The Geneva Emotion Wheel Mobile Interface: an Instrument to Report Emotions on Android Devices

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Abstract
Studying emotions is a complex task. Indeed, inferring a person's emotions involves considering many components, creating specific tools and designing an adapted methodology. Among other emotional components, the subjective feeling, which could convey a verbalization of the emotional experience, needs specific tools to be assessed. These tools should be adapted to the specificity of the experimentation context and help the users to report their feelings. Therefore, we developed an Android application to assess users' subjective feelings: the Geneva Emotion Wheel Mobile Interface (GEWMI). It is based on an existing instrument to measure emotions: the Geneva Emotion Wheel (GEW) that we adapted to mobile devices. This digital instrument was developed as a standalone and configurable open-source application for Android devices.

Author Keywords
Smartphone; Emotion; Self-report; -Android Application

Introduction
One of the major concerns for experimenters in the science of emotion or affective computing is to assess subjects' emotional state. Indeed, assessing emotions is necessary in order to label data and then to develop, for example, an automatic emotion recognition systems or to evaluate an emotion induction experimental design. This task is mostly done by

asking the subjects to report their own feelings with adapted instruments. We consider that mobile devices, like smartphones or tablets, are particularly suitable for this purpose. Especially since these devices, because of their uses and their ability to record data, are more and more studied in affective computing [5]. Therefore, we suggest adapting existing emotions self-report instruments, available in the literature to smartphones and tablets.
This paper aims to present an Android smartphone application we designed: the Geneva Emotion Wheel Mobile Interface (GEWMI). This application was developed to address the challenges of subjective feelings measurement on mobile devices and was adapted from the Geneva Emotion Wheel (GEW) [10, 11].

Background

Appraisal Theory and Emotion Definition
In 1960, Arnold suggested that a cognitive appraisal occurred when a relevant stimulus for the organism appears [1]. This appraisal leads to the activation of certain behaviors and reactions in the organism. Such a statement has led to the modern theory of appraisal, which emphasizes the determining role of cognition in the whole emotional process. According to Scherer [10], emotion is a hypothetical process that can only be inferred through external symptoms. Therefore, he suggests the following definition of emotion: "An episode of interrelated, synchronized changes in the states of all or most of the five organismic subsystems in response to the evaluation of an external or internal stimulus event as relevant to major concerns of the organism." The first and most important organismic subsystem, essential for the theory of appraisal, is the cognitive component, which evaluates internal or external events or objects. The four other components of this model are the following:

- Physiological component (bodily symptom): System regulation.
- Motivational component (action tendencies): Preparation and direction of action.
- Motor expression component (facial and vocal expression): Communication of reaction and behavior.
- Subjective feeling component (emotional experience): Monitoring of internal state and organism-environment interactions.

Each of these components is an indicator of an individual's emotional state.

Subjective Feeling
In the context of our research, we focused specifically on the subjective feeling component. This component is central in the emotional process because it reflects the changes occurring in other components. In addition, it integrates all this information until it can be expressed verbally. However, the subjective feeling is not an exclusively conscious component. In fact, Scherer defines three types of central representations in the subjective feeling component, which are illustrated in figure 1 [9, 3]:

- Unconscious reflection and regulation (module A): this one includes all of the changes of the four other components in order to create a consistent representation.
- Conscious representation and regulation (module B): this representation includes some representations of the previous module. It is completed by external representations, resulting from social and cultural norms.
- Verbalization and communication of emotional experience (module C): this module represents the "public" part of the subjective feeling. It includes parts of the internal and external representations of other modules. Furthermore, choosing a verbal label adds meanings that do not necessarily capture the emotional experience accurately.

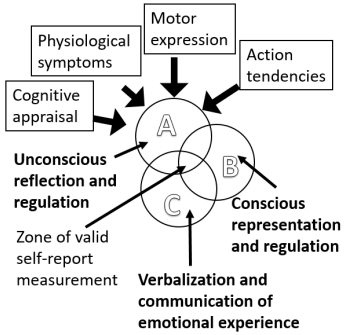

Figure 1: Representations in the subjective feeling component

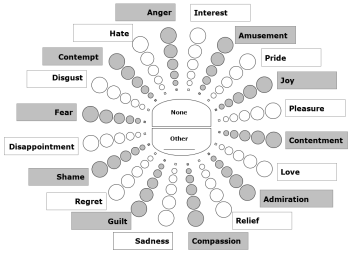

Figure 2: English version of the GEW

As a result, the final outcome available only represents a limited part of the experience lived. This highlights the need to design intuitive and accessible measurement instruments for the subjects of emotion studies.

