Calm Digital Artwork for Connectedness: A Case Study

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Abstract. Connectedness is increasingly recognized as an important aspect of life and wellbeing. The technology-driven solutions aimed at fostering connectedness can also introduce negative pressure or influence when too much precise and real-time information is involved. There are also growing concerns regarding information security and privacy associated with these solutions. This study aims to address these challenges by proposing a novel approach that combines the principles of calm technology with the expressivity of Mondrian style digital artwork to create connectedness between loved ones apart. Using a co-constructing story approach, we conducted a user study involving five participant groups to stimulate their imaginations and visions. The results showed that combining wearable data with Mondrian style artwork can provide a unique and meaningful way to strengthen emotional bonds among distant loved ones. This study provides a fresh perspective on connectedness, suggesting a novel engaging solution. Future research could explore wider applications of this approach and further refine the user experience and practical implementation.

Keywords: Calm Technology · Connectedness · Digital Artwork

1 Introduction

Connectedness, the feeling of belonging and emotional closeness in relationships, is a fundamental aspect of human well-being and social functioning [1]. Researchers have reported several different forms of connectedness, including connectedness to the self; connectedness to others, including the social network of family, friends, colleagues, and other social groups; and connectedness to a larger meaning or purpose in life [2]. Studies have consistently shown that individuals with higher levels of connectedness experience lower levels of stress, depression, and anxiety [3]. Moreover, strong social connections have been associated with improved immune system functioning and a reduced risk of mortality [4].

Technology-driven solutions have emerged to facilitate connectedness, enabling people to transcend geographical boundaries and forge closer relationships [5]. Visual-based studies such as the Carenet Display [6], Aurama [7], Daily Activities Diarist [8] and MarkerClock [9] rely on the contextual information for supporting connectedness. For individuals who do not require health monitoring, the design approach that involves exposing precise and specific data may actually have some negative effects. However, an excessive reliance on digital communication platforms and the constant availability of real-time information can lead to superficiality, information overload, heightened stress, and diminished well-being [10, 11]. This can strain family relationships, disrupt privacy, and create pressure to respond immediately, causing stress and misunderstandings [12].

In relationships and interactions, connectedness can be strengthened through the expression and recognition of implicit emotions [13]. These emotions add depth and meaning, allowing individuals to connect on a deeper level beyond explicit communication. To strike a balance between leveraging technology for connectedness and addressing potential drawbacks, this study proposes a unique approach. It combines the principles of calm technology [14] with the expressive power of Mondrian style digital artwork [15]. The abstract compositions of Mondrian, such as "Broadway Boogie Woogie," represent the lively and energetic atmosphere of New York [16]. Our study uses gathered data on a person's activities to create artwork.

2   Related Work

2.1   Calm Technology and its Application in Design

The principles of calm technology aim to create a harmonious relationship between humans and technology by reducing cognitive load, providing ambient feedback, and respecting users' attention and focus [17]. One of the key principles of calm technology is to prioritize the display of information in a non-intrusive manner. Calm technology principles have found applications in various domains, including wearable devices, smart homes, and ambient displays [18]. Wearable devices leverage calm technology to provide users with relevant health and activity information without disrupting their daily routines. Smart homes equipped with ambient displays and context-aware devices use calm technology to create a harmonious living environment that adapts to users' needs and preferences.

2.2   Understanding Mondrian Art and its Potential for Expressing Connectedness

Mondrian's artwork, known for its geometric abstraction and use of primary colors, its adaptable style has been applied in fashion, architecture, digital design, and generative art, reflecting its lasting impact [19]. Utilizing Mondrian's artwork, particularly his Broadway Boogie Woogie (BBW) (see Fig. 1), can evoke emotions and create a visual language that transcends cultural and linguistic boundaries, allowing individuals to connect and relate to the artwork on a deeper level [20]. The BBW, with its vibrant colors, dynamic rhythm, and energetic patterns, represents the pulsating vitality and dynamism of human interactions [21]. Incorporating the aesthetic principles of BBW

into design by using wearable technology, offers the potential to create visually captivating experiences that resonate with individuals, evoke emotions, and strengthen the sense of connectedness.
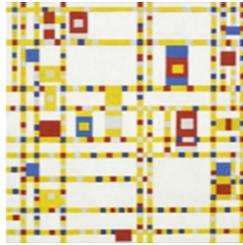

