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A Creative Artificial Intelligence System to Investigate User Experience, Affect, Emotion and Creativity

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Is it possible using photographs as source (e.g., selfies of users) to affect and enhance mood, emotion and creativity by creating AI based "digital painters" that can create art painting output that is deemed to convey a certain mood from any source photograph (user face portraits, dancers in moment)? The goal of this research is to use our Creative Artificial Intelligence System (CAIS) along with our cognitive based painting algorithms (DiPaola 2013) together with additional art analysis tools (i.e., texture and palette synthesis) to parameterize a generative artistic painting process based on mood and emotion. We discuss our methods and begin to validate the work by performing two intertwined user studies that appear to support that viewers of the generated art from our CAIS agree to a high degree on a specific mood the output conveys from our 4 emotional spaces regardless of the source material: abstract, fugitive or their self portrait. This points to the conclusion that our CAIS system can automatically generate unique artworks or "aesthetic visualization" that deemed creative and have emotional qualities, which has benefits and repeatability in many interactive fields. This work has User Experience (UX) applications in computational creativity, affective aesthetic visualization, experiential learning (of art), performance visualization (dancing), and health well-being.

Artificial Intelligence system. Aesthetic visualization. Creativity. User experience. Emotion.

1. INTRODUCTION

This research specifically addresses how CAIS (creative AI systems) as a new kind of authoring or interactive tool can possibly not only enhance creativity and encourage new collaborative practice but can also adopt aspects of affect and emotions that are aroused from the artworks produced. Our research aims to grow the 'artist's creative model' of our CAIS system by understanding the mood and emotion that artist/users' intent to portray in an artwork. This encourages new collaborative practice by creating a dialogue between the system and the users, where they can organically, share and exchange real-time knowledge, evolve their creative process and guide their artwork through an emotional space. This allows the user of such system to be a simultaneous participant and observer in an on-going collaborative conversation. To address this, we have conducted and report on two user studies to understand and validate the mood, affect and emotion that are evoked from viewing the generated artworks produced by our CAIS. Our two studies have provided us with data to inform and define various emotional spaces within our CAIS environment according to the results associated with a known psychological emotional based circumplex scale (Figure 3). The study identified corresponding emotions selected by majority of viewers of the artwork painting recipes produced by our CAIS regardless of the source. This supports that our painterly recipes, regardless of the source image being painted upon, evoke similar emotions in a universal way, making them useful as an emotional tool for our application space. In this work, we are focusing on emotion as an expression, not something we want to recognize automatically but something our viewers/users explicitly communicate with our system in the moment of interaction; the user experience (UX), an active construction and organic flow of real-time knowledge that is reciprocated between our system and users based on affect.

2. AFFECT AND EMOTION

There is much debate within the computational creativity field regarding the affect and emotion that

are conveyed in the artwork produced by creative and generative Artificial Intelligence (AI) systems. This challenge is due to aesthetic and affect being considered as higher-level semantics and based on human subjectivity, which are difficult to model computationally (Joshi *et al.* 2011). The aim of our research is to continue to grow the knowledgebase and cognitive model of our CAIS system that currently has aesthetic reasoning based on artist's creative processes (DiPaola 2009; DiPaola & Salevati 2014) to now explore/understand the concepts of 'mood and emotion' that artist/users' intent to portray in a produced artwork.

Emotions expressed in an artwork can be a reflection and record of what the artist is feeling and at the same time provoke an emotional reaction in the viewer. The choice of colour, texture and composition is to express a certain feeling or mood; a visual communication of inner emotions. Visual Art and design act as a bridge to establish a bond between psychological states of the artist with the audience, this shared meaning is affective intentional or not. It's this notion, bringing the cognitive into computational systems by attempting to understand and model this affective magic that happens between the artist and their work. With many master art works, there is this shared meaning that goes back and forth - years later an audience is connecting with what an Artist was feeling when he made his work. Within portrait work (which is one of our focuses), the emotion of the subject (or sitter) becomes a third element, we then have 1) artists' emotions when creating the piece in the trajectory of their career, 2) the emotion/mood of the subject itself shared 3) with the audience's reception to the work. We discuss this in depth and specifically when the painter and subject (and at times the audience) are the same in the next section.

