INNER-active Journal

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ABSTRACT
This purpose of this paper is to present a journal-based system that provides a way for users to reconstruct their emotions around events in their lives, and to see how recall of these events affects their physiology. Expressive writing, a task in which the participant is asked to write about extremely emotional events, is presented as a means towards story construction. Previous use of expressive writing has found profound benefits for both psychological and physical health [8]. In this system, measures of skin conductivity, instantaneous heart rate, and heart stress entropy are used as indicators of activities occurring in the body. Users have the ability to view these signals after taking part in an expressive writing task.

Categories and Subject Descriptors
H.5 [Information Interfaces And Presentation]: Miscellaneous

General Terms
Measurement, Performance, Design, Human Factors, Theory, Verification.

Keywords
emotions, physiological signals, expressive writing, story construction

1. INTRODUCTION
The INNER-active journal gives users a chance to view their physiological signals after constructing stories around emotions related to significant events. By gaining an understanding of how emotions affect the body, users can begin to take an active role in managing their emotional health.

Other papers [2,13] have focused on measuring physiological signals such as skin conductance and heart rate while involved in an expressive writing task. This paper focuses on the design, architecture, and application example of the journal. A detailed introduction to the supporting theory and how it is used in the system is given. This discussion revolves around how the system differs from, improves upon, and complements other expressive writing approaches.

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This paper is structured as follows: First, we present the rationale behind the building of this system. Second, we present relevant work and theory that has guided the system development. Third, we give a detailed description of the system architecture. Fourth, we provide example uses of the system. The paper concludes with a discussion and implications for future work

2. EMOTIONS INFLUENCE HEALTH & COGNITION
Mental health itself is a strong motivator to help teens gain better understanding as to how their emotions affect them. Teens with good emotional health are in control of their thoughts, feelings and behaviors. They feel positive about themselves and have good relationships. While drugs, alcohol, and promiscuity are sometimes symptoms of normal teen experimentation, they may also be an indication of teens with poor emotional health. Other reasons for addressing emotional health include the impact of emotional health on both physical health and academic achievement.

When an emotion is being experienced, neuropeptides are released allowing the brain to know what is occurring. While there are centers in the brain that are overall processors of emotions, there are cells in the immune system (blood, bones, etc.) that contain receptors for emotional signals. Consequently, the entire body experiences emotions, and holds memories of emotions in the same cells. Long-term negative emotions harmfully affect the immune system [12].

Isen and colleagues (1987) have demonstrated that positive affect can influence the way cognitive material is organized and have shown that this influences creativity [4]. Using a variety of different techniques such as gifts, comical movies, or refreshments, positive affect state was induced in the study participants. The emotional state had direct affect on performance on tests such as Duncker's (1945) candle task and M.T. Mednick, S.A. Mednick, E.V. Mednick's (1964) Remote Associates Test and medical decision-making with hypothetical patients [3,7]. Subjects also better integrated the material presented to them and exhibited an ability to better organize their protocols as compared to a control group [5].

According to Schwarz, a negative affective state corresponds to a higher level of spontaneous causal reasoning, which fosters bottom-up, data driven processing. Therefore, when involved in an analytical task, it may actually help to be in a sad mood [14].

3. RELEVANT WORK

Systems which help users gain a better understanding of their emotions, systems which enable the user to construct stories, as well as systems which aid users to interpret what is occurring in their bodies have greatly influenced the design of this system.

Granada Learning's *Just Like Series* is an educational system that attempts to compel learners to think about emotions related to an event. The system includes four videos that portray real-life stories of children who have faced adversity [1]. Each story is set up to enable children and caretakers to talk about these issues and includes an animated storybook with audio and narration. Once children hear and read these stories, they can write a response to the story using an emotions word bank, the same animation, and certain omitted text. Next, two questions are asked that accompany the same animations. The first focuses on the emotional content of the story, while the second encourages children to self-reflect on the same issue in terms of their own experience. The last activity allows children to match emotions to the character in the story to help them to view the situation from another's perspective and relate actions and feelings to everyday environments.

Although this environment encourages reflection, the stories and emotions are limited to the ones chosen by the software designers. A more open-ended environment where children can construct their own narratives may add another dimension to emotional understanding

One example of this type of environment is the Digital Diary developed in the Today's Stories project [16]. The members of the project developed a curriculum to support social, communicative, and emotional development of children 4 to 8 years old. The project consists of a wearable technology called the KidsCam, to gather information from daily activities, as well as a tangible interface called the Magic Mirror to manipulate the data collected through the wearable. The Magic Mirror allows children to review their video collaboratively and annotate episodes with signs and symbols that make explicit the interpretations of what they see in their experiences. These annotations can be linked to related episodes or other material supporting the pedagogical purpose. This environment allows children to construct narratives and annotate some emotions; however, it was not created for the explicit purpose of exploring emotions.

