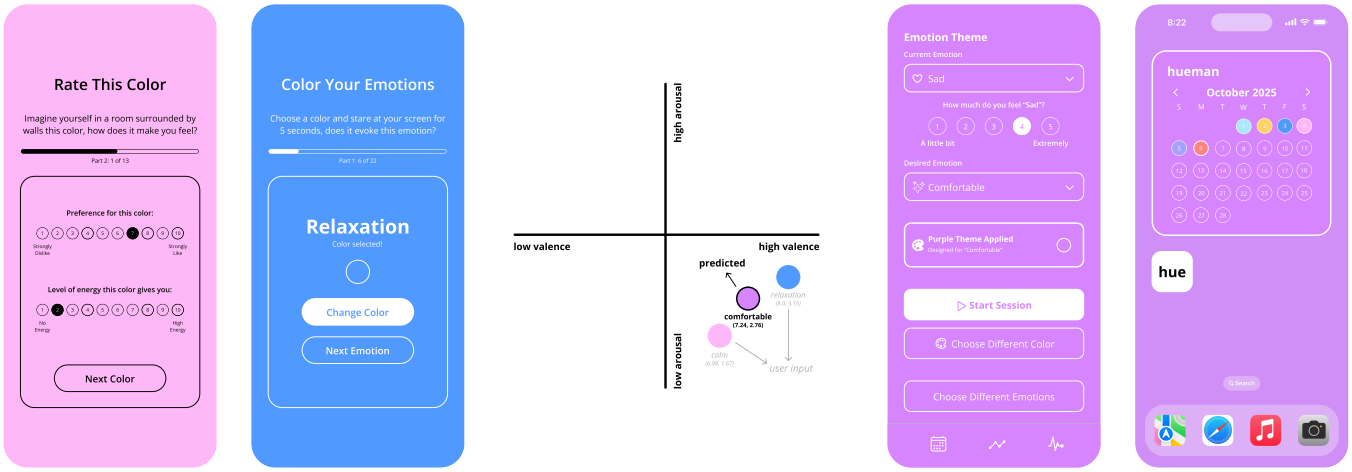
Personalized Color-Forward Emotion Tracking and Adaptive Mobile Interfaces for Reflection and Adjustment

Catherine Liu
Claremont McKenna College
Claremont, California, USA
cliu26@cmc.edu



Onboarding: user creates initial color emotion mappings

Prediction: additional mappings created based on onboarding (adjusted with ongoing user logs)

Adaptive theme: app and phone reflect predicted emotion color

Figure 1: Hueman is a color-forward emotion tracking and management system that learns from each user's unique color-emotion associations. Hueman creates initial color-emotion mappings (middle) from an onboarding survey (left). These mappings can be used for emotion management through adaptive mobile interfaces (right).

Abstract

Emotional awareness and reflection through self-tracking can enhance mental well-being, and personal informatics systems facilitate this practice through diverse methods of expression. However, existing tools offer limited opportunities for meaning-based personalization combined with adaptive support. We developed Hueman, a color-forward emotion tracking and management system that learns from each user's unique color-emotion associations and uses them to adapt mobile color themes for emotional adjustment. Through a preliminary evaluation with seven participants, we found that Hueman prompted reflection on existing color-emotion associations and ways that color shapes everyday emotional experiences. We observed that the impact of color-based user interface themes varied according to individual experiences, personal associations, and situational context. These findings highlight the potential of color as an expressive medium and suggest ways mobile devices can be intentionally used for emotional support.

CCS Concepts

• **Human-centered computing** → **User interface design**; *Visualization design and evaluation methods*; • **Computing methodologies** → *Affective computing*; • **Applied computing** → Fine arts.

Keywords

Personal informatics, Affective computing, Adaptive user interfaces, Human-centered computing

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1 Introduction

People are highly emotional beings, yet the ability to recognize, regulate, understand, and express emotions does not come naturally to many [12, 43]. Supporting emotional awareness and adjustment therefore remains a persistent challenge. Personal informatics systems aim to address these challenges by helping individuals collect and reflect on personally relevant information to gain self-knowledge [37]. Engaging in emotional regulation and self-reflection practices can improve happiness, enhance self-understanding, and contribute to overall quality of life [12].