Categorizing Emotions

There are many ways to represent emotions and categorize them. First, discrete models categorize emotions with a limited number of labels. Researchers of evaluation theories have developed categorization models according to the appreciation of events and their consequences. For example, the OCC model [7] classifies 22 emotions according to the desirability of the event, its consequences for oneself or the others and the reasons of the event.

Second, dimensional models are based on the concept that an emotional state can be represented as a point on a multidimensional space. Each dimension defines a specific affective characteristic. For example, Mehrabian [6] proposed the PAD model: Pleasure, Activation and Dominance. We can define the mentioned dimensions as follows:

- Valence (or pleasure): it illustrates the positive or negative characteristic of the feeling caused by the emotion.
- Arousal (or activation): it defines the mobilization of energy caused by the emotional process.
- Dominance (or control): it describes the feeling of control over the situation.

Categorizing is a necessary step to better discriminate or gather affective experiences. Choosing the best way to categorize emotions depends on the context.

Self-Report Instruments

Numerous instruments were designed to assess emotions in experiment contexts, by collecting the subject's subjective feelings with self-reports. For instance, the PANAS [12] (Positive Affect and Negative Affect Schedule) computes 20 questions to give the overall valence. Another method is to use pictorial scales, like the Self-Assessment Manikin designed by Bradley and Lang [2]. Dimensions of pleasure, arousal and dominance can be assessed with a 9-point Likert scale illustrated with characters. However, dimensional scales give a low level of granularity to understand the emotion experienced by the subject.

To combine discrete and dimensional models, Scherer et al. developed the Geneva Emotion Wheel [10, 11]. On the last version of the wheel, 20 emotions are displayed according to two dimensions: valence and control (figure 2). Moreover, the intensity level of the emotion felt is indicated by the size of the circles on the wheel. In addition, the authors have made available the method on the website of the Swiss Center for Affective Sciences, to develop variations of the wheel in other languages or for other contexts. The annotations of the participants can be analysed according to the dimensions and in a more detailed way with the labels. In the same manner, the intensity levels can be computed.

The Geneva Emotion Wheel Mobile Interface Design

In order to test the GEW on a smartphone, we designed an Android application: the Geneva Emotion Wheel Mobile Interface (GEWMI). This application aims to collect peoples' emotions and their intensity. It is mainly designed for experiments, but it is also possible for individuals to use it in order to keep track of their daily emotions.

Self-Reports

Phone screens being relatively small, we chose to divide the process in two steps for a better visibility: selecting the emotion on the wheel (figure 3) and then selecting its intensity

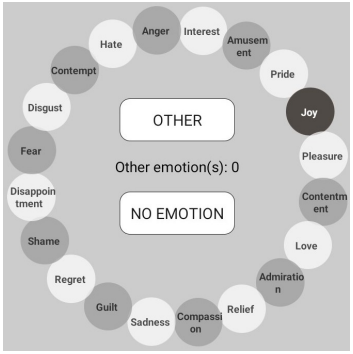

Figure 3: The GEWMI in grey levels mode

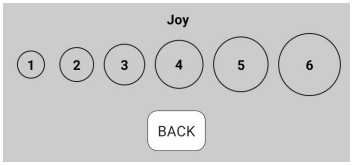

Figure 4: Selecting the intensity of an emotion on the GEWMI

(figure 4). If the emotion felt is not avaiable on the wheel, it is also possible to enter a new emotion label. Those who do not feel any emotion can select “no emotion” instead. Once users have selected a predefined number of emotions (or “no emotion”), they can save their self-report. It is then stored in a CSV file. In each emotion column, the value stored is the intensity selected for the corresponding emotion or -1 if the emotion was not selected. This format allows the user to easily interact with the data with Python. For the “other” emotions, we store the label and the intensity in two different columns for an easier data extraction. If the user selects “no emotion”, then we store a “1” in this column, else we store “0” following a boolean coding.

