A Hybrid Evaluation of Emotional Responses to Interactive Systems

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ABSTRACT

With the use of sensors to monitor the physical processes that correlate to particular behaviors and sensations, technological advancements and resources supplied by neuroscience began to provide the capacity to interact with the study of the brain directly. This allows us to experiment with as many sensory channels as feasible while still applying computational solutions. Brain-Computer Interfaces (BCI) can infer information about a user's state and intentions by observing his/her physiology, behavior in the work environment, and authority relationship. Using this data, it is possible to determine the efficacy of the computer tools used to respond to the emotions evoked by the user when interacting with the solution and adjust the tool's goals. In this work, to analyze these interactions, we adopted a hybrid approach using user responses via the digital SAM questionnaire and data collected using electrocardiogram and electroencephalogram sensors to check for any changes in the participants' mood during their interaction with an End-User Development interface for authoring of serious games. The results of this round of evaluation were positive, demonstrating not only the good use of the tools but also motivating us to continue developing improvements and conducting new tests on the prototype created to collect the physiological data.

KEYWORDS

Brain-Computer Interfaces, Self-Assessment Manikin, Affective Computing, EEG, Digital Therapeutic Games, Emotional Responses

1 INTRODUCTION

Interaction between the human brain and the computer requires the use of physical devices to record and send biometric signals. Non-invasive approaches enable the capturing of electrical brain activity in a simple and quick manner, without the need for specialist teams or the risks associated with surgical procedures in the brain.

The EEG (electroencephalogram) is non-invasive biometric equipment that is widely used and researched because of its excellent temporal resolution and mobility. In addition to the EEG, there are various non-invasive equipment, the most notable of which is the ECG (electrocardiogram), which monitors the heart beat on a regular basis and with enough precision to detect changes in behavior during examinations.

The interfaces between the brain and the computer are basically a communication channel in which non-muscular information is conveyed via brain signals, recorded by BCIs (auxiliary equipment), then processed and analyzed by the computer to classify emotions.

This mode of communication between the human and the machine has a wide range of applications, including clinical psychiatry, motor disabilities, and the integration of emotion detection, an interdisciplinary problem involving Neurobiology, Psychology, Engineering, Mathematics, and Computer Science. At a more specific level, and in relation to this effort, integration in terms of therapeutic and telemedicine software development to assess their effectiveness during treatment.

One of the primary goals of scientific study in fields as diverse as Artificial Intelligence, Medicine, and Psychology is the identification and classification of emotional states in people. The difficulty of deciphering some of the human emotional states based on the gathering and analysis of biometric data motivates this effort. This sort of data is collected utilizing several instruments, the most notable of which are the EEG and ECG.

This work uses physiological sensors (EEG and ECG) to collect emotional responses from users when interacting with computational solutions. A low cost prototype was developed to collect EEG and ECG data. We aim to improve the device to be more efficient and accessible than other commercial devices, and that can inform researchers about users' emotional responses, allowing them to calibrate their solutions and propose "escape routes" in the solutions aiming at a positive interaction experience. In this work, the computational solutions evaluated are digital games, and it was expected that the good gameplay and player engagement experience can be identified through the developed prototype.

The work is organized as follows: Section 2 describes the way for collecting emotional responses, Section 3 describes the materials and methods used in this work, Section 4 reports the tests carried out, Section 5 describes the results, Section 6 provides a discussion of the data collected, brings the conclusions and future work.

2 COLLECTION OF EMOTIONAL RESPONSES

The brain and heart are connected via the Autonomic Nervous System (ANS), in which both indirectly influence each other's behavior [1]. The ANS connects the Sympathetic Nervous System (SNS) with the Parasympathetic Nervous System (PNS). Emotional events can therefore cause changes in heart rhythm, which can be detected using ECG (Electrocardiogram) data. The purpose of this research was to outline current literature on the use of ECG as an input to emotion recognition algorithms. This research also looks at ECG characteristics like Heart Rate (HR) and Heart Rate Variability (HRV).

HRV is the fluctuation in the time intervals between adjacent heartbeats and is a neuro cardiac function indicator that is caused by heart-brain interactions and dynamic non-linear Autonomic Nervous Systems activities. HRV is still a characteristic of interconnected regulatory to environmental and psychological stress and represents the control of autonomic balance, blood pressure, heart, and stomach.