Affective computing is rooted mainly within neurology and psychology and the biology on how emotion is processed in the brain, body and interaction with systems (Sundström, Ståhl & Höök 2005). There are several models that attempt to measure a user's emotional state through variables and signals in face, body, voice, muscle tension and so forth (Bradley & Lang 2000; Bradley *et al.* 2001). We explored how generative AI systems can adopt aspects of aesthetics and emotions evoked by art viewers and audience through our multiple studies. This has informed us to define emotional spaces within our CAIS. This encourages new collaborative practice that allows for users in their dialogue between intelligence systems to organically, share real-time emotional knowledge, evolve their creativity and guide their artwork through an affective space.

3. SELF-PORTRAIT

Traditional self-portraits celebrated individuality. Artist putting themselves into their work and share their essence and soul with truth and posterity unfiltered. Self-portraiture represents self-indulgence, pride or self-mockery and to advertise a new aesthetic (DiPaola 2005, 2007, 2009). They expressed a stage of the Artist's life; traces of emotions, mood and affect are portrayed through the colour palette, brush stroke and style (DiPaola 2005, 2007, 2009).

Modern self-portraits known as "Selfies" allow for expression of mood and sharing of experience. The selfie has become apart of our culture; they are a form of social interaction relying heavily on context and their existence on-line. Self captured images portray mood through facial expressions and pose; reinforcing an identity or personal image. Some researchers discuss selfies as an extension of modern narcissism – an inflated sense of self (Drexler 2013). Our research focuses on the juxtaposition of selfles with traditional self-portraits of artist as a reflection of essence - a mirror of emotions that are explored through various painting attributes.

Self-portraits were once only reserved for the master painters like Rembrant or Van Gogh but now Selfies have become ubiquitous due to their democratic and non-permanent nature (DiPaola 2010). Selfies echo the traditional self-portraits such as Van Gogh's series with less intensity due to its immediacy, nonetheless revealing the inner-self and emotions to the outside world in the most vivid way. Selfies are casual, improvised and quick and their main purpose is to be shared on social network. However their spontaneity does not dismiss their value, expression of affect and visual communication of self. They may be instant but their existence is lived and distributed.

4. STUDY 1

Both our studies use modules from our labs large and multifaceted CAIS system. One module used extensively in this work is, ePainterly, which takes source photography and filters it through computer modelled art techniques using algorithmic, image processing and perlin noise sub-modules to generate colour palette, stroking and style techniques associated with modern art painting. The system is written by the authors in the Lua programming language and is an extension to our labs major cognitive painting system Painterly (DiPaola 2009, 2013, 2014), which models the cognitive processes of artists based on years of research in this area.

Our first study focused on affective assessment. Here we take as inspiration the works of Rosalind Picard's work on affective learning (Kort et al. 2001) that propose an emotion model built on Russell's circumplex model of affect (Figure 1) and works of Sundstrom, Stahl and Hook's emotional mobile messaging (2007) work that map that model to a palette (Figure 4). Russell's proposed circumplex model categorizes emotions by two axes of arousal and valence. Arousal represents the energy and activation of an emotion including high (positive arousal) and low (negative arousal). Valence describes the pleasure (positive valence) and displeasure (negative valence) of emotions (Russell 1980). We used this model for our emotional assessment in our two studies. We choose the following 12 emotions in 4 different categories (3 from each quadrant of Russell's model): excited, delighted, happy - satisfied, relaxed, calm - tired, bored, sad - frustrated, angry and afraid.

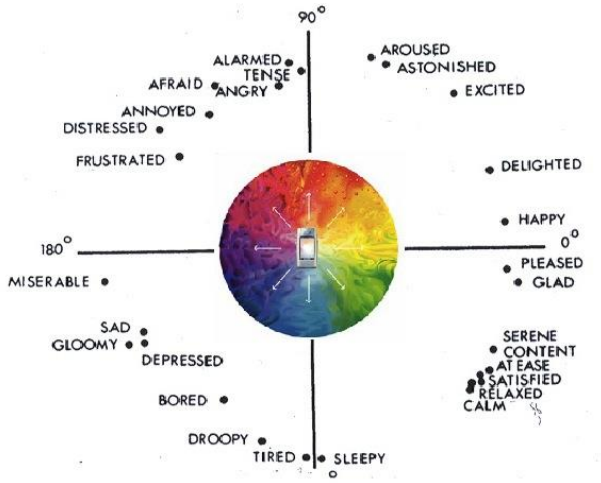

Figure 1: *Russell's circumplex model of affect and Sundstrom, Stahl and Hook's eMoto colour mapping*

