

# SUM Preliminary study; Conclusions

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## 1 Introduction

The main objective of the preliminary experiment was to *desgin an experimental protocol* which targets the validation of the following scientific hypothesis:

- Knowing the mood expressed by a musical performance allows us to know which mood is felt by a listener (may be the same mood).
- Knowing the motions of the hand holding the bio sensor could allow us to compensate and/or complement the estimation of affective states.

The experiment was conducted by Bruno Herbelin and his students in the Master education in Medialogy in AAUK. This document presents the conclusions and observations on the establishment of an experimental protocol and the guidelines for the analysis of the data obtained from physiological and motion data and from cognitive assessment.

## 2 The experiment

After a design session (with Lars Graugaard) where the overall structure of the experiment has been shapen, it has been decided to test various ways to conduct the experiment in order to obtain experience and subjects' feedback on the following points; the setup (equipment, room, etc.), the tasks to be performed by the subjects, the timing of those tasks, the profile of the subjects in the cohort, and the data to be gathered.

A preliminary study protocol has been described and four subjects (3 men, 1 women, age between 24 and 29) have been tested accordingly. In short, the protocol had two phases, the first consisting in passive listening and the second in trying to express the mood felt by moving the body. For each phase, four versions of a classical piece of music were played; the first always being the reference (MIDI file played without modification) and the three others being the same music modified with the KTH rule system to express various moods (happiness, sadness and anger in random order). Data have been recorded (3

axis acceleration, BVP, GSR) and a cognitive assessment of affective state have been requested (arousal, valence and dominance) for the 8 sessions with each subject.

Follows a short description of the main questions to be enlightened by this preliminary test:

1. Setup; Is the device usable? Are the listening conditions adapted?
2. Tasks; Are the instructions clear? Did the subjects perform as expected? Is it easy to manage the randomization of tasks (order of musics)?
3. Timing; how long should the tasks be (specific choice on 1 or 2 minutes of listening task per music)? How much time is needed extra (filling in questionnaires, etc.)?
4. Cohort; Were the subjects sensible to the music?
5. Data; Was the questionnaire designed (SAM rating) usable and meaningful? Which sampling rate to use for the sensor? Were there problems / difficulties for recording data?

Further on, a pre-analysis of the data was performed in order to define the features which can be extracted out of the measurement and which could potentially be interested for the validation of the hypothesis.

### **3 Results 1: decisions for the experimental protocol**

The experiment guidelines established a-priori were progressively adjusted to find good experimental conditions and subjects were briefly interviewed after each session to obtain feedback on the process they have been going through (subjects being also Master students, they could reflect on the needs for an experiment).

#### **3.1 Subjects feedback and comments**

##### **Setup**

A 'cosy' corner (fig. 1) has been setup with room separators, a small table and a chair. Subjects reported that they liked the feeling of intimacy produced to feel more free to move / dance without being observed. They appreciated not to be video recorded.

We used a 4.1 sound system (Logitech Z5500) setup for stereo (pseudo 4.1) with a relatively good sound quality (powerful bass). No comment were given about this.



Figure 1: The isolated corner for the subjects

### **Tasks**

For the first phase (static), there was no difficulty in understanding what to do. For the second phase, people were asked to stand up and “Move as the music makes you feel; dance, conduct, play imaginary instruments, etc.” Subjects did not object to it verbally, but they had very various attitudes, some being very static (small body movements, changes of balance). To compensate, the final subjects was asked to do the same thing but essentially with his arm; this seems to be necessary in order to gather significant motion data (to be confirmed by the acceleration data analysis).

### **Timing**

The first subject was tested with 2 minutes exposure to each music. This was perceived as being way too long, leading to boredom. It was decided to test with 1 minute exposure time further on. This duration was considered as really fine, also when asking them if they thought they have had enough time to get into the music.

The timing for the presentation of the experiment and the giving of instructions was not strictly pre-determined; measurements (table 1) allows to estimate the time needed (5 minutes total) ; four minutes to introduce the overall experiment, the SAM rating, and the first task, and one more minute between the two phases to introduce the second phase. Timing the sessions also allowed us to estimate how long is needed to fill in the questionnaire (45 seconds on average).