Fig. 1. Broadway Boogie Woogie (BBW), Piet Mondrian 1943

3 Design and Implementation
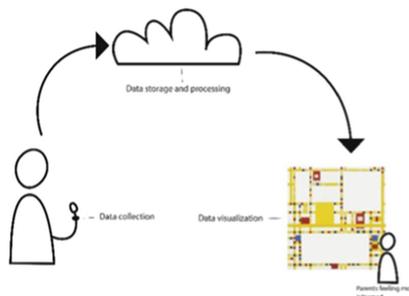
3.1 Design Concept of Artify

Fig. 2. Concept structure of Artify system

Artify system (see Fig. 2) aims to connect users by means of artistic data visualization, which consists of data collection, data storage and processing, and data visualization. Data is collected by wearable which could track the step, calorie and heartrate, which could be tracked by current health products. Asynchronously collected data is then processed for generating artwork visualization. This program is written in the Processing environment, based on Java. To strike a balance between the artwork's aesthetic effect and the meaningful representation of activity data, we have incorporated rules based on Mondrian's BBW artwork principles, such as creating little blocks inside the lines and not overlapping blocks or lines, to maintain similar visual effect to the original.

3.2 Data Mapping in Processing

Amount of Steps. The number of steps taken by an individual influences the composition of the artwork, specifically the number of bars and small squares. The relationship

between the two is intertwined, with approximately 20–25 small squares corresponding to the desired number of bars. The original artwork displays the maximum of 20 lines, which is equivalent to a person walking up to 15000 steps a day. However, to maintain visual recognition and aesthetic appeal, the minimum number of lines is set at 6 (see Fig. 3).
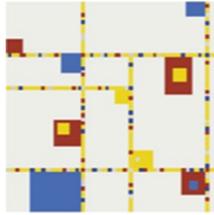

Fig. 3. Example of minimum lines (6) displayed

Amount of Calories. Recommended calorie ranges [22] for men (2000–3000) and women (1600–2400) are used as a basis for calculating the number of calories burned per hour. The calories burned are divided into three levels: low, medium, and high. A single layer block represents a low amount of calories burned, two layers for a medium amount, and three layers for a high amount (see Fig. 4). The size of the blocks varies randomly within a specific range, with smaller blocks representing lower calorie levels and larger blocks accommodating nested blocks for higher calorie levels. The range is determined by the original artwork's block sizes.
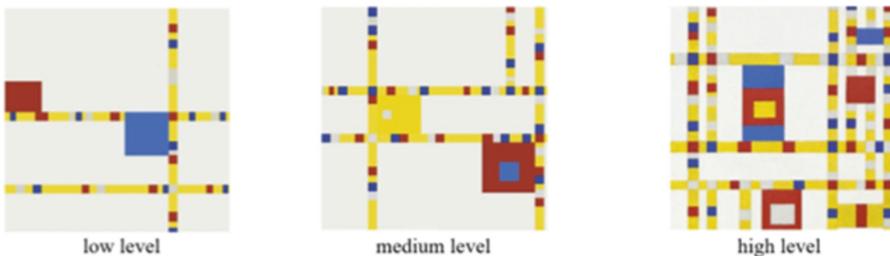

low level   medium level   high level

Fig. 4. Example of level of calories

Heart Rate. Heart rate would be mapped to the dynamic part of the little blocks. Have the little blocks move in place, pulsing based on the average heart rate per day. The little blocks on the yellow lines would be stationary and would enlarge and get smaller in a pulsating manner.

3.3 Integration of Calm Technology Principles

Prioritize the Display of Information in a Non-Intrusive Manner. This means that notifications and alerts should be designed to be subtle and unobtrusive, minimizing

disruptions to the user's focus and flow. So we use wristband information to stay connected, and display one day activity asynchronously through Mondrian style artwork, so the receiver will not be overwhelmed by constant interruptions.

Design for the Periphery. In the context of connectedness systems, this means presenting information and interactions in a peripheral or secondary manner, rather than demanding constant attention. In our study, we involve using ambient photo frame to convey information without requiring direct and continuous user interaction.

Consider the User's Cognitive Load and Mental Well-Being. Excessive cognitive load, such as dealing with an overwhelming amount of information or complex interactions, can lead to user frustration and reduced engagement. Our study minimizes cognitive load, receivers can better focus on and maintain meaningful connections with their loved ones, without being overwhelmed by excessive or precise information that may cause worry or anxiety.