There were a total of 30 study participants (aged 20-45, 11 male, 19 female). We ran the total of 3 surveys, including 10 images in each (10 painterly recipes) with different seed files. We wanted to confirm that each recipe (i.e. painting instruction script) within our system regardless of the subject matter would trigger and arouse the same feeling and emotion in our subjects. It was important for our study to not be content specific due to the results from our earlier pilot study where participants were mapping emotions based on a facial expression and pose of the subject in the photos. We wanted to de-couple the content from the influence of visual attributes on mood. Our goal was to map the palette, brushstroke and texture to a particular emotional space.

Procedure: each survey was 6min (35s per photo) and participants had the option of choosing a primary emotion and also secondary emotion that they thought best matched each image as "humans rarely associate definitive emotion with pictures and believe that great works of art evoke a mix of emotions" (Joshi *et al.* 2011). Therefore we provided the participants with categories that are not completely independent, where the primary and secondary options allow them to define a space and correlation between 2 different emotions.

The result of the study provided us with preliminary data to inform and define various spaces within our ePainterly based CAIS environment (Figure 2). The survey identified corresponding emotions selected by majority of viewers of the various artwork (scripts or recipes) produced by our CAIS's ePainterly. In our synthesis we were able to identify recipes within each quadrant particularly four that were most selected by our participants. Each script (recipe) or ePainterly has several lines of calls to create different hierarchical layers of colour palette, stroke and style deviations. The recipes have archaic names like 'P12P32' based on the calling script to ePainterly, which we will refer to in the next sections.

4.1 Summary of the results

The general findings included the following:

- Cool colours were tagged as calming
- Warm colours were tagged as energetic
- Highly saturated colours were felt more intensely
- Lighter colours were associated with positive feelings
- Darker colours were associated with negative feelings
- Palette and Saturation conveyed a greater emotional impact.
- Colour schemes that vary in saturation and value were more effective at communicating emotion.
- Texture and tension communicated emotion through exaggeration of forms, and stroke style - intensity of swirls (smooth swirls provoked positive emotions, short interrupted strokes were matched as negative)

After further examination of our survey results (Figures 2,3) the finding can be summarized into the following quadrants based on visual attributes and the most selected corresponding recipe (the extreme 4).

Quadrant 1- Excited, Delighted, Happy (Recipe P12P33)

- Palette: bright red, pink, orange

- Brush Stroke & Texture: high pigmented, defined, contrasting, bold (Chiaroscuro, opaque)

Quadrant 2- Satisfied, Relaxed, Calm (Recipe P12P12)

- Palette: deep and light green and blue
- Brush Stroke & Texture: soft texture, blurred, informal (hatching, glaze)

Quadrant 3- Tired, Bored, Sad (Recipe A06)

- Palette: soft purple, pink, navy blue
- Brush Stroke: blended, transparent, soft (scumbling, glaze)
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Quadrant 4- Frustrated, Angry, Afraid (Recipe A07)

- Palette: deep purple, magenta, red
- Brush Stroke: swirly, intensified, saturated, bold (opaque)