A central design question in emotion-tracking systems concerns how emotions are represented [49]. Color offers a compelling medium for emotional expression and reflection, as it is closely associated with affective experience and can communicate nuanced emotional states [19, 55]. Existing color-integrated systems often assume universal [54] or static [5, 7] relationships between color and emotion. In contrast, theory and prior work suggest that color meaning is inherently contextual, personal, dynamic, and shaped by cultural practices [29, 35, 45]. Psychological research further supports this notion [16, 23, 25, 27, 30, 34, 47, 48, 57]. Therefore, systems that learn from and adapt to users' evolving color-emotion associations may better support emotional reflection and in-the-moment regulation. Adaptive user interfaces (AUIs) [10] offer a promising direction for addressing this gap by dynamically responding to a user's current state and preferences. Prior work demonstrates that adaptive visual elements, including color themes, can influence mood and evoke emotional responses [3, 8, 33, 38, 46, 58]. Applying these principles to emotion-tracking systems suggests the potential for interfaces that not only reflect emotional states, but actively support emotional regulation through personalized visual adaptation.

We developed Hueman, a mobile application for color-based emotion logging, reflection, and adjustment (Figure 1). Hueman constructs personalized, bidirectional, color-emotion mappings through a two-part onboarding process and models emotional states along the valence-arousal (VA) space. Hueman supports a co-constructive approach to emotional self-tracking: users log emotions by selecting colors that resonate with their current experience, and the system generates personalized emotion label suggestions derived from users' historical patterns. Users can engage with visualizations that reveal longitudinal trends in their emotional life. Hueman can also adaptively adjust interface and mobile color themes toward user-specified desired emotional states, combining adaptive and adaptable interaction paradigms [21]. Hueman continuously reconstructs color-emotion meanings based on user input and interaction.

We evaluated Hueman through a weeklong deployment with seven participants. Our research questions centered around (1) how engagement with personalized color-emotion associations supports reflection and (2) how interaction with color-adaptive interfaces influences emotional adjustment. Our findings offer qualitative insights and design implications into users' relationships with color and how this impacts emotional awareness. The aim of our work is to contribute insights towards a design space for emotional systems that are adaptive and personalizable beyond individual applications, rather than to make causal claims about the regulatory efficacy of color-adaptive interfaces. In addition, we seek to prompt users to reflect on their color-based visual preferences as emotionally grounded forms of personal knowledge that already shape everyday experiences. Our findings suggest that color can reveal personal and contextual influences on emotions, supporting reflection and self-knowledge. While color-adaptive interfaces can influence emotions, their impact varies according to individual associations and situational context.

2 Related Work

2.1 Personal Informatics for Emotional Well-Being

Within personal informatics, there has been continued development of systems that support the collection, reflection, and management of everyday life, defined by Li et al. as systems that help people collect personally relevant information for self-reflection and self-knowledge across stages of preparation, collection, integration, reflection, and action [37]. Emotion-focused PI systems diverge primarily in their methods of data collection and integration, drawing either from physiological and behavioral indicators such as heart rate, screen usage, or biometrics [32, 39, 40], or from users' own mental constructs of emotion through manual logging and expressive practices [5, 7, 36]. While automated approaches enable low-burden tracking, they are limited in the types of emotions they can infer, as many emotional states are not physiologically legible [44, 52, 59]. In contrast, manual emotion tracking preserves user agency, supports reflection-in-action [51], and allows users to define and interpret their own emotional states through symbolically rich forms such as text, color, or tangible artifacts [2, 5, 36]. However, manual tracking is high effort and prone to abandonment [2, 24]. Hueman seeks to maintain lightweight digital interaction while supporting personalized meaning-making and agency.

2.2 Color and Emotion

Color-emotion associations exist at universal, cultural, and individual levels [23, 27]. Brighter and lighter colors are generally associated with positive valence, while darker colors align with negative valence, with warm hues linked to higher-energy emotions and cool hues to lower-energy emotions [29, 35, 57]. However, these meanings are not fixed: hue, value, and saturation all shape emotional impact, and the same color can hold different meaning depending on situational context [29, 57]. Cultural context further complicates color–emotion mappings, as colors take on different emotional meanings across societies [6, 13, 14, 26, 29]. At the individual level, personal experience and preference strongly shape color–emotion associations, suggesting that systems using color to communicate affect should account for both cultural regularities and individual variability through personalization or adaptive mappings [20, 27, 30, 34, 48].

