The Virtual Touch Toolkit: An Interactive Media Mobile Application for Promoting Well-Being through Affective and Social Touch

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***Abstract*—The "Virtual Touch Toolkit" is the exergame bundle of a newly developed smartphone application for mental health. The primary aim of the exercises is to promote self-discovery by focusing on social, affective touch. The necessity of acknowledging the undervalued properties of affective touch in this day and age is more important than ever as a global pandemic is provoking societal changes that are predicted to be detrimental to our mutual need for affective touch. The toolkit comprises multiple features and sets of exercises, which are designed to stimulate the user's oxytocinergic and reward systems while offering educational insights on affective touch.**

Keywords—mobile media, gamification, health technologies, well-being, neurology, affective touch, social distancing, COVID-19

I. Introduction

The COVID-19 pandemic has challenged us in many ways, but it has also provided many opportunities for the invention of creative solutions to help us cope with it. Mandatory solitude and perceived loneliness were some of the many challenges, which, albeit intolerable for some, provided space and time for focusing on personal facets of life by practicing self-awareness and introspection. The "Virtual Touch Toolkit" (VTT) smartphone application is an exergame bundle that promotes self-discovery by focusing on social, affective touch, which refers to the emotional as opposed to the discriminative dimension of the touch modality [1]. Specifically, the exercises of the toolkit aim to popularize scientific knowledge regarding the neurobiology of affective touch while also providing a novel approach to social bonding.

Social, affective, touch is the emotionally driven and intentional physical contact between humans and one of our most unrecognized needs. Recent research has revealed that affective touch is essential for the healthy development of infants but also the emotional regulation of adults [1]. Until only recently, touch, as a sensory modality, was considered to be entirely discriminative, meaning that touch was viewed as the process of localizing contacts on the skin, as well as the encoding of pressure, vibration, slip and texture [2]. Low threshold mechanoreceptors (LTM) coupled to myelinated A-beta afferent nerves in human skin send signals through the somatosensory system to the brain at speeds of 200 miles per hour that subserve discriminative touch. On the contrary, a recently discovered subclass of unmyelinated afferents in humans called "C-tactile afferents" (CT), also known as C low-threshold unmyelinated mechanoreceptors, send signals to the brain at far slower speeds and relay a different variety of signals than the A-beta afferents [3]. Studies suggest that CTs are the transmitters of "social touch" in mammals, as the main functionality of these afferents is to respond to stimuli, which are typical of a caress [2,4]. Many factors contribute to the stimulation of CTs and the pleasantness generated by social touch, some of them being the body temperature of the groomer (the ideal being around 32°C) [5], the stroking speed [3], gender [6], who the groomer is and what the hedonic tone of the groomer's physical touch is like [4]. The distinction between affective and social touch is that affective touch focuses on the emotional component of somatosensory stimulation while social touch signifies the exteroceptive aspect of affective touch through social interaction [1]. The toolkit is primarily self-oriented, with a focus on activation of the affective touch and reward systems through either self-touch [7], vicarious touch [8], or imagined touch [9]. The exercises of this application are designed for individual use but they often require the participation of partners or the involvement of other users who own the VTT.

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Specifically, this application addresses the importance of social, affective touch through a digitized and secure form and this aspect is considered to be its contribution to counter the ever-growing social isolation which has resulted from regulations to curb the pandemic. It should be noted that social isolation and reduced physical contact before the pandemic has been linked to loneliness, a pandemic per se, that predates COVID and is likely to require addressing long after [10]. Loneliness could also be experienced within once fulfilling social relationships and this phenomenon, called entropy, could be explained in neurobiology from a lack of the oxytocin neuropeptide, which is the hormone of "social bonding". A highly recommended solution to the issue of entropy is to engage with loved ones or acquaintances in recreational activities [11], such as playing the proposed games, most of which are especially designed to modulate the oxytocinergic system. VTT is also created with the prospect of enriching the user's understanding of their mental health by providing a clear outlook on their changes in mood over time. More potential uses of the VTT, which are still under consideration, range from using affective touch for tackling neuropsychological disorders, such as body image disorders, to exploring the differences in the experience of affective touch between ethnic groups.

II. THE VIRTUAL TOUCH TOOLKIT

The layout design of the toolkit has been selected from an array of custom layouts, created especially for this project. Some of the software programs that were used in the development and design of the application are the Unity game engine, Adobe Illustrator, Clip Studio Paint, and Axure Pro. The toolkit is available on Android and iOS operating systems. The VTT is designed for neurotypical adults, who struggle with physical, social contact or affective touch in general. The VTT could also prove useful to anyone simply interested in learning about affective touch and the discovery of its undervalued properties in well-being. Furthermore, the design of the toolkit's development allows data collection, which is used both for the enhancement of user experience and the study of experimental procedures on affective touch. The data include the user's emotional state, performance in each exercise, data from custom texture mapping, as well as exercise evaluation, which results from questions answered by the user after completion of each exercise.