Ekman [2] emphasized the importance of emotions in real human contact by stating, "*If B detects A's facial expression of emotion, B's conduct toward A may alter, and A's observing this may impact or dictate A's experience of emotion*." Meanwhile, Reeves and Nass [3] suggest that people viewed computers as though they were also living beings. From these considerations, it can be argued that if computer systems can detect and respond to human emotions, the interactional gap between humans and computers will be as realistic as conversing with a buddy, and the Human–Computer Interaction (HCI) will improve.

We can analyze users' emotional responses by gathering physiological data from them. Electrocardiogram and electroencephalogram are two of the most frequent data gathering procedures. Speech and self-report are two alternative ways to gather the information, in witch the user is encouraged to talk or express their emotions regarding the interface they used, allowing the researcher to examine the data.

SUS (System Usability Scale) is another way to collect emotional responses by self-report. The instrument was developed by Brooke [4] as a "quick and easy" measure of usability. The measure consists of twelve questions that are answered on a Likert scale of five points [5]. The scale provides a general overview of subjective usability classifications. The technique used to choose items for a Likert scale is to find examples of situations that lead to extreme expressions of the attitude being captured. In this work, we used a digital version of SUS, available on the EmoFrame, a framework that provides self-report instruments for emotional response [6]. An example of SUS's items says *"I would recommend this app to other people"*. In this case, the answer must indicate how much the person agrees with the statement. The evaluation score yields a usability score between 0 and 100. The closer the score is to 100, the greater the system's usefulness. SUS has the advantage of providing a unique benchmark score for participants' perceptions of a product's usability. SUS is a popular option among usability specialists due to its simplicity of administration and scoring. The instrument may be used as a subjective follow-up measure after assessing the usability of functional systems as a pre and post-test component, in addition to being a common choice for online usability research [7, 8].

In this work, we conducted a usability assessment on RUFUS[1] platform for authoring digital games [9–11]. The aim was to collect the emotional response of volunteers when trying to create games on an End-User Development (EUD) platform [12]. We collected data from physiological sensors and self-reported data through the SUS questionnaire and semi-structured interviews to assess the emotional response during the use of the interface.

The next section describes the materials and methods used in the assessment.

3 MATERIALS AND METHODS

To conduct the study described here, we used a hybrid approach that contained instruments for collecting emotional responses based on self-report and physiological sensor data.

The tests were carried out during the interaction of volunteer users with the RUFUS platform, which allows the authoring of serious digital games.

The self-report instruments used were the SUS and SAM questionnaires, in digital versions. For collection using sensors, we used a low-cost prototype, created by the research group, of an Electroencephalogram and an Electrocardiogram.

The next subsections describe the RUFUS platform, the self-report instruments, and the physiological sensors used.

3.1 RUFUS - Platform for Authoring of Digital Games

The RUFUS platform [9–11] allows professionals from different fields, extra Computing, to create their own games and use them with their populations of interest in pedagogical or therapeutic practices. There are currently five predefined game mechanics: quiz, puzzle, collecting, storytelling, and inverted storytelling.

The platform was developed by a multidisciplinary team comprising designers, specialists in Health, Education and Computing. This cooperation aims to involve users in the design of the interface, making it more understandable to other users [9]. The interface evaluated in this study is the interface for creating storytelling games mechanic.

Figure 1 illustrates some of the steps to configure a game of this mechanic on the platform.

3.2 Self-report Instruments

In this subsection, we describe the self-report instruments used in our hybrid approach to collect emotional responses from volunteers in the usability test with the RUFUS: eSUS and eSAM.

3.2.1 Digital System Usability Scale - eSUS. The SUS is a widely used instrument in Computing for usability assessment. It is used to assess 3 aspects of an interface: 1) Effectiveness (successful use of the product), 2) Efficiency (the effort to use the product) and 3) Satisfaction (experience in using the product) [13]. The questionnaire is composed of a set of 10 questions, which are rated by the user on a scale from 1 to 5, with 1 - "Strongly disagree" and 5 - "Strongly agree". The ten questions in the questionnaire are: [1] I think that I would like to use this system frequently; [2] I thought the system unnecessarily complex; [3] I thought the system was easy to use; [4] I think that I would need the support of a technical person to be able to use this system; [5] I thought the various functions in this system were well integrated; [6] I thought there was too much inconsistency in this system; [7] I would imagine that most people would learn to use this system very quickly; [8] I thought