Settings

The GEWMI application is available in two languages: English or French. It is possible to change the minimum and maximum number of emotions selectable per self-report. The wheel can be displayed in colors for more clarity or attractiveness, or in grey levels for more neutrality. During an experiment, it is possible to save one or several self-reports for each subject, in order to show a subject 10 videos and collect their emotions after each one. Experimenters can modify the emotion labels, the colors and the number of emotions displayed on the wheel. Therefore, they can adapt the tool to different contexts.

Availability

A git repository is available on email request to the authors. It includes the source code, a README (in English and French) explaining how the app works and an APK allowing experimenters to install the application on an Android device.

Experiments

Method

We conducted an experiment in order to assess participants’ emotions in a smartphone context. This way, we aimed to study subjects’ emotions when interacting with a short messaging chat application on a smartphone. For this purpose, we developed a mobile application consisting of a chatbot playing videos, then prompting users to describe these, and finally to annotate their emotions. We used the French version of the previously presented GEWMI for the self-report task (figure 3). Subjects could declare up to two emotions and the corresponding intensity after each clip. They could also declare a "no emotion" value or new values using the item "other".

Three conditions of valences were used: positive, negative and neutral. In order to induce emotions, we selected 13 video clips from the video clip database designed by Samson et al. [8]. The valence of each video in this database was evaluated on a scale between 1 and 7, by a panel of participants. We used four video excerpts for each condition and one neutral video excerpt for training. These videos are about 30 seconds long and represent scenes filmed by amateurs, collected online. Negative valence video clips portray accidents with explicit injuries (valence < 2). Positive valence video clips represent funny situations with babies or animals (valence > 4.5). The neutral valence video clips depict banal situations such as preparing a dish in the kitchen or visiting a museum (valence between 2.5 and 3.5). The table 6 depicts the average valence of each condition, for the selected videos. A training video clip and self-report with the instructions were given so that subjects could familiarize themselves with the tool. The order in which the videos were presented was counterbalanced to avoid biases.

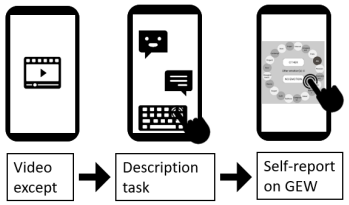

Figure 5: Experiment setup for one task. The task was repeated 12 times

Condition	Average valence
Negative	1.85
Neutral	3.19
Positive	4.97

Figure 6: Average valence by condition

40 participants have completed our experiment in laboratories of Orange Labs Service, 21 females and 19 males. 25% of subjects were aged 18-24 years, 17.5% were aged 25-35 years, 35.0% were aged 35-49 years and 22.5% were aged 50-64 years. We collected 480 self-reports with 0 to 2 emotions declared on each one.

Results

The mean numbers of declared emotions (positive valence or negative valence) by condition are shown on figure 7. According to a Kruskal-Wallis test ($T = 268.30$, $p < 0.001$), negative valence emotions were statistically more widely reported for the negative condition compared to the positive and neutral conditions. Likewise, according to a Kruskal-Wallis test ($T = 123.964$, $p < 0.001$) most of positive valence emotions were declared for video clips in the positive condition. Generally speaking the analysis of valences shows an expression of subjective feelings consistent with the content of the video clips. However, we can observe a surprising number of positive emotions declared for videos with a negative valence.

The figure 8 shows the global distribution of declared emotions during the experiment. A more detailed analysis shows that the choice of positive labels in negative conditions is widely represented by the label "compassion". This particular emotion, pertaining to a social dimension, is not well described in the GEW model that we used to construct the GEWMI. Indeed, subjects watching painful situations reacted in an empathetic way.