2.3 Color-Emotion Adaptive Interfaces

Hueman builds on prior research demonstrating that aesthetic design can induce emotional responses [9, 33, 53]. Existing AUIs explore this potential. EmotionControl uses model-free reinforcement learning to adapt interface elements (including light and

dark color themes) to evoke specific emotional responses [3]. Similarly, EChat adjusts messaging interface color themes based on Plutchik's mappings in response to detected negative valence [33]. FACE2FEEL integrates adaptive visual and content-level UI components that respond to users' emotional states; its interface uses default color-emotion-associated backgrounds, which users may override through setting their own associations [22]. AUBUE proposes a framework that changes interface color schemes based on inferred emotional and mood states derived from keyboard interaction behavior [15].

While these systems demonstrate the promise of emotionally adaptive interfaces, they largely rely on predefined, generalized, or static mappings between color and emotion. In contrast, Hueman treats color as a dynamic, evolving medium for personal meaning-making. This distinction is significant: as discussed in the previous section, color-emotion relationships are highly personal, context-dependent, and subject to change over time.

This difference in design philosophy relates to questions raised in the 2022 CHI workshop on The Future of Emotion in Human-Computer Interaction, where the authors state that "agency is often ambiguous" and ask "Who is changing whose emotion, how, when?" [1]. In many existing adaptive systems, agency is often more strongly weighted toward system-driven adaptation: the system determines what the user is feeling and how the interface should respond, often through automatic adaptation based on detected emotional states. Hueman adopts a different approach. Rather than defining or interpreting emotions and colors on the user's behalf, Hueman emphasizes user involvement in constructing, revising, and enacting these meanings within the interface.

3 Designing Hueman

In designing Hueman, we drew inspiration from existing digital [7, 31] and manual [28, 41] self-tracking tools and practices. We took note of preventing abandonment [2, 37], maintaining ease of use [2, 7], making visualizations easily understandable [4], and preference for aesthetically pleasing interfaces [2, 4].

Hueman was implemented as a mobile application using Expo, a React Native Framework. The adaptive home screen widget was developed separately in Xcode. The VA space that Hueman uses is from a dataset of words with VA scores from Warriner et al. [56]. We extracted 552 emotion-related words from that dataset. Emotion valence ranged from 1.90 (hateful) to 8.48 (happiness). Arousal ranged from 1.67 (calm, dull) to 6.95 (ecstatic, sexual).

Hueman uses a modeling approach that combines user-provided color–emotion associations with interpolation in the VA space. During onboarding, users specify a set of direct associations; the system then infers mappings for additional emotions using k-nearest neighbor interpolation based on proximity in VA space. Color values are interpolated in HSV space by independently adjusting hue (H), saturation (S), and value (V). As users continue logging emotions with colors, these mappings are iteratively updated, and predictions for related emotions are regenerated accordingly. The code for Hueman can be found at https://github.com/cliu26/hueman-emotion.

4 Preliminary User Study

With IRB approval, we conducted a user study with seven participants who had prior experience with various forms of self-tracking, such as social media-based logging, automated biometric logging, fitness tracking, and journaling. These participants were recruited from the researchers' social network. Participants had an average age of 28.43 (SD = 13.48). Six participants identified as female and one as male.

Participants were guided through the onboarding process via a combination of verbal instructions and a written onboarding guide. This included downloading the app, creating an account, and setting up the AUI. Participants then used the application for a week. They were encouraged to explore the app and interact with its features daily, but were not required to log at specific times. Instead, they were instructed to log emotions when it felt natural or meaningful to them. At the conclusion of the study, each participant completed a 30-minute exit interview. The interviews were transcribed and analyzed using reflexive thematic analysis [11]. Over the course of a week, the first author coded all the data considering Hueman's research questions and design philosophies.