[1] https://rufus.icmc.usp.br/login

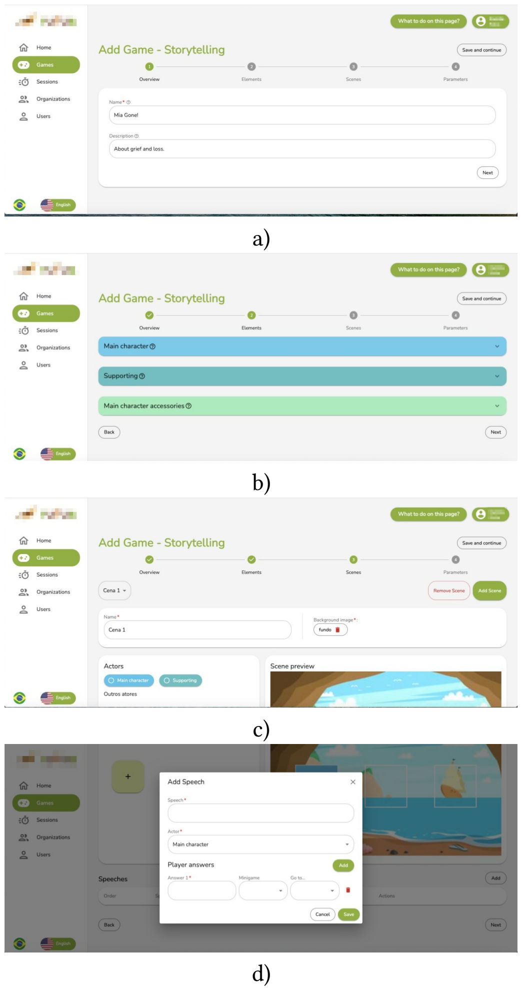

Figure 1: Creating a storytelling game: a) Defining information such as name and description; b) Defining characters and accessories; c) Defining the scene and its elements, such as characters, their positions and speeches; d) Defining the speeches, who will speak them, and the narrative routes. ***Source: da Hora Rodrigues et al. [11].***

the system very cumbersome to use; [9] I felt very confident using the system; [10] I needed to learn a lot of things before I could get going with this system [10].

We used eSUS, a digital version of SUS that allows computer professionals to apply the instrument and know the evaluation results in real time. It is noteworthy that the eSUS does not differ from the SUS in terms of content, the digital only makes it easier to apply the instrument remotely and with the possibility of analyzing the results at the time of application of the test. eSUS is part of a EmoFrame [2] framework [6], created to provide instruments for collecting subjective and emotional responses from users when interacting with computer systems. Figure 2 illustrates the eSUS' interface.

[2]https://emoframe.icmc.usp.br/

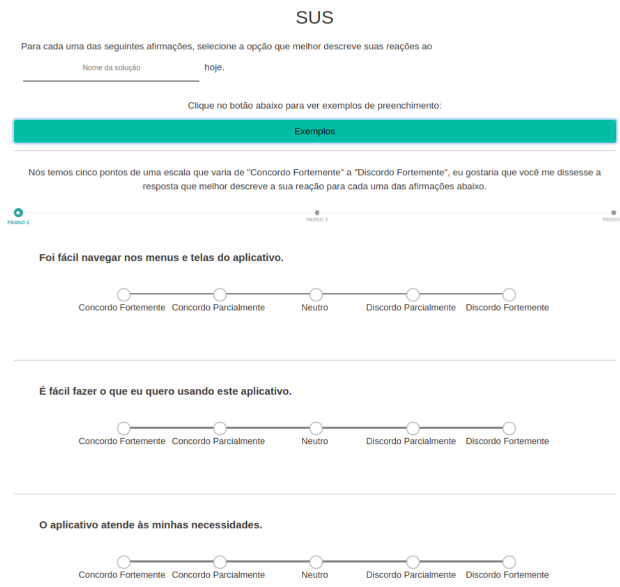

Figure 2: eSUS' interface (*In Portuguese*).

The eSUS was used to collect subjective satisfaction and other usability aspects of the user when interacting with the RUFUS authoring interface to create a storytelling game.