A. *Virtual-touch exercises*

The toolkit includes a host of short exercises that make use of the user interface elements and 3D models. The exercises are divided into four different types, namely mindfulness, stress control, bodily awareness, and touch training, although most of them constitute combinations of these four (Fig. 1).

Fig. 1. Virtual-touch exercises. The list of the VTT exercises (left). The four types of exercises of the VTT, i.e. stress control, mindfulness, touch training and bodily awareness (right).

For this reason, we categorize the exercises below as "affective-touch exercises with virtual humans", "discriminative-touch exercises", "Self-touch exercises", "Social-touch exercises", and "Rhythm exercises". Each exercise has three main sections: (i) relevant educational information (ii) tutorial on how to perform each exercise (iii) a questionnaire evaluating the effect that the specific exercise had on the user's mood.

1) Affective-touch exercises with virtual humans: Here the user is encouraged to interact with a "virtual human". They must first imagine being stroked on various body sites while having the 3D model of the human body as a reference. Specifically, the user is prompted to "paint" the body sites of the virtual human and indicate where they feel more and less comfortable while being stroked [12], where being touched would feel more and less pleasant [13] and where being touched would feel more and less soothing [14]. By selecting the preferred colors from a color gamut, the user can create a representative body image that can be compared across time to reveal how they feel about touch changes (Fig. 2).

The user is given the tools to indicate their perceived acceptability of social touch when it comes to loved ones and acquaintances. Then, a comparison by contrast between the changes in social (for acquaintances) and private (reserved for loved ones) acceptability of touching follows. These changes could be the result of time, context, and the developing relationship between the involved people [12]. The fun part of this exercise comes when a group of users has to guess each others' touch boundaries. Each user's painted 3D avatar reveals the correctness of the other user's guesses.

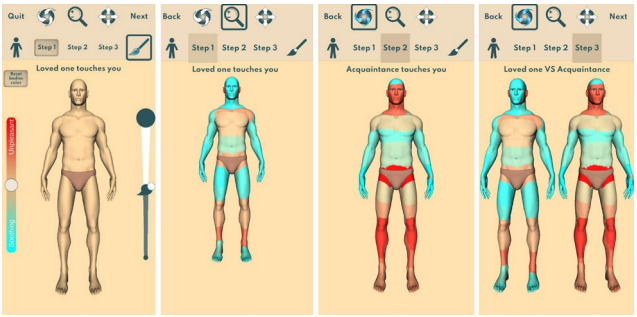

Fig. 2. Users are given the opportunity to indicate their perceived acceptability or pleasantness across social (e.g. shoulders) or private (e.g. groin) body parts, when it comes to loved ones or acquaintances. Blue-leaning colors represent a tendency for pleasant or acceptable touch while red-leaning colors represent a tendency for unpleasant or unacceptable touch.

Interestingly enough, a set of large-scale experiments, across five countries and more than a thousand participants, reveals that the areas of the body, which humans consider highly receptive to social touch, transcend cultural boundaries [12]. As a general consensus, arms and hands are used for social touch without the establishment of a close emotional relationship while the head, neck, and pelvic area are consistently reserved for individuals who share a closer emotional bond [15]. Studies on gender differences and affective touch demonstrate that men are more confident in touching than women [16]. The designation of touch zones

by males and females through the proposed application could shed more light on the aspect of societal gender norms and provide quantifiable evidence about touch boundaries.

2) Discriminative-touch exercises: The experiential design of the exercises in this category is still under development. The general concept of discriminative-touch exercises is that contrast between discriminative and affective touch helps the user distinguish the differences between the two modalities [17]. These exercises are meant to encourage the user to focus on their emotions while using discriminative touch. The "main ingredients" that we envisage incorporating into discriminative-touch exercises comprise a list of visual representations of materials to virtually interact with. The virtual materials include skin, wood, water, and a variety of fabrics, minerals, sponges, and plastics. The texture of each material is inevitably the same as the texture of the smartphone screen, but the experience is enhanced by incorporating the sounds of touching these surfaces, as a form of multisensory enhancement, by evoking the well-established multisensory illusion known as the "parchment-skin illusion" [18]. The parchment-skin illusion stems from incongruities between tactile and aural information, which occur when the sound of friction produced by touch is concealed by a modified version of the sound. The audio files that are currently attached to the images of said materials are relevant to the visual representation of each material and the audio is activated upon touching the screen. To make the parchment-skin illusion more realistic, the force of tapping or sliding the screen determines the pitch and volume of the activated audio.

3) Self-touch exercises: A fundamental function of social, affective touch is that of mood regulation and stress relief. Based on previous research, even without the presence of another, the oxytocin system activated through CT-mediated touch has been proposed as a key behavior for regulating our mood [19]. Self-touch exercises encourage free self-experimentation while lacking a concrete set of rules. Some of them involve rhythmic strokes on areas of the torso or the head (the temples and the forehead), assisting in blood circulation in the vessels of the head and oxygen consumption [20]. Other self-touch exercises encourage the users to wrap their arms around their bodies and focus on their emotions. Awkward as it may seem at first, hugging oneself could trick the brain into releasing oxytocin and offering feelings of euphoria. Hugs lasting for approximately 10 minutes contribute significantly to the release of oxytocin [21].