### **Cohort**

In practice, 4 students present on campus were invited to come for a short experiment. Nothing significant can be observed from such small sample (3 men, 1 women, age between 24 and 29).

	S0	S1	S2	S3	Average S1-S3
introduction	4:29	3:57	3:47	3:15	3:39
filing initial form	0:40	0:36	2:38	1:48	1:40
music 1	2:07	1:04	1:02	1:04	1:03
pause 1	0:23	2:32	0:20	0:14	1:02
music 2	2:04	1:07	1:10	1:09	1:08
pause 2	0:14	0:54	0:23	0:07	0:28
music 3	2:06	0:54	1:17	1:11	1:07
pause 3	0:13	0:51	0:41	0:08	0:33
music 4	1:54	1:05	1:05	1:11	1:07
pause 4	0:20	0:39	0:30	0:02	0:23
instruction	1:32	1:17	1:06	1:08	1:10
music 5	2:01	1:01	1:02	1:02	1:01
pause 5	0:23	0:46	0:26	0:02	0:24
music 6	2:17	1:07	1:07	1:21	1:11
pause 6	0:10	0:50	0:31	0:04	0:28
music 7	2:23	1:16	1:44	1:10	1:23
pause 7	0:14	0:42	0:23	0:13	0:26
music 8	1:57	1:08	1:07	1:06	1:07
pause 8	0:10	0:35	0:20	0:06	0:20

Table 1: Timetable of each task of the protocol as performed by the subjects

The only noticeable element is that none complained about the type of the music, nor expressed the wish to fit better with their taste. They were asked which music they usually listen too (classical, traditional, pop, blues, country, electronic, folk, rock, heavy metal, hip hop, jazz, reggae) and this shown very eclectic tastes (all listening to 6 genres on average) which was apparently not correlated to any other element (age, gender, and their comments).

All that to say that, as expected, the use of classical music seems as appropriate as any other genre of music for our purpose.

## Data

Cognitive assessment by self report was performed to complement movement and bio-data. The subjective arousal and valence evaluation scale proposed with the Self Assessment Manikin from [?, ?] allows to select values on a 1-9 scale for three components describing an emotion (Figures 2a and 2b). Comments from subjects on the use of this scale led to useful guidelines for the future:

- The first subject was only asked to rate 'his' emotion. However, in the post-session discussion, he recognized that he had in fact filled in the form to express what the music expressed. He proposed on his own (not suggested by us) that we ask both 'what did you think the music express' and 'what did you feel'. This was already one of our idea for improvement,