3.2.2 Digital Self-Assessment Manikin - eSAM. Another questionnaire used in this work to collect emotional responses was the SAM. The Self-Assessment Manikin [14] is an instrument capable of measuring the effective aspect of an individual in response to events or objects. For this, images categorized into three dimensions are used: valence, arousal, and dominance. Each dimension has a set of images that represent some kind of feeling. The valence dimension varies from a smiling and happy figure to a grumpy and unhappy figure. The representation for arousal ranges from an excited, wide-eyed figure to a relaxed, sleepy figure. For the dominance dimension, the representation varies from a large figure, which indicates control of the situation, to a small figure, which characterizes the lack of mastery of the situation. The questionnaire is a 9-point Likert scale, in which the first two domains - between 1 and 4 - represent positive feelings; 5 is a neutral feeling, and between 6 and 9 negative feelings. In the third domain the scale inverts, between 1 and 4 reflecting a feeling of low control, and between 6 and 9 high control in the use of the solution [10].

We used in this work the digital version of SAM, the eSAM, available in the EmoFrame framework [6]. Figure 3 illustrates the eSAM' interface.

3.3 Physiological Sensors

In this section we describe the physiological sensors used in this work to collect emotional response from users.

3.3.1 Electrocardiogram - ECG. In clinics, an ECG identifies pathological cardiac disorders such as arrhythmia and heart problems. An ECG detects the heart's electrical activity in different stages and

Figure 3: eSAM' interface (*In Portuguese*).

views depending on the scenario and electrode configuration (see Figure 4). The signal obtained is used to show (graphically) each cardiac cycle's deflection and wave series.

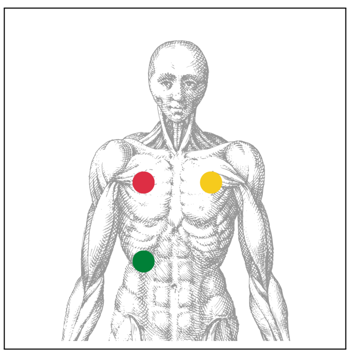

Figure 4: Triple Connector - In red the pin RA (Right Chest), in yellow LA (Left Chest) and in green RL (Right Abdomen). The sensors could also be put on the right and left wrists, as well as the right thigh and ankle, but this was the most effective arrangement for the interaction in this study.

The ECGs have been adopted as a modality for emotion identification in many investigations because of their high quality and information about human emotions contained in the signals and one of the most extensively utilized biosensors in emotion identification according to Rattanyu and Mizukawa [15] and Bexton et al. [16].

In our prototype for collecting data through sensors, we can measure the pulse and heart rate with the AD8232 ECG sensor, which uses electrodes to capture electrical pulses and heartbeats. It is feasible to analyze the body's behavior using heart rate and pulse data, primarily during physical activities or, in this case, contact with our computational solution. The electrical signal obtained by the sensors is transferred to the AD8232 IC (Datasheet Search Engine), which analyzes, amplifies, and filters the signal to emit frequency and pulse data.

The Arduino Uno R3 is a microcontroller board based on the Tmega328 (datasheet). It contains 14 digital input/output pins, six analog inputs, a 16MHz crystal oscillator, a USB connection, a power input, an ICSP connection, and a reset button (see Figure 5).

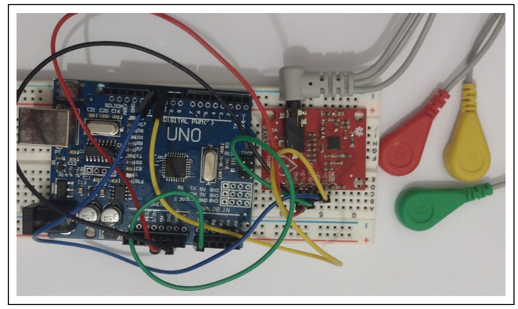

Figure 5: Arduino Uno R3, AD8232 ECG Module Monitoring Heartbeat and Triple Connector.

We use the described prototype to collect physiological data from the user when interacting with the interface of the digital game authoring platform.

3.3.2 *The Heart's Autonomic Innervation.*

The centers of the ANS's (Autonomic Nervous System) control over the heart rhythm are located at the medulla oblongata [17]. Both centers, in the absence of any external influence, supply an infinitesimal amount of stimulation to the heart muscle, causing it to have an autonomic tone. However, when stimulated, the cardioaccelerator produces the neurotransmitter norepinephrine, causing the heart rate to skyrocket.

This process occurs throughout the SNS (Sympathetic Nervous System) one of the autonomic nervous system's two divisions) as well as at the sinoatrial (SA) node, and is commonly known as the "fight or flight" response [18]. In terms of HR reduction, the cardioinhibitory centers send the neurotransmitter acetylcholine (Ach) to the PNS (Peripheral Nervous System). This activation might be referred to metaphorically as the "rest and digest" operation [18].

