How to Collect Haptic Expressions of Spontaneous Emotions?

Methodological considerations

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***Abstract*—Eliciting emotions to collect affective expressions is frequently used in studies about facial, spoken or bodily expressions of emotions. However, recent works in affective haptics focus mostly on expressions of acted emotions. The expression of spontaneous emotions using the haptic modality remains unexplored. This paper discusses methodological considerations for designing experimental protocols to collect haptic expressions of spontaneous emotions. We highlight the main difficulties to solve, provide illustrative examples from several experiments that we conducted, and describe methodological considerations for eliciting emotions and collecting corresponding haptic expressions.**

Index Terms—haptic, kinesthetic, emotion elicitation, experimental protocols

I. INTRODUCTION

There are several approaches to collect affective expressions [1]. The first approach consists in collecting expressions of acted emotions. Researchers ask participants/actors to simulate an emotion using more or less staging and directing instructions, and then record their expressions. The second approach consists in collecting expressions of spontaneous emotions. Researchers are eliciting emotions in participants and collect their expressions. This approach aims to collects more natural expressions but is more complex to achieve.

Several studies investigates approaches to elicit spontaneous emotions. The first approach uses various media supports. For example, the IAPS images corpus (International Affective Picture System) contains validated images that are displayed to participants to elicit some emotions, such as content or disgust [2]. An alternative approach uses sounds or music to elicit moods or emotions in participants [3]. The IADS (International Affective Digital Sounds) corpus contains validated audio stimuli that are played to participants to elicit some emotions [4]. Videos are also very effective for the elicitation of intense emotions and are able to catch the attention of participants [5]. However, the elicitation of the emotion might not be uniform during the whole video and contain dynamic blends of several emotions [6].

Another approach involves interactions since the social component of emotions is known to be quite important [7]. In natural settings, multiple emotions appear during social interactions between two or more people. This method consists for example in placing two participants in an isolated room. In some cases, these participants already know each other. In other cases, some experimenters are involved in the interaction with the participants. The main difficulty of this method is to achieve a balance between the level of control of the interaction by the experimenter (e.g. for the elicitation a specific emotion) and the natural aspect of the interaction between participants (e.g. they should forget as much as possible that they are recorded). This method is usually employed for the elicitation of emotions such as stress [8].

Previous studies collected affective expressions in various modalities such as facial or gestural expressions using those protocols [9]. Studies investigating the potential of haptics to convey efficiently emotions are more recent [10]. We collected and analyzed a corpus of haptic expressions of acted emotions in a previous work [11]. However, the collection of haptic expressions of spontaneous emotions remains unexplored. This is an issue since it is not possible nowadays for a computer to recognize an emotion expressed by a human using the haptic channel, or to synthesize realistic affective haptic expressions.

This paper discusses methodological considerations and explores possible designs of experimental protocols to collect haptic expressions of spontaneous emotions. Section II presents the main constraints to solve when collecting haptic expressions. Section III investigates different experimental protocols for eliciting emotions and collecting haptic expressions of those emotions. Section IV suggests some design recommendations for collecting haptic expressions of spontaneous emotions. Section V concludes the paper.

II. COLLECTING HAPTIC EXPRESSIONS OF SPONTANEOUS EMOTIONS

As shown above, many studies focus on eliciting emotions. One of the main objective of those studies is collecting natural expressions for a given modality. However, for the haptic modality, this collecting step displays three specific constraints.

A. Technologies recording haptic features require physical contact

Once an emotion is elicited in a laboratory context, recording corresponding affective expressions is quite easy for some modalities. For example, a camera can capture facial or bodily expressions of emotions. However, the study of haptic expressions requires the measure of other features such as pressure [12]. This is an issue since existing devices designed to measure pressure require a physical contact with the effector. In our case, the effector is a participant. There are two solutions:

- Attaching the device measuring pressure on the participant. This solution is intrusive since the participant has to wear constantly the device. It might also obstruct some natural and spontaneous expressions.
- Placing the device measuring pressure on the surface on which the participant expresses his emotion. This solution is non-intrusive. However, it requires covering the entire surface with pressure sensors in order to capture all expressions.