Although the purpose of this system is not biofeedback, these types of systems allow user to see how their emotions affect their physiology; therefore, they are important for this work. *Freeze Framer* developed by the Institute of HeartMath allows users to view their heart rate variability in real-time [6]. As they view this signal, if they are in a negative state, they will see that it is very jagged and irregular. However, once they are trained to place themselves in a positive emotional state, they should see their signal become smoother and more regular. Researchers have found that users achieve better clarity and balance after repeated use of the system.

4. Expressive Writing

James Pennebaker and colleagues (1986) found that written emotional disclosure, writing about extremely upsetting experiences in one's life, has profound effects on physical and psychological health [8]. The standard experimental design is to assign one group the task of written emotional disclosure and the other group the task of writing about superficial events such as the steps to brushing teeth. Each group is instructed to write about the assigned topic for 15-20 minutes each day for 3-5 days.

After the writing, during follow-up interviews 2,4 and 14 months after the writing, Pennebaker and others have found participants show fewer doctor visits, improved immune functioning, increased mood, and higher grade point averages [9,10,11]. The conclusion drawn is that writing about significant life events allows participants the opportunity to find meaning and increased understanding of their emotional reactions to the event. This can also result in reduced distress.

Expressive writing, however, is not expected to be an end-all cure. There have been cases where no significant results were found after subjects participated in the expressive writing task. For instance, Sangsue monitored the health of teenaged males and females after writing about self-image. Months after participating in the study, there was not significant improvement in the health of the female subjects [15]. The most consistent criticism of Pennebaker's work is that it does not always work; however, expressive writing is merely an option and not a panacea. For the INNER-active journal, health benefits are expected, however they will not be the focus.

For use in the journal, users will be instructed to construct stories around important, not necessarily traumatic experiences. During the process of constructing these stories skin conductivity, heart stress entropy, and instantaneous heart rate will be gathered and users will be invited to reflect on how theses signals change during their story.

5. SYSTEM DESIGN

The system utilizes an adaptation of the personal, mobile data collection and annotation platform, known as PMobile, developed at the MIT Media Lab [6]. The architecture consists of three layers. The first is the sensor layer, consisting of a Fitsense Heart Rate Monitor and a Bluetooth skin conductivity sensor shown in figure 1. This layer communicates to the second, a data collection platform. Once data has been gathered, information is displayed visually in the third level.

The Pulser, a Fitsense Technology for gathering electrocardiogram information, is set to transmit information every two seconds using a Data Variant 3 [6]. Data Variant 3 transmits a data message containing the beat count and the last sixteen inter-beat intervals (IBIs) in milliseconds. The electrocardiogram information is used to calculate the instantaneous heart rate and heart stress entropy. The Bluetooth skin conductivity sensor is used to measure skin conductivity. The device is worn as a watch with extensions that connect to an electrode to attach to the hand.

The Data Collection Platform runs on a HP 5550 iPAQ running Windows CE 4.0 and an Compaq laptop running Windows 2000. The iPAQ gathers the data from the Heart rate monitor, while the laptop receives skin conductivity data via Bluetooth. The visualization interface was developed in Matlab 6.5.

Figure 1: INNER-active Journal System. Fitsense Heart Strap sends data to iPAQ while Bluetooth skin conductivity sensor sends data to laptop.

The INNER-active journal begins with an expressive writing assignment adapted from the Pennebaker experimental procedures. The user is instructed to write without regard to spelling or grammar. To signal to the system that the task is finished, '0' is typed into the new line. From this point, the journal entry is finished and users can view the data collected through the interface. Figure 2 shows a portion of the interface.

The drop down menu of the interface has the choice of 'Skin Conductivity', 'Instantaneous Heart Rate', and 'Heart Stress Entropy'. Each graph has the time the entry was written for the horizontal axis and the value, depending on the selected graph for the vertical axis.

Once the decision is made, the "Update" button is pressed and the new graph is displayed. Each graph has tick marks indicating where a new sentence begins. If there are any attention-grabbing points in the graph, the user can select the spot on the graph. When a point is selected, a circle or 'x' will appear on the graph. The user can then click the "Press to View Sentence" button and see what sentence corresponds to the point on the graph.

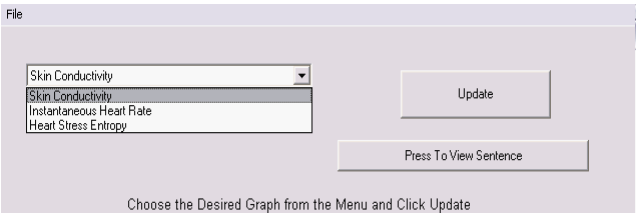

Figure 2: The INNER-active Journal interface

6. EXAMPLE INTERACTION

The following presents an example interaction of the INNER-active Journal during an expressive writing task. There are steps that must be followed in order to write a story using the journal system. First, the Pulser is strapped around the chest, and the skin conductivity sensor is placed on the wrist and hand. Second, the PMobile application is started on the iPAQ and the journal application begins. Before typing into the journal, a blank white screen, a short time is taken to establish a baseline reading for the sensor data.