SNS and PNS stimulation travels to the SA and AV nodes through the cardiac plexus, cervical ganglia, and superior thoracic ganglia, with nerve fibers reaching the atria and ventricles. Figure 6 illustrates a simplified representation of the vagus nerve (PNS) and sympathetic cardiac nerves (SNS).

The physiological interrelation between the heart and brain communication influences certain characteristic changes when it comes to emotion. The ANS's influence on emotional changes regulates various other body parameters [19]. According to the HeartMath Institute, the dynamic, continuous, and bidirectional communication of both organs affects one's perception, emotion, intuition, and general health [20]. Hence, detecting the cardiac rhythm for emotion recognition purposes based on autonomic innervation is necessary in healthcare as a preventive measure towards negative emotions such as stress [21].

3.3.3 *Electroencephalogram - EEG.*

Brain-Computer Interfaces (BCIs) can acquire and analyze brain signals before converting them into usable pre-programmed commands for some task. The electroencephalogram (EEG) signal is one of the non-invasive ways in which electrodes are implanted in particular areas of the scalp to record neural activity (i.e., voltage potential) of brain signals, and the data correspond well with human emotions.

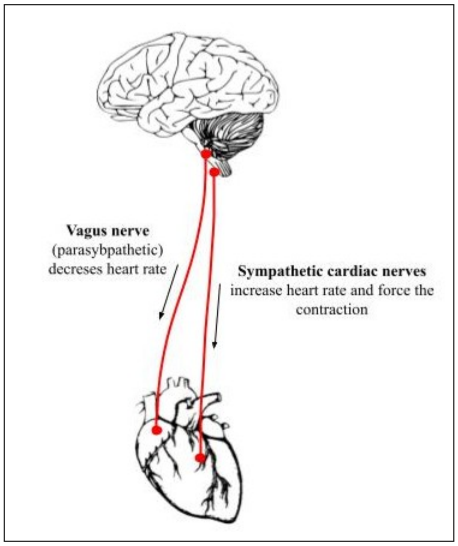

Figure 6: The ANS interaction between the brain and the heart. Source: Authorship.

Physiological brain reactions are significantly more difficult to disguise and hence a more reliable foundation for deducing emotions than external responses such as facial expressions and body language. EEG-based emotional state evaluation necessitates using well-designed procedures to extract information from the incoming data. To categorize the signals, machine learning techniques have been devised (generally with a lower signal-to-noise ratio). However, based on manual feature extraction, this technique had trouble tuning to a particular subject or achieving a certain generality across subjects, which would be beneficial for human-interface applications.

In our study, feedback was supplied utilizing low-cost consumer BCI hardware (see Figure 7) and datasets that simulated identical conditions regarding the amount of data accessible.

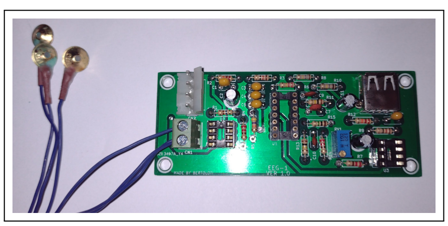

Figure 7: EEG Module Monitoring Prototype Triple Connector.

Creating emotion recognition systems involves numerous processes. The goal of this work is to create emotion recognition systems utilizing Machine Learning techniques. The first stage is preprocessing, which removes undesirable noise from the signal. The following step is feature extraction utilizing various approaches. The use of feature selection and feature reduction to identify significant emotion-related characteristics is optional and may be done after feature extraction. The final stage is to use machine learning algorithms for classification and validation. Figure 8 illustrates the emotion recognition model pipeline that was used.