3.4 Incorporation of Mondrian-Inspired Elements to Express Connectedness

In terms of design principles, this artwork embodies several important principles of Mondrian's art. Firstly, it exhibits balance, as the lines and shapes within the composition are distributed and balanced, with no single element dominating the visual weight, resulting in an overall sense of harmony. Secondly, it demonstrates boldness, with Mondrian's use of vibrant and saturated colors, as well as precise lines and shapes, showcasing his courage and determination in visual expression. Lastly, it incorporates white space, creating visual space and balance, allowing other elements to stand out and command attention.

4 Methodology

The co-constructing story [23] is a participatory design technique to elicit users' in-depth feedback and suggestions about the design concept. Artify is a system which aims to connect users by means of artistic data visualization. In this study, Artify was presented as a probe to evoke users' contextualized visions based on their experiences. We have created a storyboard that presents Artify as an open design concept, rather than a completed prototype, to stimulate users' imagination and vision.

4.1 Participants

A total of 10 participants (5 pairs of parents and children) were selected as participants for the study, aged from 20 to 60 years old(parents M = 49.8, SD = 4.83; children M = 22.2, SD = 1.74). The inclusion criteria for participant selection were based on the relationship between the participants (parent-child) and their willingness to participate in the study. The snowball sampling [24] technique was employed for participant recruitment. This study was approved by the local Ethical Review Board (ERB). To avoid causing unwanted feelings, users are informed in the consent form that they can stop participating at any time. They can revoke their permission to use their data under any circumstances.

4.2   Co-constructing Stories

Sensitization Phase.   *"Jim has been living with his parents for a long time now and this was of course not always easy or fun, but overall it was a good time. Jim recently moved out of his parents' house to live on his own while studying in a different city. While he enjoys the freedom, he also misses certain aspects of living with his parents. His parents, on the other hand, miss him greatly and frequently reach out to him through text messages and calls during the week. Although sometimes inconvenient, Jim understands that their messages come from a place of love and concern."*
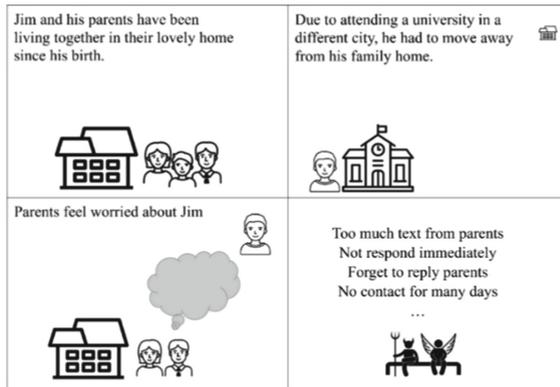

Fig. 5. Sensitization scenario

In the sensitization phase, we started with a fictional story through sketch(see Fig. 5) to introduce a couple of scenarios in order to evoke participant's past experiences on connectedness. As a result of this dialogue, stories revealing past experiences were elicited that enriched our understanding of the current context of interaction between the parents and the child.
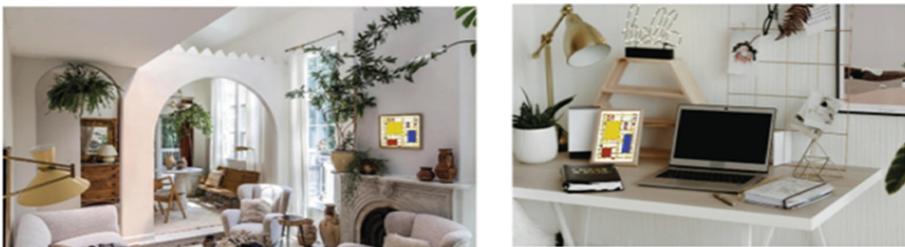

Fig. 6. Visioned context

Elaboration Phase.   In the elaboration phase, we introduced Artify in a visioned context(see Fig. 6) and illustrated the concept. Then we explained how the Artify system

worked and how Jim and his parents interacted with it. After the story ended, we asked the participants to illustrate suggestions about the Artify design to elicit their positive and negative feedback. At last, they were asked to fill out a questionnaire with 5 points Likert scales (ranging from -2 to 2), the questionnaire is developed independently for connectedness(unobtrusiveness, minimal disruption and calm), calm technology(more connected, easily contact, emotion enhancement, understand lives of others) and user experience(enjoyable, customized, positive impact, relaxed) for liking-the overall impression of the concept. The whole session lasted about forty minutes and was audio recorded.

Analysis. We transcribed the interview recordings that covered the whole storytelling session. In total, there were 530-min of data from all the participants; each in-depth interview lasted for approximately one hour. We conducted the thematic analysis method to identify user's contexts, expectations, as well as attitudes on the usage of visualization design. These aspects formed our main analytic interests.