After completing the expressive writing task, all three components of the system are stopped. The file containing the IBI data is then transferred to the laptop via Bluetooth and the InnerActiveFinal program is run through Matlab. Below is a story written during the interaction. (Spelling mistakes and punctuation errors remain since they are ignored with the expressive writing task).

"I found outthat my aunt passed a couple of weeks ago. I have found it extremely hard to concentrate since then. At the funeral it was hard to see her because she's always been so beautiful and lit up the room. she had these beautiful cat green eyes the shined when she smiled. she was my mother's best friend. she really knew who I was. my mom was having a reaaly hard time with her death. she prayed the night before the funeral that God would just let her know that everything wasokay. i remember they used to have this saying one of them would say "are we having fun yet?" and the other would reply "havin som fun now." they would laugh, everytime. the morning of the funeral, my mother was reading the paper. she was just scanning really unable to concentrate. on one of the pages, there it was, "are we having fun yet?" -- an advertisement for dollywood? Yes, but even more, i think, a sign from God. i am gld to know that He has her. I will miss her everytime I go to my phone to try and call her. i've never lost anyone close to me. i almost lost my father, but he was okay in the end. it's hard to accept sometimes but there is a pyrpose for everything…"

Figures, 3, 4, and 5 are the graphs that correspond to the story that are seen through the interface during this interaction. In the skin conductivity graph, the normal first response where there is an initial jump can be seen followed by a settling of the graph over time. Once the writing starts, another jump occurs corresponding to the user writing about the inability to concentrate.

In the Instantaneous heart rate graph, an anomaly exists in the graph between the 3.63s and 3.64s time value that may be a malfunction in the system. However peaks in the interbeat intervals occur once again while writing about the funeral. The heart stress entropy shows similar results as the skin conductivity graph when the user is writing about the funeral.

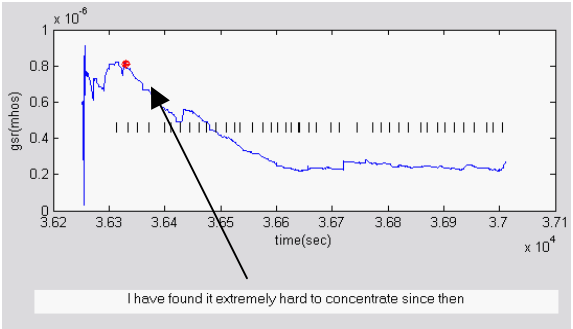

Figure 3: Screenshot of skin conductivity graph and corresponding sentence. Red dot corresponds to portion of the graph selected.

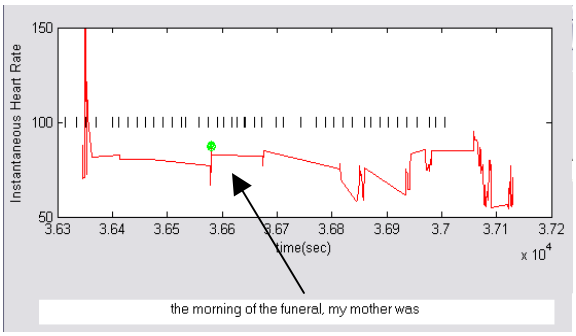

Figure 4: Screenshot of Instantaneous Heart Rate graph and corresponding sentence. Green dot corresponds to portion of the graph that was selected.

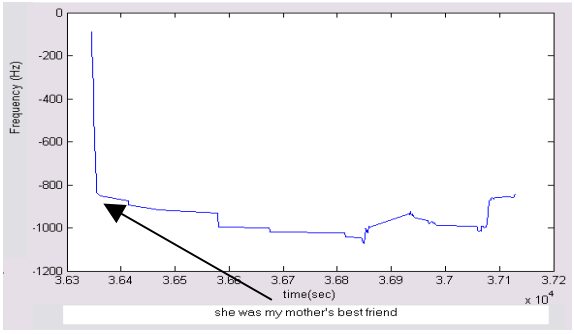

Figure 5: Screenshot of Heart Stress Entropy graph and corresponding sentence.

7. CONCLUSIONS & FUTURE WORK

The purpose of this system is to allow users to view their physiological signals that arise while involved in an emotionally expressive writing task. It is important to point out that outside factors may affect the data collected. Typing speed may affect when a physiological signal shows up on the graph. Additionally, thinking of an event may appear before it is actually typed; therefore, it would not correlate exactly with the graph. Motion artifacts from the hand may affect the skin conductivity.

By enabling users to view their own signals, they can see for themselves the effects that their emotions have on their bodies. This may help them to become more active about expressing their emotion as they see effects over time. Future work will involve allowing more users to interact with this system and integrating the system with other activities that encourage reflection and understanding of emotions.

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