4) Social-touch exercises: These aim to make the user become aware of the differences between touching your skin and the skin of a partner, as the contrast makes the distinction between the sensory modes more clear [17]. This category involves experimenting with the users' kinesthetic abilities, which help them decode sensory information, such as when a partner forms the shape of a letter on a blind spot of the user's skin and the user must guess the letter. One wins if they guess the letter correctly.

5) Rhythm exercises: Lastly, the rhythmic exercises instruct the user to synchronize to the rhythm of a melody and practice affective touch with the assistance of the user interface and a metronome (Fig. 3). The practice of affective touch in combination with other rhythmical inputs, like singing, is especially important from a developmental

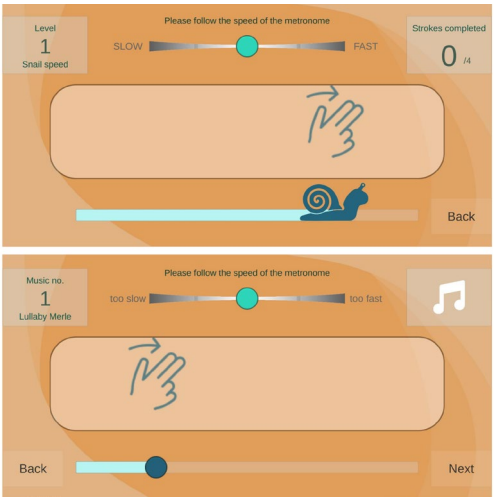

Fig. 3. Rhythm exercises about affective touch, featuring the "Goldilocks' Effect" (top) and "Lullaby" (bottom).

viewpoint for establishing and maintaining caregiver-infant bonds [22]. The use of the metronome in these exercises is based on findings of Löken et al. [3], suggesting that there is a Goldilocks zone where CT afferents are preferentially tuned to an optimal medium velocity stroking speed, "not too fast, and not too slow". According to the findings of the same study, affective caressing of hairy skin, where CT fibers are found, causes feelings of pleasantness when the stroking frequency ranges between 1 and 10 cm/s. The rhythmic exercises elucidate the frequency aspect of affective touch, both in theory and practice. The user can compete in 3 different stages (i.e. snail, tortoise, hare) and the difficulty of each stage increases according to the user's performance.

B. Emotional monitoring

Each time the user logs into their account, a scale resembling Russell's circumplex model of affect appears [23]

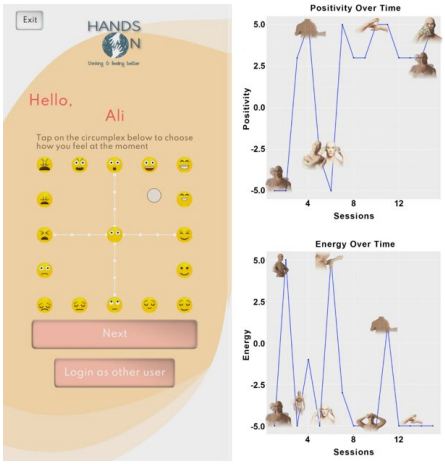

Fig. 4. Mood map of emotional state. The emoji version of the circumplex model of affect, where the users indicate their level of valence, as indicated by the horizontal axis coordinate, and arousal, as indicated by the vertical axis coordinate (left). Example dataset showing changes in mood map ratings, by positivity (valence in a more layman term) and energy (arousal) over app usage sessions with the suggested exercises undertaken by the player (right).

and the users must select the specific coordinates of the scale, which best represent their current emotional state. The use of emojis and specifically the adopted model of the EmojiGrid [24] is found to be a valid tool for assessing emotional state and its association with somatosensory and gustatory modalities [25]. The toolkit calculates the user's emotional state (Fig. 4), while also taking into consideration previous emotional states that the user experiences throughout the same day. The calculation of the user's daily emotional state is achieved by averaging the x and y coordinates of the circumplex respectively each time the user logs in throughout the day and declares an emotional state as described. Tracking the emotional state across time could allow the tracking of mood changes and assist in drawing conclusions about the user's overall mood. Moreover, depending on the user's emotional state upon logging in, the VTT offers recommendations of the included exercises.

A video demo of the Virtual Touch Toolkit can be found here: https://youtu.be/26a17eA9yL8

III. CONCLUSION

In conclusion, the toolkit serves as a reminder of the importance of affective touch, as a fundamental biological human need. Long before the COVID-19 pandemic, we lived in an era where the value of social touch was undermined and since the outbreak of the pandemic, this issue has been exacerbated. VTT is designed to bring people together by instigating the discovery of veiled facets of one's self through affective touch. The potential of this application goes beyond its entertaining qualities, which are expected to improve even further through beta testing and the development cycle. In the future, the application of the VTT could be adapted for empirical or clinical use within clinical cohorts to monitor and quantify changes in mood across time, as a function of app usage.

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