Both solutions limit the spontaneity of haptic expressions.

B. Affective haptic expression requires physical contact with a human partner

In everyday life, the participants express emotions on human partners. It is difficult to have the same behavior on non-animated objects (e.g. pressure sensors, robotic structure). One would expect that they do not use spontaneously haptic channel for the emotional expression during experimental studies using devices.

C. Touch is considered as a violation of intimacy

Touch is a natural and efficient way to communicate some emotions [10]. In some cultures, touching people is considered as a lack of respect. Thus, people avoid using touch to communicate their emotions. This is an obstacle when we want to collect haptic expressions of emotions. Moreover, in some modalities, the expression of emotion is hardly restrained by people (e.g. the micro-expressions in the face [12]). Touch requires a more complex interaction, acting in two steps: approaching the object to be touched, then touching it in a specific way. This makes spontaneous haptic expressions easer to inhibit.

The next section explores three different protocols for collecting haptic expressions of spontaneous emotions considering those constraints. These protocols use a Geomagic Touch X haptic device[1]. This device is held as a pen by its user, and enables to perform 3D haptic tasks while recording features of gestures by tracking the movements of the pen. For instance, measures as the mean speed of the movements of the hand, their direction or their fluidity can be recorded this way. Following those recording, the gestures can be haptically reproduced by the device. Moreover, it is possible to attach sensors (e.g. pressure sensor) directly on the pen. This makes it less intrusive and still in constant contact with the participant.

III. Experimental Protocols for the Elicitation and Collection of Haptic Expressions of Emotions

The two last sections presented the existing approaches for eliciting emotions in laboratory. We propose and discuss three experimental protocols for collecting haptic expressions of spontaneous emotions. These protocols are all based on a haptic task to which we added emotional stimuli. We chose this approach for two main reasons:

- Participants should not be aware in advance of the emotions elicitation aspect of the experiment since the emotions we wish to elicit have to be spontaneous.
- The completion of the task requires the use of a haptic device (a Geomagic Touch X), which can record haptic and gestural features of expressions.

The recorded affective expressions are not the expressions of elicited emotions alone. They are combined with the movements due to the haptic task itself. We do believe that this is more useful for designing haptic-based interactive applications. We are interested in exploring how affect impacts the haptic task itself.

A. Collecting haptic expressions in a learning task

This task was inspired by the interaction protocol presented in section I, and tasks used to study collaboration integrating haptic feedbacks [13]. Two participants were involved in this experiment. They were located in different rooms to ensure that they could not see or hear each other. The first participant (thereafter named P1) had the role of a teacher. Before the experiment, he was trained to complete a specific task (i.e. amplifying the movement of a dynamic pendulum by varying the length of its cord). It was done by controlling one of the extremity of the pendulum with the haptic device (see Fig. 1). After this training phase, P1 guided a second participant (thereafter named P2) using his or her haptic device. P2 had the role of student. The haptic devices of P1 and P2 were in a mutual strength submission configuration. Thus, P1 was able to guide P2 using his or her own movements, while feeling what P2 was doing. During the whole experiment, participant P2 had his or her movements recorded. The two pendulums displayed on the screens were synchronized.

For eliciting emotions, we added the face of a virtual human issued from the MARC framework next to the display of the pendulum on P2's screen (see Fig. 1) [14]. We told P2 that the face of the virtual human was controlled by the participant P1 (the real controller was the experimenter). First, P2 was trained to control the pendulum. Then, we started to send to P2 some stimuli. For instance, one of the stimulus was displaying an angry face, while the audio message "you are doing it very bad" was played.

