methods* 40, 2: 531–539. http://doi.org/10.3758/BRM.40.2.531
6. Margaret Bradley and Peter J Lang. 2007. The International Affective Picture System (IAPS) in the Study of Emotion and Attention. In *Handbook of Emotion Elicitation and Assessment*, Richard J. Davidson, Paul Ekman and Klaus R. Scherer (eds.). Oxford Press, Oxford.
7. Margaret Bradley and Peter Lang. 1999. *International Affective Digitized Sounds (IADS): Stimuli, Instruction Manual and Affective Ratings*. Gainesville, FL.
8. Paul Ekman. 1993. Facial Expression and Emotion. *American Psychologist* 48, 4: 376–379.
9. Matthew J Hertenstein, Rachel Holmes, Margaret McCullough, and Dacher Keltner. 2009. The communication of emotion via touch. *Emotion* 9, 4: 566–573. http://dx.doi.org/10.1037/a0016108
10. Hsin-ni Ho. 2015. Color-temperature correspondence and its impact on object temperature perception. *Proceedings of VINCI 2015*.
11. Hans Ijzerman and Gun R Semin. 2009. The Thermometer of Social Relations. *Psychological Science* 20, 10: 1214–1220. http://doi.org/10.1111/j.1467-9280.2009.02434.x
12. Keith Jacobs and James Suess. 1975. Effects of Four Psychological Primary Colors on Anxiety State. *Perceptual and Motor Skills* 41: 207–210.
13. George Lakoff and Mark Johnson. 1999. *Philosophy in the Flesh: The embodied mind and its challenge to Western thought*. Harper-Collins, New York.
14. Peter J Lang, Margaret M Bradley, and BN Cuthbert. 2008. *International Affective Picture System (IAPS): Technical Manual and Affective Ratings*. Gainesville, FL.
15. Albert Mehrabian. 1996. Pleasure-Arousal-Dominance: A General Framework for Describing and Measuring Individual Differences in Temperament. *Current Psychology* 14, 4: 261–292. http://doi.org/10.1007/BF02686918
16. Marianna Obrist, Sriram Subramanian, Elia Gatti, Benjamin Long, and Thomas Carter. 2015. Emotions Mediated Through Mid-Air Haptics. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '15)*, 2053–2062.

http://doi.acm.org/10.1145/2702123.2702361

17. Sébastien Paquette, Isabelle Peretz, and Pascal Belin. 2013. The "Musical Emotional Bursts": A validated set of musical affect bursts to investigate auditory affective processing. *Frontiers in Psychology* 4, AUG: 1–7. http://doi.org/10.3389/fpsyg.2013.00509
18. AT Poffenberger and BE Barrows. 1924. The Feeling Value of Lines. *Journal of Applied Psychology* 8, 2: 187–205.
19. James A Russell. 1980. A Circumplex Model of Affect. *Journal of Personality and Social Psychology* 39, 6: 1161–1178. http://dx.doi.org/10.1037/h0077714
20. Katri Salminen, Veikko Surakka, Jani Lylykangas, et al. 2008. Emotional and behavioral responses to haptic stimulation. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '09)*, 1555–1562. http://doi.org/http://dx.doi.org/10.1145/1357054.1357298
21. Katri Salminen, Veikko Surakka, Jukka Raisamo, et al. 2011. Emotional Responses to Thermal Stimuli. *Proceedings of ICMI 2011*, 193–196. http://doi.acm.org/10.1145/2070481.2070513
22. Katri Salminen, Veikko Surakka, Jukka Raisamo, et al. 2013. Cold or hot? How thermal stimuli are related to human emotional system? *Proceedings of International Workshop on Haptic and Audio Interaction Design (HAID '13)* 7989: 20–29. http://doi.org/10.1007/978-3-642-41068-0_3
23. Marc Schröder. 2003. Experimental study of affect bursts. *Speech Communication* 40, 1-2: 99–116. http://doi.org/10.1016/S0167-6393(02)00078-X
24. Hasti Seifi and Karon E. Maclean. 2013. A first look at individuals' affective ratings of vibrations. *Proceedings of World Haptics 2013*, 605–610. http://doi.org/10.1109/WHC.2013.6548477
25. Smith and MacLean. 2007. Communicating emotion through a haptic link: Design space and methodology. *International Journal of Human-Computer Studies* 65: 376–387. http://www.sciencedirect.com/science/article/pii/S1071581906001911
26. Dzmitry Tsetserukou, Alena Neviarouskaya, Helmut Prendinger, Naoki Kawakami, and Susumu Tachi. 2009. Affective haptics in emotional communication. *Proceedings - 2009 3rd International Conference on Affective Computing and Intelligent Interaction and Workshops, ACII 2009*, 1. http://doi.org/10.1109/ACII.2009.5349516
27. Dzmitry Tsetserukou, Alena Neviarouskaya, and Kazuhiko Terashima. 2013. iFeel-IM!: A cyberspace system for communication of touch-mediated emotions. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* 8186 LNCS: 70–77. http://doi.org/10.1007/978-3-642-41033-8_12
28. Patricia Valdez and Albert Mehrabian. 1994. Effects of color on emotions. *Journal of Experimental Psychology* 123, 4: 394–409. http://doi.org/10.1037/0096-3445.123.4.394
29. Deltcho Valtchanov and Mark Hancock. 2015. EnviroPulse : Providing Feedback about the Expected Affective Valence of the Environment. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '15)*, 2073–2082.

30. Hanna Venesvirta, Veikko Surakka, Yulia Gizatdinova, et al. 2015. Emotional Reactions to Point-Light Display Animations. *Interacting with Computers*, 1973: iwv028. http://doi.org/10.1093/iwc/iwv028
31. Lois Wexner. 1954. The Degree to Which Colors Are Associated with Mood-Tones. *Journal of Applied Psychology* 38: 432–435.
32. T W Whitfield and T J Wiltshire. 1990. Color psychology: a critical review. *Genetic, social, and general psychology monographs* 116, 4: 385–411. http://www.ncbi.nlm.nih.gov/pubmed/2289687
33. Lawrence Williams and John A. Bargh. 2008. Experiencing physical warmth promotes interpersonal warmth. *Science* 322, 1: 606–607. http://dx.doi.org/10.1126/science.1162548
34. Graham Wilson, Dobromir Dobrev, and Stephen A Brewster. 2016. Hot Under the Collar: Mapping Thermal Feedback to Dimensional Models of Emotion. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '16)*.
35. Yongjae Yoo, Taekbeom Yoo, Jihyun Kong, and Seungmoon Choi. 2015. Emotional Responses of Tactile Icons : Effects of Amplitude , Frequency , Duration , and Envelope. *Proceedings of World Haptics 2015*, 235–240. http://dx.doi.org/10.1109/WHC.2015.7177719