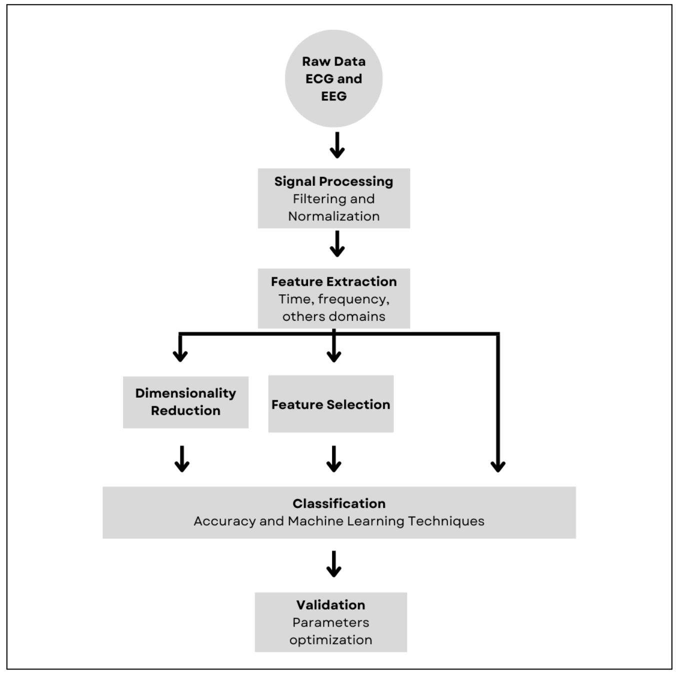

Figure 8: ECG and EEG based emotion recognition system: general techniques.

4 USABILITY TESTING ON THE RUFUS INTERFACE

Using our hybrid approach, users' emotional responses were collected during interaction with the RUFUS platform in a Usability Test [22]. A group of volunteers was recruited for convenience [23], and the invitation was made to the research groups of Multimedia Systems, Software Engineering, and Robotics of the University of São Paulo, Brazil. Ten volunteers accepted the participation and interacted with RUFUS to create a storytelling game with a free script. Of the volunteers, 6 people were men and 4 women, all aged between 21 and 29 years. Volunteers indicated that they had completed higher education and had some experience with development. Only 2 out of 10 reported having no experience with digital games and storytelling.

The evaluation was conducted in five stages, namely: 1) explanation about the RUFUS platform and signing of the Free and Informed Consent form; 2) completion of the profile collection questionnaire; 3) interaction with the RUFUS Web platform (following a script of activities); 4) responses to the SUS and SAM questionnaires, with self-reports on the use of the Web platform and, finally, 5) conducting a semi-structured interview.

We requested the participants not to use their mobile phones or any other technological or wearable device throughout the experiment so that the emotional reactions were limited to the interactions.

The electrodes were then positioned on the thorax, as indicated in Figure 4 and in the ranio with electrode placements at P9 and P10 (Parietal Lobe) and Oz (Occipital Lobe), when the retina receives a light visual stimulus, capture the signals are produced that fluctuate at particular constant frequencies, and sent via cable to a computer The placements of the appropriate electrodes are illustrated in Figure 9 and Figure 10.

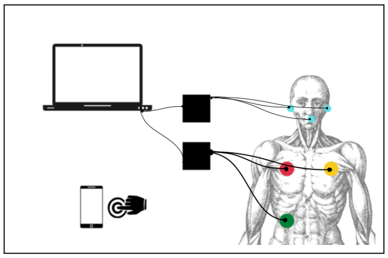

Figure 9: The test scenario to collect emotional responses from users during the interaction.

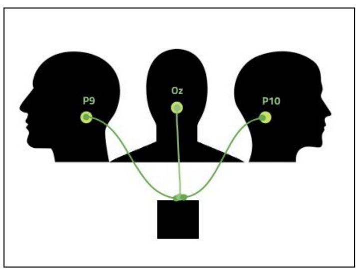

Figure 10: An illustration of the electrode sites utilized for capturing evoked potentials (not to scale). Occipital (Oz) and left/right mastoid (P9/P10) scalp electrodes are used. The percutaneous connection is displayed on the right side of the skull in this case.

Figure 11 illustrates one of the participants during the test.

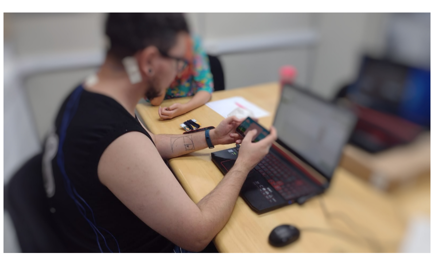

Figure 11: Scenario of interaction with participants.

5 RESULTS

The tests lasted an average of 28 minutes for each participant. Here we show the outcomes of interacting with the platform in our scenario. The subjects' ECG, EEG, eSUS, eSAM, speech (from interview), and interaction responses were evaluated independently, and the results are presented below.

Table 1 describes the ECG and EEG sensors results.

Table 1: ECG and EEG Results.