We made some pretests to highlight eventual limitations of this protocol. The task seemed quite complicated for P2. The

[1] http://geomagic.com/en/products/phantom-desktop/overview

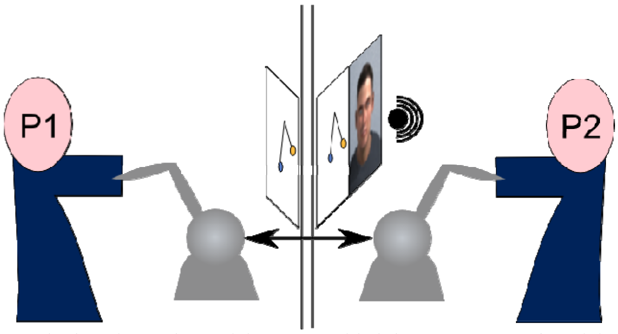

Fig. 1. The learning task. Participant P1 guided the movements of participant P2 to complete the task thanks to a mutual strengh submission. Meanwhile, an avatar displayed facial expressions of emotion to elicitate emotions in P2. P1 was able to feel the movements done by P2, which where also recorded.

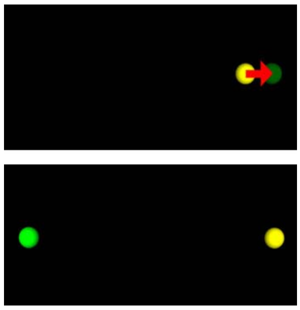

Fig. 2. The pointing task. Participant had to reach a green ball using the haptic device, represented by a yellow ball (top image). After this, another target ball is displayed

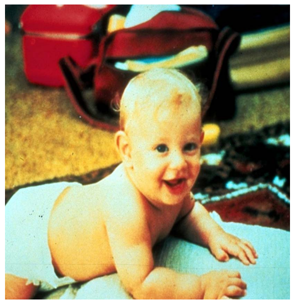

Fig. 3. An example of a visual stimulus displayed to participants, extracted from the IAPS. It was visually displayed in front of the task. A sound corresponding to a baby laughing accompanied this

pretests highlighted that most of the time, P2 just followed the haptic instructions from P1. Besides, those instructions could vary a lot depending on the strategy of P1. A solution could be to remove P1 and instead to simulate his behavior. This would make the movements of the teacher more consistent over time. But this would not change the difficulty of the task.

B. Collecting haptic expressions through a pointing task

Considering the limitations highlighted in the protocol tested in the previous section, we explored a second task which was expected to be simpler to learn and control: a pointing task. This task consisted in reaching a target using the haptic device as a pointer. The target was displayed darker and darker as the participants were closed to it. Once a target was reached, another was displayed at the opposite side of the screen (see Fig. 2). Every ten targets, we changed the axis on which the targets were displayed (left-right axis, then up-down axis, then depth axis). This was intended to prevent participants to getting used to the movement, without removing the periodicity of their movements. This periodicity was expected to help analyzing the data (for example to compare the effects of the presence/absence of a given stimulus eliciting affect).

This protocol also proposes a different way of eliciting emotions, including visual and audio stimuli. The stimuli are visually displayed at the same location as the graphical objects involved in the task (see Fig. 3). When stimuli appear, we observe any changes in the movements of the participants. Two different stimuli were here involved. The first stimulus aimed to elicit Joy. It corresponded to the image of a baby smiling accompanied by the sound of a baby laughing. The second stimulus aimed to elicit Disgust. It corresponded to the image of dirty toilets accompanied by the sound of someone vomiting. Both stimuli were presented to users, in random order.

Three participants informally tested the system. They reported the task was easy. This solved the main limitation of the previous protocol. However, they also highlighted some limitations. First, when the target moved across the depth axis, it was difficult for participants to evaluate its position. This is due to depth perception problems in 3D environments. Participants sometimes missed the target. This required them to change their direction to go back. This limited the periodicity of their movements. A last limitation concerned the administration of the stimuli. The participants did not know how to react when the target disappeared behind the visual stimulus, and often just stopped moving. Thus, the analysis of the gesture is valid only during the first few seconds of the stimulus.