5 Results and Discussion

5.1 Personalized Color-Emotion Associations

Through using Hueman, users began to reflect on their existing color-emotion associations which were predominantly media-influenced, such as through the movie Inside Out [18, 42]. Participants reported that through using the application, they realized that media-influenced associations did not always match personal experience. P1, P2, and P4 reported that the colors they liked made them happier. P2 expressed that green and blue colors reflected positive valence for them, differing from the common associations that blue represents sadness. P6 further mentioned that *"I realized sometimes I feel blue, but it doesn't really attach to any negative or sad feelings. I just want to get close to water"*.

Hueman encouraged participants to think more deeply about personal color-emotion associations. P4 associated purple with collaboration, noting it "kind of clicked" for them during emotion logging, even though they had not seen this association elsewhere. P4 also reflected on intrinsic associations revealed by Hueman's data visualizations: *"I didn't realize I used light pink for stress and frustration, I personally did not think that about myself"*. Participants reported that Hueman prompted them to question their assumptions. They asked, *"Why do I think this color is this feeling?"*, and brought connections in the brain to an explicit level. We found that participants described experiences consistent with defamiliarization [50] of colors and how they interact with colors. P6 said that using Hueman made them more sensitive to color and the differences between colors: *"I would say my color association with emotions is stronger now after using the app"*.

Hueman prompted users to question how emotions emerge across situations and how color meanings shift across contexts. P5 mentioned that they logged two shades of orange in the same day, but one as excitement and one as calmness. When logging orange as calmness, they were in a cafe. The cafe was orange and it made them feel calm. They realized this impact when reflecting on the representations of colors and emotions within the Hueman

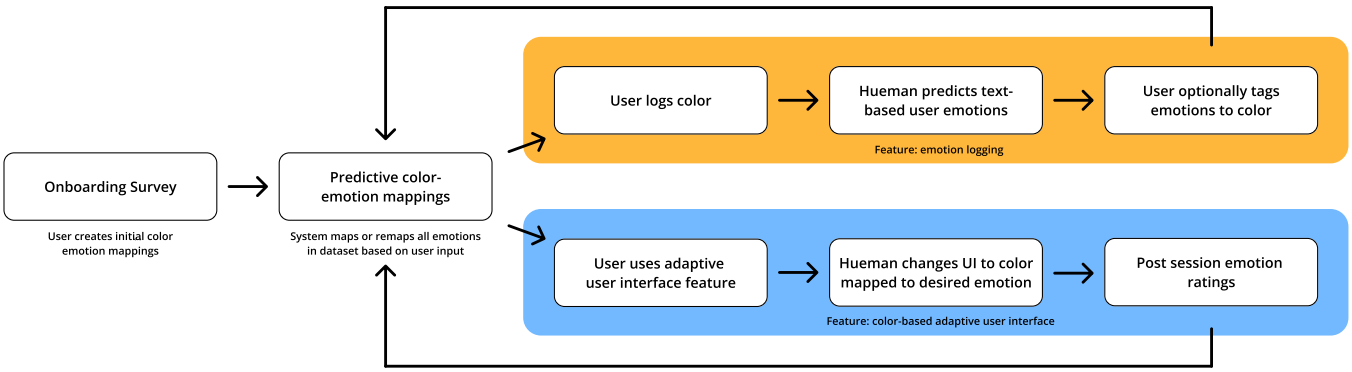

Figure 2: System user interaction flow of Hueman

app and had made these associations more subconsciously in the moment. Through using color as a medium for personal meaning-making, personal informatics systems can support increased modes of reflection—such as surfacing implicit aesthetic preferences—and foster self-knowledge.

5.2 Experiences with Color-Adaptive Interfaces

Hueman demonstrates the potential of color-adaptive interfaces to support emotion management. We found that participants reported greater perceived usefulness for high-valence, low-arousal states, such as calmness. For example, P5 used green to calm down and red to improve their energy. They mentioned that green helped them a lot, while red maybe not so much. We further noticed that color-adaptive UI may work better for color-emotion associations where that color is associated with only one emotion, or one type of emotion for that user. P4 noted that while blue evokes calm, its association with sadness makes emotional interpretation ambiguous, whereas yellow—linked uniquely to energy and joy—more reliably induces positive feelings. These findings suggest that adaptive systems should avoid using colors with emotionally conflicting meanings for users (e.g., colors which are mapped to opposite ends of the valence-arousal spectrum) and that personal color–emotion associations have a stronger impact than fixed or generalized mappings.