Participant - P	Description	Interaction time
P1	anxious, unconfortable, tense	15min 35s
P2	interested, enlightened	30min 18s
P3	anxious, tense	12min 58s
P4	tired, tense	15min 23s
P5	anxious, depressed, comfortable, frustrated	30min 50s
P6	interested, relaxed	20min 39s
P7	anxious, apathetic, relaxed, confortable	43min 47s
P8	apathetic, relaxed	33min 54s
P9	anxious, tense, frustrated	31min 29s
P10	anxious, comfortable, relaxed, impressed	40min 18s

The tests averaged 28 minutes, with the least being 12 min. and 58 sec. and the longest lasting 43 min. and 47 sec. Overall, the participants appeared nervous and doubted how the intended activity should be carried out.

Participants responded to a questionnaire on their understanding of games and, if they play them, what they usually play, which were not necessarily storytelling games. They appeared to have an easier time comprehending the game's development structure by exploring the tool more and spending more time on the assessment. Those who reported having little or no experience with games were more cautious and hesitant, investigating fewer options in the interface and ending up with a shorter engagement time.

Table 2, describe the results of the eSUS.

Table 2: eSUS results.

Participant - P	Result	Avaliation
P1	77.68	Good
P2	88.39	Great
P3	91.07	Better possible
P4	77.68	Good
P5	91.07	Better possible
P6	95.54	Better possible
P7	86.61	Great
P8	89.29	Great
P9	97.32	Better possible
P10	89.29	Great

The scores obtained in the eSUS are related to a usability rating. This classification is an adaptation of the scale proposed by Bangor et al. [24]. The authors analyzed the relationship between SUS scores and people's ratings of systems and products they evaluated in adjectives such as "good", "bad", or "excellent" and found a correlation. Although there is no consensus among the evaluators, the results shown in Table 2 are within acceptable usability standards.

It is important to note, however, that some participants were tense and anxious, such as P3 and P5, often restless, but marked the usability data as "Better possible". We can make different inferences in this regard: the state of tension and anxiety are characteristic of the individual and have no relation to the system in use, or that despite being tense and anxious, the participant felt satisfied when interacting with the solution. This last case seems inherent to an observational study, especially one with sensors attached to the body. However, as it is possible to see in the next section, P3 had great difficulty understanding the system and how to start interacting with it, a situation that leads to discomfort and corroborates the data from the sensors, but not with the data from the eSUS reported by the same.

The SAM results, illustrated in Table 3, also showed positive feelings while using the RUFUS. All domains (Valence, Arousal and Dominance) obtained positive scores from all volunteers.

Table 3: eSAM results.

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Domain Valence	7	9	9	9	8	9	9	9	9	9
Domain Arousal	6	7	8	7	9	9	9	9	9	9
Domain Dominance	7	6	9	7	8	9	8	9	9	8

5.1 Interview Results

From the comments and interviews, it was possible to identify issues, such as [25]:

- Some of the participants had difficulties understanding what to do and felt lost at first (P1, P2 and P3);
- The need for greater fluidity in the construction flow was pointed out (P4);
- There was no agreement on the definition of the requested tasks (P3);
- Declaration of small fonts and implication in the difficulty of interaction in parts of the platform (P6);
- Confusion with input buttons for backgrounds (P6);
- Concern with the arrangement of elements, such as the proximity between the insert button and the delete button for a scene (P7);
- The use of the term "texture" in some parts of the platform was not understood (P7 and P8);
- Not understanding the naming of characters (P7);
- Difficulty in composing a scene, involving what constitutes it and the characters' objectives (P8).

Next are some of the participants' comments during the interaction with the platform: P1 - *Knowing what I was doing and what I should do next*; P2 - *I was a little confused because it was my first time using it*; P3 - *When she first began, she had no idea what she was doing or what to expect from her*; *I didn't comprehend the concept of where to set the alternatives*; P4 - *Needs to be more fluid (construction)*; P5 - *The line formation is a little hazy*; P6 - *Small typefaces in certain areas*; P6 - *Inversion of Background Buttons*; P7 - *The placement of the add and delete buttons*; *The term "texture" is ambiguous*; *Give the selected characters an initial name*; *It might be more flowing; everything is quite square*; P8 - *Don't call everything a texture*; *Incomplete responsiveness*; *The save button is in an inconvenient place.*

The results corroborate with the data from the sensors and some of them with the eSUS. The participants had difficulties in understanding some terms and took time to understand how to create a storytelling game. In addition, we noticed a difficulty in understanding narratives and how to elaborate one.