C. Collecting haptic expressions through a tracking task

Considering the limitations highlighted in the protocols described in the two previous sections, we explored a third task: a tracking task. This task consisted in tracking a visual target using the haptic device. A blue target travelled on a circle trajectory at constant speed. The objective for the participant was to remain as close as possible to the target. The depth axis was not covered by the target. The ball representing the current position of the device was red, becoming greener and greener as the ball moved closer to the target (see Fig. 4). The stimuli were the same as in the previous protocol (visual + audio stimuli). However, this time the images appeared behind the scene (see Fig. 5).

We made some pretests to assess eventual limitations of this protocol. The removal of the depth component helped participants since it removed the depth perception problem. The participants were not disturbed by the stimuli to complete their task. However, a new limitation appeared. When the stimuli occurred, participants stopped moving one second, then continued the task. Indeed, the task was too precise and might have limited their movements (e.g., even if participants

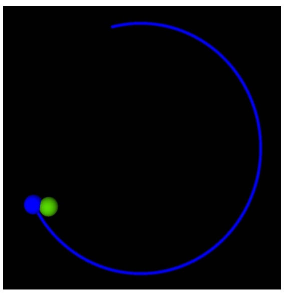

Fig. 4. The tracking task. Participant had to follow a blue ball using the haptic device, represented by a ball (greener and greener as they were closer to the

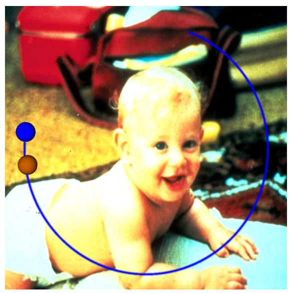

Fig. 5. An example of a visual stimulus displayed to participants, extracted from the IAPS. It was visually displayed behind the task. A sound corresponding to a baby laughing accompanied this stimulus.

wanted to accelerate, they could not due to the speed of the target ball).

IV. GUIDELINES

The protocols and their informal testing described above provided several clues for elaborating an efficient configuration for eliciting emotions during a haptic task. This elicitation should enable to collect haptic spontaneous expressions of emotions. This section provides some guidelines to design an efficient experimental protocol for this goal.

1) The choice of elicited emotions is important

All emotions are not conveyed equally by haptics. For example, self-focused emotions, contrary to basic or social emotions, are not efficiently conveyed by haptics between strangers [10]. Besides, in a previous experiment that we conducted for collecting gestural expressions of acted emotions using a Geomagic Touch X, the participants could not find any gesture to express contempt with a handshake. Thus, the records corresponded to null movements, which could not be interpreted as haptic stimulations since touching somebody requires a gesture [11].

2) The presented stimuli should not interfer with the task.

The main problem of some emotional stimuli presented above is that they remove the focus of participants from the task. Thus, when a stimulus is presented, it is complicated to determine if a change in the participant's behavior comes only from an emotional mechanism or also from a change in their focus. Thus, the type of presented stimuli and their presentation is crucial. The proposed task should be both simple to complete, and offering some liberties in the movements of the participants.

3) The contact with the device should remain natural

Participants should forget at some point that they are touching a device. If they need to remember it at every moment, the collected expressions will lose a lot of their spontaneity. Our proposal to use the same device to collect task-based command and expressions of emotion might help here.

V. CONCLUSION

This paper investigated several experimental protocols to elicit emotions in participants in order to collect spontaneous haptic expressions of emotions. Considering the specific constraints of the haptic modality (cultural and technical aspects), several guidelines were proposed in this paper. The protocols enabled to find out several points that have to be taken into account in the design of an experiment: the choice of the elicited emotions, the kind of stimuli to be used and the inclusion of sensors in the experiment as a joystick.

However, some limitations remain. For example, if a given stimulus is expected to make participants react emotionally, the effects of this stimulus might quickly decrease with time as participants will focus solely again on the haptic task (which also involve the visual channel). This might occur even if the emotional stimulus remains present on the screen. A solution to solve this issue could be to make the stimuli parts of the task itself.

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