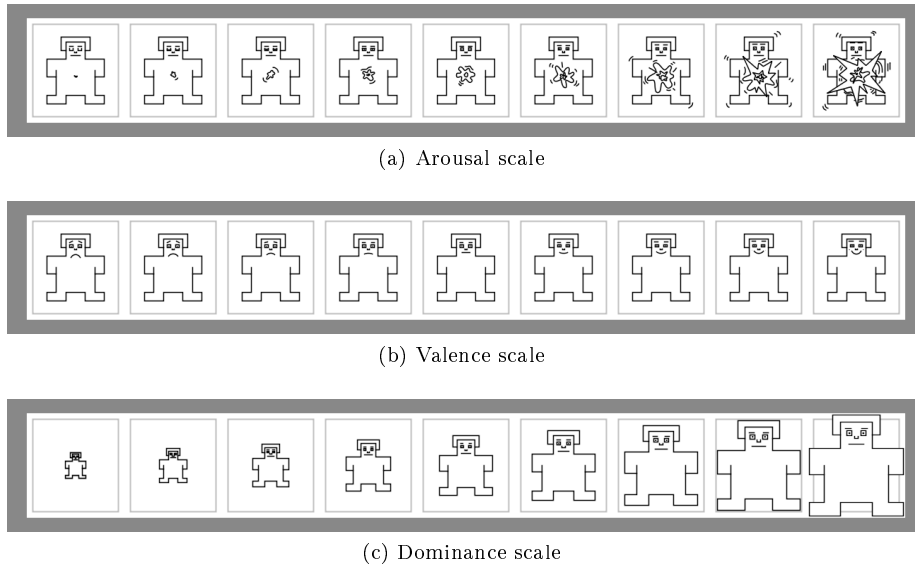


Figure 2: 9-scale version of the Self Assessment Manikin

and the fact that it came from the subjects comforted us in our choice. Further on, the 3 other subjects were asked to put a cross for rating the 'expressiveness of the music' and a circle to rate their personal inner feelings. This was considered as a natural and simple task for them (except dominance, see below).

- The SAM rating scale was explained during the introduction to the experiment. The rating of arousal and valence was considered as simple and did not cause doubts nor hesitation, both for the music-expressed and felt emotions. The dominance factor was less clearly understood. One subject could not even relate it to the expressivity of the music (could only rate according to his feelings). We insisted on this and tried to explain it better (as it is truly a concept which is not usual); the better explanation we could give was that dominance is 'how much you feel in control of yourself (and of your emotions)', or 'how much you feel your mind is in control of your body', which translates for the expressivity of music into 'how much the music provides the feeling of power'. This seemed to have been successful and last subjects eventually managed without too much problem.

To sum-up, it is better to ask subjects to rate their inner feelings *and* what they think the music expressed. The three PAD dimensions (pleasure, arousal, dominance) from [?, ?], or AVD (arousal, valence, dominance), can be assessed in both cases if a special care is taken in explaining the concept of dominance.

Regarding the gathering of data from the sensor, there were no noticeable issues. The recording software was improved on the fly to enhance its usability (remember last save location, automatic adding of file extension, etc.) and worked without problems. The sampling rate originally set to 60ms (16Hz) for the 2 mn sessions was way too low and a quick look at the data shown that it should be doubled in order to capture the BVP correctly. Setting the sampling at 30ms (33Hz) was then appropriate and led to 160kB files per minute, aka 1.3MB per subjects for the 8 recordings. This is not manageable in Excell but without problem is programs like R<sup>1</sup>. A bit higher frequency (up to 50Hz) should be an even better solution for a more detailed analysis.

### 3.2 Experimenters feedback and comments

Four students were conducting the experiment and were all proactive and motivated. The points raised from the experimenter point of view were the following:

- The more important role is the introduction to the experiment, explaining the questionnaire, and giving the instructions.
- One has to check the correct fit of the sensor (check for good pulse signal)
- It was laborious and repetitive to each time save the data file (clic, browse, type filename). It was hard to synchronize the start of the music with the start of the recording (two applications).
- There should be no communication between subject and experimenters during a session, which was not done here as the subjects had to say 'ready' to tell us when to start the next song.
- Music clips should be already of the desired length (1 minute)

All in all, it was agreed that a dedicated little program should allow the subject to follow instructions on screen during the recording sessions; clic start, listen to music (black screen), then questionnaire appears on screen, when filled in, visual count down to let the subject prepare mentally, start new music, etc. The instructions for the second phase could also be integrated in the software. Human contact is however necessary for the introduction to the experiment.

### 3.3 Concluded protocol

#### Setup

Simple room, no visual distractions. Light a bit dimmed (making the room less visually apparent). In a 'cosy' corner, the sound system is setup. The chair (comfortable) is in the center, A small table is nearby to fill in questionnaires. Experimenters are hidden behind a room separator (controlling the music and recording of data from a laptop).

Equipment check-list:

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<sup>1</sup><http://www.r-project.org/>

- Room separators (high enough)
- A chair which needs to be able to be easily removed (wheels). A table.
- Sound system capable of providing sufficient sound quality for it to "disappear". Small but good.
- Hand-held USB sensor (BVP, GSR, 3 axis acceleration) + towels (wipe hands)
- Laptop + USB cable (long)
- Audio files for 3 expressions of moods (happy, sad and aggressive) and one 'neutral'.
- Software for recording data and for playing music (mp3).
- Questionnaires, pen, watch.