5 Results

5.1 Calm Technology and Connectedness

Figure 7 shows the average score of Calm Technology, Connectedness and User Experience for Liking score of the different concepts. Several participants mentioned that using the technology made them feel more connected to others. It allows users to stay in touch over any distance, offering some personal implicit representation of the loved one through activity data. One participant even envisioned a collective artwork as a symbol of their family's unity. They believed that having a shared piece of art will allow them to bond with siblings and strengthen their family bonds. They also expressed a desire for works of art to incorporate data reflecting mood and emotion. They believed this would lead to a deeper understanding of each individual's emotional state and facilitate more meaningful dialogue and support among family members. By avoiding an over-reliance on precise data and prioritizing emotional communication and interaction, participants believed that calm technology could foster genuine connection without compromising privacy or causing discomfort.
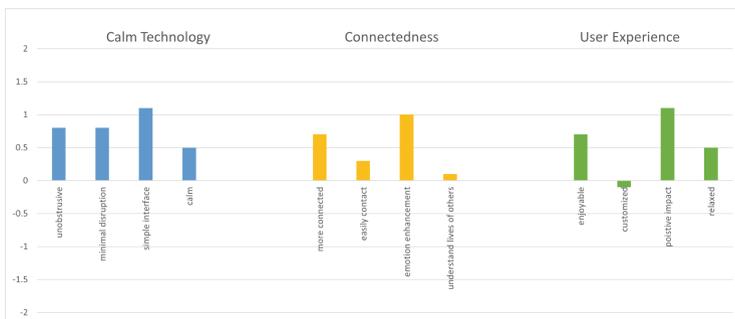

Fig. 7. Mean score of calm technology, connectedness and user experience of 10 participants.

5.2 Mondrian-Inspired Digital Artwork

The participants expressed keen interest in the Artify system, envisioning it as a platform for fostering connectedness within families. They desired a shared artwork representing the family unit, with personalized sections for each family member. The visually appealing Mondrian art style was seen as suitable for prominent display in living environments, serving as a central piece for family connection and conversation. Privacy concerns were emphasized, with participants emphasizing the need to respect personal boundaries and avoid surveillance. Additionally, some participants wanted the freedom to customize their own digital works beyond the constraints of Mondrian's style.

6 Discussion and Limitations

6.1 Discussion

Artify system offers a unique and innovative way to foster personal and family connections. Where traditional approaches typically rely on communication platforms, social media or messaging apps to facilitate connection, Artify leverages art and data visualization to create a more engaging and meaningful experience. A notable strength of Artify is its ability to bridge the gap between technique and aesthetics. While other technology-driven approaches may focus primarily on function and information exchange, the Artify system emphasizes visual appeal and artistic expression. By incorporating personal data into visually pleasing artwork, the system adds an aesthetic dimension that enhances users' emotional connection and engagement.

Furthermore, Artify provides a balance between privacy and connection. Participants expressed the importance of privacy and did not want the system to be intrusive or overly revealing. The system solves this problem, allowing individual artwork for each person or family member, enabling individualized performance while promoting a sense of togetherness through shared visual elements.

6.2 Limitations

The small sample sizes used in the user study may limit the generalizability of the findings. It is important to include a larger and more diverse pool of participants to gain a comprehensive understanding of user experiences and preferences related to connectivity and digital arts. This study mainly relies on hypothetical scenarios and participants' perceptions and preferences rather than real-world implementations. The lack of testing and evaluation with deployment in the real context can lead to unanticipated challenges or limitations not identified in the research. It is crucial to conduct practical trials to verify the functionality and effectiveness of the system.

7 Conclusion and Future Work

The study explored the integration of calm technology principles with Mondrian-inspired elements in the design of an artwork based on activity data. The findings contribute to: 1) understand how technology can be used to facilitate connection to address the limitations of traditional communication methods; 2) Designers and researchers can develop

interventions that promote meaningful and balanced connectedness while addressing privacy concerns and avoiding information overload.

Future research directions could focus on gaining insights into how individuals perceive the meaning of data visualizations and integrating these interpretations within interconnected contexts are crucial steps to elevate the efficacy and influence of Artify. The artwork could find application in healthcare settings, creating visually stimulating and calming environments that promote well-being and connectedness. Future research and practical applications could further explore the impact of such artwork on individuals' well-being and expand its utilization in various contexts.

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