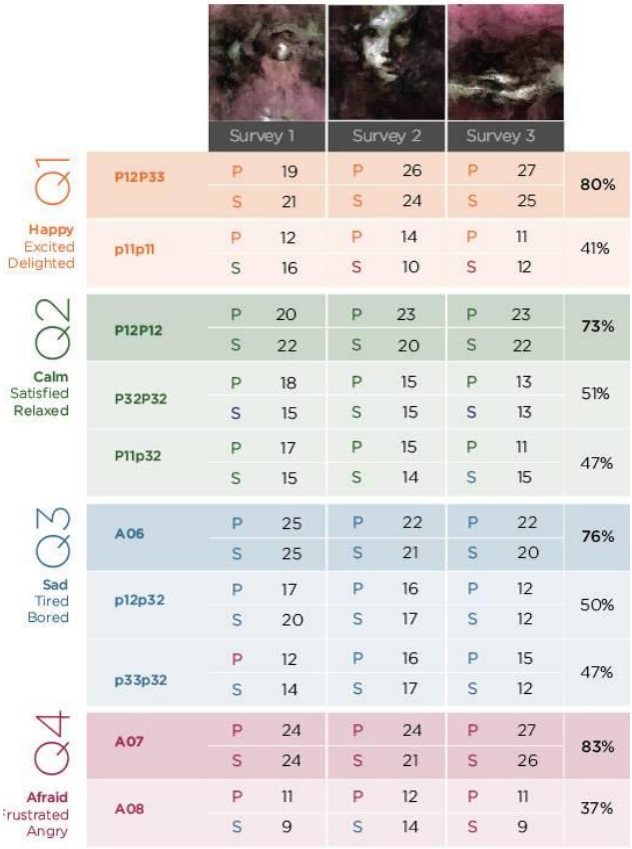

Figure 2: *Results from our first study*

We also visually mapped the placement of these recipes within Russell's Affective Model (Figure 3) to document the variant degrees of the emotions portrayed by each image. We designated a space to each recipe based on the calculations of primary and secondary tagged emotions.

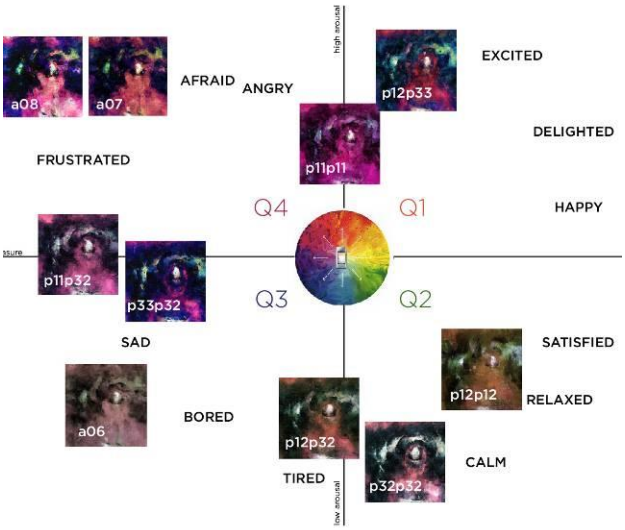

Figure 3*: Visual Quadrant map of study results*

5. STUDY 2

This second study aimed to validate our results from our first survey study. Due to the fact that our research focuses on an interactive portrait system as an investigation of various affect and emotion, we wanted to confirm our findings (recipes to emotional mappings) through an individual self-portraiture emotional assessment.

This second study included a total of 20 participants (aged 20-45, 10 male, 10 female) that were not involved in our first study. Each participant using our CAIS interactive system had their portraits taken. This photo was then processed through our ePainterly module and evolved in our system based on the four identified recipes found as a result of our first study (Quadrant 1-4). These four evolved art portraits (Figure 4) representing the different emotions (palette, brush stroke, texture) were then shown to each participants at high resolution for them to self assess and match their portraits with different quadrant of emotions based on Russell's circumplex. The purpose of this study was to affirm that our four CAIS emotional recipes (from study one based on non-content specific artwork) match with study two participant's emotional evaluation of their own self-portraits.

Procedure: each participant took about 3-5 minutes to examine each of their 4 portraits in high-resolution / full display size and after proceeded in matching each photo to the different emotional category (Russell's quadrants of emotion) provided. After an unstructured interview they provided general feedback about their reaction to our ePainterly based generated portraits, picking their favourite, and gave reasoning behind their emotional category selection and which portrait they most related to at that moment.

***Figure 4**: Evolved portraits of one of our participant's source photo (Jordan 2015) based on the four emotional recipes identified in 1st study*

5.1 Summary of the results

The findings validated the emotional mappings of our recipes identified through the first study. The majority of our participants matched the correct recipe to the corresponding emotional quadrant (Figure 5).

The participants found that the portraits were striking, unexpected and at the same time strange to look at. They were able to relate to all portraits as they recognized the emotion that they evoked through the different palette, brushstroke and texture. Quotes from the participants:

> *"When I saw the portraits, I was amazed at what I saw, they are beautiful, striking and intense, I am full of emotion. I thought to myself, is that me?" (Zina 2015)*

> *"They are unexpected, like an abstracted version of me" (Rob 2015)*

> *"The longer I look at them the more interesting they become, hard to recognize it as myself but the longer you stare and having to go through and assign qualitative emotion it becomes more interesting - I can relate to all of them, they are beautiful!" (Jordan 2015)*

> *"I can't believe it's my picture! I Love them. It's amazing how different colour tones and lighting can affect your emotions in different ways." (Lisa 2015)*

> *"I was amazed with how my pictures could have evolved into different ones. I can recognize my picture but the facial features were changed dramatically depicting different emotions. It was interesting how this was possible." (Jackie 2015)*

> *"The colour is the most powerful, I'm also drawn to the eyes" (Michael 2015)*

They felt that each portrait expressed and brought out their essence in a different way. For instance 15/20 participants picked the "Happy (P11P32)" as their favourite due to the energetic and positive emotion it triggered.