Beyond explicit tracking and reflection, people often use their phones to regulate emotions in everyday life, sometimes intentionally and sometimes unconsciously [1]. For example, individuals may pick up their devices to alleviate boredom or stress, to feel excitement or joy, or to seek calmness and a sense of social connection. In this way, mobile devices act as ubiquitous tools for feeling or not feeling emotions. However, unintentional use of digital devices for emotional regulation is complex and can have harmful effects [17]. This shows the need for emotional adjustment to be thoughtfully integrated into digital environments, such as through color theme adaptation.

5.3 Agency

Users of Hueman valued agency in rhythms of reflection, manual logging, mobile adaptation, and using predictive features. Participants reported using Hueman as a resource for emotional reflection both in the moment and retroactively. Some users, like P1, P2, and P5, used the logging feature of the application as they recognized emotional changes. Others, like P4, used the app at the end of the day to reflect on their entire day. Emotional self-tracking systems should be built to support diverse temporalities of reflection, enabling users to adapt the system to their personal preferences and evolving goals. Participants appreciated the manual logging aspect, which gave them agency in identifying and processing their emotions. Hueman's time-based logging format supported context-based emotional reflection. Users reported thinking more about the causes of their emotions even without explicit prompts. For example, P4 noted that *"[Hueman] forced [them] to think about what [they] did that day. Certain social events made [them] happier and [they] reflected on how things made [them] feel"*. P6 added that they noticed *"[they] usually feel really happy after talking to someone [they] love, and a lot more stressed or concerned after spending a long time alone"*. In addition, P1 noted that sometimes the app applied adaptive colors that did not match what they desired. In such cases, users appreciated that Hueman allowed for preview and modification before applying a color system-wide.

Hueman's predictive emotion suggestions demonstrated potential for scaffolding emotional articulation. In the 20 or so emotions that Hueman recommended for each color entry, participants felt that at least one suggestion resonated with their experience. P7 mentioned that the application was *"very accurate"* at identifying the emotions they were feeling. P5 mentioned that Hueman's predictive recommendations could lead them to find a word to describe their emotions that they couldn't have thought of themselves, but believed was accurate. In addition, Hueman's emotion predictive system led users to use a broader variety of language in describing their emotional states. P1 said that *"Usually I would've said I'm happy, but if the app recommended joyful I might choose that instead"*. Beyond the predictive suggestions, Hueman allowed participants to search the emotion database manually and select terms outside of the recommendations. This combination of predictive and manual exploration enabled users to actively learn and refine their understanding of their own emotional states. However, in using predictive algorithms, limitations remained, particularly where color-emotion mappings were ambiguous (e.g., blue representing both calm and sadness). These findings underscore the importance of framing predictive support as inspiration rather than prescription.

6 Limitations and Future Work

Our study has several important limitations. First, our evaluation was with a small sample size, exploratory in nature, and limited in participant diversity. In the future, we are interested in conducting a longitudinal evaluation with more diverse users and statistically validate the use of mobile color themes for emotional adaptation. Our study is exploratory and design-oriented; we do not aim to establish causal claims about the effects of color-adaptive interfaces on emotional outcomes. Rather, we use Hueman to surface how personalized color–emotion associations and adaptive interfaces shape reflection, agency, and subjective emotional experience. Due to the limitations of wallpaper and mobile phone theme adjustment, Hueman was limited in the range of colors it could change iOS backgrounds to, relying more on the application widget for complete color adaptation. While Hueman enables reflection on emotions, it primarily captures surface-level or situational triggers rather than deeper causal mechanisms. Hueman is also not intended to diagnose or treat mental health conditions, nor replace professional care. Hueman is not designed for users with color vision deficiencies. This restricts the generalizability of Hueman's findings to users with typical color perception. Future work can utilize multimodal methods which do not priortize color in order to engage users in emotional adjustment.

Importantly, affective regulation has the potential to be integrated seamlessly across both digital and physical spaces. Color offers one promising method for such integration—for example through color-changing interfaces or ambient lighting—but other modalities may also be effective, including texture, shape, and sound. As technology increasingly supports unconscious and potentially harmful forms of emotional regulation, such as through social media platforms, future work should explore more intentional, transparent, and personalizable approaches to embedding affective interventions.

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