Comparing with the sensor data, we noticed the following behaviors for each participant: P1 - Was calm, yet he/she occasionally laughed quietly while working. P2 - During the narrative production process, he/she appeared anxious and had a few giggles. P3 - No clear reactions were expressed during building. P4 - Was in silent while constructing, yet he/she moved a lot. The mobile platform game did not work at first. This might have induced anxiety. P5 - Was focused throughout creation, but he/she also moved a lot, frequently putting his/her palm on his/her face. Was taken aback when the game failed to save. P6 - Despite calm demeanor, kept closing her/his lips and murmuring as moved through the steps. The lines were more self-statements, such as "I understand." P7 - Was peaceful, although he chatted a lot, asking a lot of questions and making remarks. P8 - Seemed stern and composed at first, then began to smile freely at one point. P9 - Was a little apprehensive because mentioned that she/he doesn't play games in that way and had no idea how their frameworks worked. P10 - Was really thrilled and involved in the entire design process, recalling a past experience in order to build a game that would aid in this experience.

According to the observational evaluations, the participants were usually apprehensive of producing a narrative and sought advice on how to do so. Some quickly proposed that there may be some form of guide to piecing together the tale without the need for assistance.

This had an effect on utilization, as noted by P2 and P3, who were a bit lost in their use of the instrument. Because of certain untested difficulties, the system gave an error when saving, making some participants concerned that they had done something incorrectly.

Regarding the problems with the authoring tool, these will be resolved in due course, but they are not in the scope of this work. Regarding the use of a hybrid approach to collecting emotional responses, this was essential to really understand the experience that the participants had. Some participants, in their self-reports, pointed to positive satisfaction, while the sensor data indicated anxiety and apprehension.

For the prototype of the sensors, the study was essential to validate it, and demonstrated its effectiveness in the collection of physiological emotions.

6 DISCUSSION AND FINAL REMARKS

Due to the enormous range of emotions, we may replicate, it is challenging to describe emotions in a style that a computer can identify.

Each participant in our study was asked to provide a self-assessment score in the framework for valence, arousal, and dominance at the end of each trial.The majority of the participants' remarks were rated positively. It was feasible to validate various participant instances by comparing the utterances and context and the findings of the ECG, EEG, eSAM and SUS. Following that, we will offer the conversation in light of the problems raised.

In our study there included three smokers, one person who takes controlled medication Escitalopram 10mg, and one participant with Lupus who takes the following drugs Hydroxocloquine 500mg, Sertraline 50mg, Enalapril 10mg (2x a day), Levothyroxine 50mg, Immunosuppressant 500mg (2x a day), AS (alternate-day steroids) 2.5mg. Some of these medications are beta blockers, which inhibit the beta-adrenergic receptor, which is a component of the adenyl cyclase system. Inhibition reduces cyclic adenosine monophosphate and cytosolic calcium levels. They are divided into three categories based on their cardioselectivity, or their capacity to inhibit beta1-adrenergic receptors in the heart rather than beta2-adrenergic receptors in the bronchi, blood vessels, and other places.

Tobacco, on the other hand, is high in nicotine, which increases the creation of dopamine, one of the most important chemical mediators of cells that functions in the brain's pleasure centers. The addict's brain receives less dopamine without nicotine. The body creates extra noradrenaline to compensate. That creates discomfort and anxiousness in the user during cigarette withdrawal.

Another question posed to the participants was how they felt about their mental health at the time, so that there would be no dispute between the tension, anxiousness, and exhaustion induced by the exam and/or any other event in the participants' lives, and the following were some of the responses: Normal nervousness and exhaustion; Exhaustion and mental exhaustion; Anxious, gloomy, yet trying to learn not to focus solely on the negative. Very focused on earning acceptance from others, but currently returning to treatment to better all of this; Great, and I hope to maintain it that way; Healthy and Good.

This study used a user-customizable game to assess participants' emotional reactions. Five independent approaches were used to measure emotional response: electrocardiogram (ECG), electroencephalogram (EEG), SUS, SAM and speech analysis. We were able to confirm the signal analyses of a low-cost prototype and make enhancements to the interactive interfaces as a result of this effort. We discovered that a hybrid evaluation was the best way to identify emotional reactions.

The number of participants is a significant restriction of our study. However, we leave as a contribution an example of instruments combined and employed to offer more forceful replies regarding the context of usage of the computational solution.

As future work, we have planned other case studies with a larger and more heterogeneous sample, using different computational solutions to evaluate our hybrid approach to assessing emotional responses.

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