> *"Happy (A) is my favourite because of the reds and warm colours and curved brush strokes and circular pattern! (Rob 2015)*

> *"Happy (A) is my favourite; the colours explode in there, out of the four its the more uplifting and has the brightest palette, the composition has more calmer swirls and the eyes are most distinguishable (more defined eye shape, which looks more like a person)" (Jordan 2015)*

> *"My favourite one is Happy (A), because of the pink, purple and blue tones make me feel happy" (Lisa 2015)*

> *"Happy (A) is my favourite because it's the most energetic (you can feel the mood and emotion through the brush strokes" (Maryam 2015)*

> *"Picture (A) brings the essence and life to my picture" (Zina 2015)*

Based on our findings it is evident that our recipes have captured our intended affect and mood. This study brought to our attention the awareness and level of distortion in the original photo's facial expression, which made it hard for the participants to recognize themselves. Some found it challenging to de-couple their facial expression (smile) from the overall mood represented (background).

> *"It is hard to separate the facial expression from the background (my face is not abstracted enough, I can see the smirk in my face)" (Jeremy 2015).*

We also learned that the eyes were an important factor for our participants in identifying the emotion

provoked in each portrait. For-example the fearful portrait was tagged mainly due to the expression of the eyes.

> *"I tagged D as the most fearful because the eyes are the darkest, the chaotic spirals, agitated and upsetting swirls, frenetic strokes (its like a photo of a ghost)" (Jordan 2015)*
>
> *"The lack of eyes is so scary in D, I've never seen myself like that" (Alan 2015)*
>
> *"D is the most fearful because of the un-human nature of it – it portrays anxiety" (Graeme 2015)*

Happy Excited Delighted	P12P33	16/20	80%	Q1
Calm Satisfied Relaxed	P12P12	17/20	85%	Q2
Sad Tired Bored	A06	16/20	80%	Q3
Afraid Frustrated Angry	A07	17/20	85%	Q4

***Figure 5**: Results from our 2nd study*

6. USER EXPERIENCE (UX) IMPLICATIONS

Our studies have confirmed our approach to designing interactive CAIS experience where emotional can be an active parameter within several domains and applications. These include: within computational creativity, affective aesthetic visualization, experiential learning in museums (art education), performance visualization (dancing), and health well-being. The design of such systems has to act as both a support tool engaging some cognitive load of creativity, and also to provide a poetic and intuitive UX that evokes reflection through interaction. We strive to design systems that facilitate communication by establishing a dialogue that supports affective knowledge exchange in a non-linear interactive experience - promoting collaboration and active participation between user and the CAIS based on emotional mindfulness.

6.1 Art Education

Within the art education domain (DiPaola & Salevati 2014, 2015), our CAIS interactive experience complements the traditional art viewing process by allowing users to explore various palette, brushstrokes and texture to improve their understanding and connection with the Artist's creative process and emotional experience. This promotes engagement and active learning within museums by facilitating deeper personal appreciation of artwork through immersion. Not only this added interaction shapes and influences a specialized learning environment by arousing viewer's curiosity but also embraces their creativity; fostering attention, aesthetic, novelty and prolong involvement. Our system (Salevati & DiPaola 2015) defines the nature of the activity by allowing visitors to participate in the formation of purposes driven by their own interest in order to create knowledge (Figure 6), rather than simply transferring it (such as exploring Futurism or the colour palette and stroking style of late Van Gogh's self portraits). Our CAIS museum applications are driven by interest and then sustained by a flow state and reflection; fully involving the mind & body in an intrinsically emotional activity. This self-directed and multi-modal experience is visitor focused, open-ended, triggers the process of making meaning, thus preparing the viewer for broader, richer experiences by expanding possibility through emotional co-creation of ideas and self-concept.