Moreover, there were significantly more negative emotions declared under the neutral condition than under the positive condition. This result could be explained by a particular video in the neutral condition which evoked the label "sadness" probably because of the facial expression of the represented character. Besides, we can observe an uneven distri-

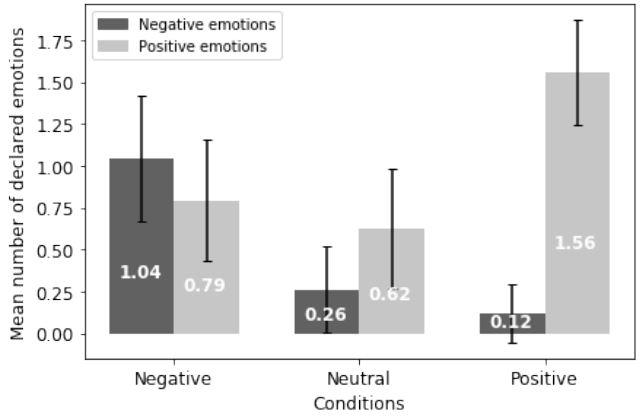

Figure 7: Type of emotions declared by video condition

bution of the declared emotions. For instance "pride", "love" and "guilt" have very few occurrences (less than 10). It can be explained by the external nature of the stimuli, which does not involve the subject and his skills (for the case of "pride" or "guilt"). On the contrary, some emotions are largely expressed like "interest", "amusement", "compassion" or "sadness".

Conclusion and Discussion

The subjective feeling is a key element to understand the emotions felt by an individual as it could represent the changes of the other components. However, the subjective feeling is difficult to access because of the complexity of the representations involved in this component (See figure 1). While laboratory experiments are necessary to test tools and to induce emotions, they remain artificial situations. Nevertheless, developing innovative research tools is a necessary step and we believe that the method and tool we designed is another step toward the study of emotions in more ecological

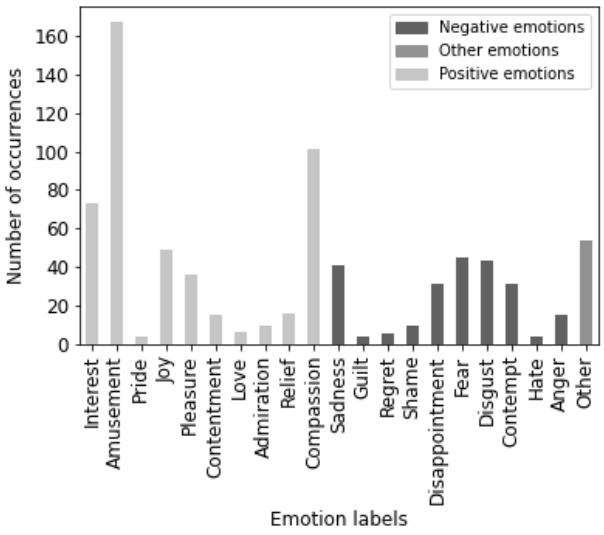

Figure 8: Distribution of declared emotions

situations.

The GEW proves to be a flexible tool, adaptable for many situations. In our case, we focused on the analysis of the valence dimension. Our design for mobile format allowed us to conduct an experiment with smartphone devices. The results show that reported emotions could be synthesized to levels of valences or to specific labels. These features are convenient to analyse data for affective computing experiments. In addition to the analyses shown in this paper, we could add the analysis of the average intensities or the number of emotions by condition. Furthermore, as several mixed self-reports can be annotated by subjects we could compute more complex feelings. However, some labels underline the limitations of the tool. For instance, the label "Compassion" was mostly used in the experiment to refer to negative valence videos. Therefore, the question whether compassion should be considered as an emotion with a positive valence remains to be addressed.

Another concern was about the format we used on our mobile application: unlike the original GEW on paper or with a numeric version on tablets, we had to display the emotion's intensity on a screen different from the labels. This difference in format could be a limit, and its potential influence over the self-reports made needs to be carefully studied before validation. We believe that assessing users' emotions offers many opportunities. For example, Desmet et al. used quantitative and qualitative emotions assessment data to categorize mobile phone designs [4]. Moreover, tools like GEWMI could be used to label more complex data, in order to create automatic emotion recognition systems with supervised classification.

In conclusion, we were able to demonstrate that the GEWMI application is useful and usable for experiments on smartphones, at least in laboratory studies. We designed this application to be suitable for a wide variety of contexts. By sharing this application in open-source, we hope that experimenters could use it for their researches and possibly propose improvements.

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