***Figure 6:** Example of an exploration of palette of the Post-Impressionism era of Vincent Van Gogh 1889 using our CAIS personal portrait system*

6.2 Performance Visualization

We have also explored our interactive affective CAIS within movement awareness and performance (dance) domain (DiPaola & Salevati 2014). We used cognitive and AI parameters to produce unique artwork from live user movement of a performer/dancer in front of the digital canvas to automatically generate an "aesthetic visualization" based on various emotions and mood. With this investigation we are interested in the performer (dancer) awareness and understanding of their movement and its like to emotional expression through performance within the visual art field (Figure 7). Through our system we produced a process where a performer/dancer through movement and flow, becomes an active participant in the art making process and can interactively produce and evolve the style of an artwork through different emotions, thus experiencing art through

the creation process. This explored an AI based analysis and generation of aesthetic interactive visualizations of art styles with human movement an expression. A dancer moving in front of our work is sequenced (using a Kinect), through which our AI algorithms auto generate artwork in various styles based on generative parameters and user's behavioral & emotional engagement through various UX strategies.

Figure 7*. Example of a user moving in front of our system is sequenced where our CAIS generates artwork in various styles based on affect.*

6.3 Health Well-being

We expanded our Affective CAIS interactive experience within the health and well-being sector as we saw a great potential of its benefit in the therapeutic domain. In collaboration with Fraser Health Medicine Program we investigated the design and development of adaptable therapeutic experience – an interactive and evolving application and story using our CAIS to bring a refreshed perspective to the mission of healing (Salevati & DiPaola 2015). We wanted to engaging patients in a creative process to redirect their fear and anxiety through a positive distraction. CAIS promotes the act of creation and creativity as therapy and brings interactivity to the traditional nature of art therapy. Our interactive CAIS, which generates computer graphics based art portraiture, where we try to recognize what patients are experiencing (emotionally) when they view certain art work styles by considering their emotional responses in creating and evolving their portrait painting and using that as input within our system (Figure 8). Through the use of our affective CAIS, patients are presented an affective visual sensory application that provides the calming stimuli that supports 'healing.' This encourages new collaborative practice that allows for patients to create a dialogue with the system that can organically, share and exchange real-time information and to guide their artwork through an emotional space, redirecting anxiety and fear. Communication and behaviour are mediated through our CAIS system; resulting in a faster and more positive journey back to wellness.

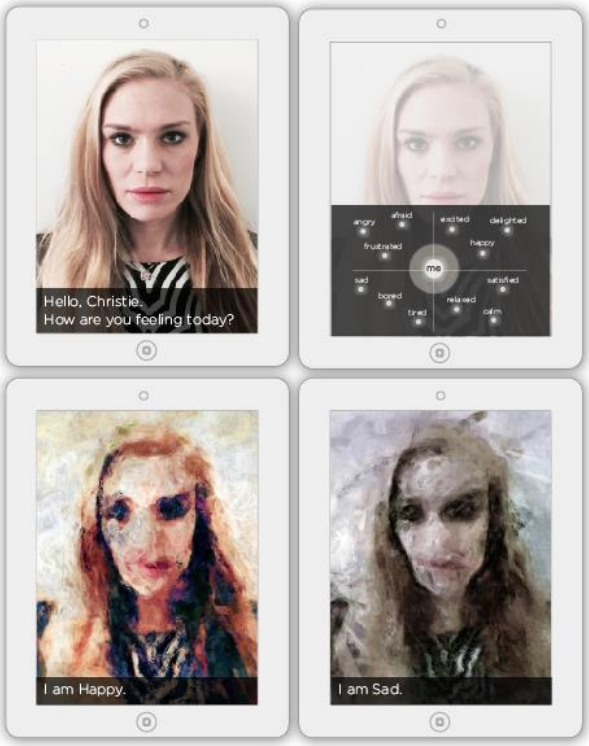

Figure 8: *Example of an exploration of our Interactive Affective CAIS in health well-being domain.*

7. CONCLUSION

With the success of our evaluation we are more confident that our Affective CAIS can be used for variety of applications. Our findings have expanded our AI system's affective cognitive model by defining emotional spaces that map to corresponding aesthetic visualization. We have learned that the integration of emotional exploration within interactive CAIS systems not only enhances the user experience but also stimulates a personal narrative. The reflection of essence and expression of emotion that is made explicit by our systems are relatable promoting a deeper connection by establishing a real-time dialogue between users and the system. The users through observation, affective experimentation and creativity broaden their thought process and discover and navigate their emotional state and mood.

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