### Tasks

When arriving, subjects are asked to:

1. Wash their hands (for GSR signal)
2. Listen to introduction (presentation of the questionnaire, presentation of the tasks)
3. Sit on the chair, grab the sensor in left hand, listen to first instructions.
4. *Listening task 1*: Just sit and listen to the 4 musical performances, trying to relax and not physically move; after each music, quickly answer to the questionnaire.
5. Stand up (move the chair), keep the device in the hand, listen to second instructions.
6. *Listening task 2*; Move / dance to the music; after each music, quickly answer to the questionnaire.

For the two listening tasks, the instructions are given orally in ways similar to these sentences;

#### ***Listening task 1:***

“Stand still while listening to the music. Let the music influence your mood.”

#### ***Listening task 2:***

“Move your arm (with the sensor) as the music makes you feel; dance, conduct, play imaginary instruments, etc. (nobody is watching you and we are not recording video).”

For both listening tasks, the order of the music mood is identical for a participant, and always starting with the neutral. The order of the moods is randomized between participants ( e.g. Neutral, Sad, Happy, Aggressive, or N,H,S,A, or N,S,A,H, etc.).

### **Timing**

For a total of 20 minutes per subject:

- ~4 minutes initiating experiment, give instructions, adjustment to the room, etc.
- 8 times ; *1 minute listening to a music* + 45 second break to rate PAD between musics.
- + ~2 minutes extra.

### **Cohort**

No specific request.

Only care; sufficiently good health for dancing 7-8 minutes.

### **Data**

The device measures conductivity of the skin between two fingers, variations of blood volume pressure on a finger, and acceleration on 3 axis (of the hand). It provides us with the following data;

**AN0** - Acceleration X axis (approx. 0V-4V and approx 2V at rest)

**AN1** - Acceleration Y axis (approx. 0V-4V and approx 2V at rest)

**AN2** - Acceleration Z axis (approx. 0V-4V and approx 2V at rest)

**AN3** - BVP (1,2-4V approx)

**AN4** - GSR (0V-5V approx. 0-2 MOhm non linear)

All values are normalized (range above) when recorded.

## **4 Results 2: guidelines for features extraction**

A rapid pre-analysis of data for the four subjects, although of course not significant statistically, allows to test the relevance of computational features for each induction session; discard the obviously unadapted ones and determine other potentially interesting ones by the observation of the apparent tendencies of the data.

#### **4.1 BVP**

The amplitude of the blood pressure obtained from the photoplethysmo sensor varies a lot between subjects (

#### **4.2 GSR**

The initial value of GSR varies a lot between subjects; it does not seem appropriate to compare

#### **4.3 Motion**

#### **4.4 Cognitive assessment**

### **Annexes**

Subject		1	2	3	4			
Task 1								
		Music?	feeling	Music	feeling	Music	feeling	Music
Neutral	Arousal	1	4	5	8	6	5	5
	Valence	5	6	4	3	4	7	5
	Dominance	8	4		7	7	7	5
Sad	Arousal	1	3	5	8	8	2	3
	Valence	4	3	2	2	4	1	1
	Dominance	9	5		3	2	5	2
Agressive	Arousal	4	3	5	7	5	8	9
	Valence	6	3	2	6	7	8	7
	Dominance	9	5		7	5	9	9
Happy	Arousal	4	7		6	8	7	8
	Valence	6	5	4	7	8	8	9
	Dominance	9	3		5	4	7	5
Task 2								
Neutral	Arousal	2	7	7	7	8	5	5
	Valence	5	7	4	4	3	7	5
	Dominance	9	6		4	2	7	5
Sad	Arousal	1	7	7	7	9	1	1
	Valence	5	7	5	3	2	2	1
	Dominance	8	3		3	2	2	2
Agressive	Arousal	3	8	9	6	8	9	9
	Valence	6	6	4	7	6	7	8
	Dominance	9	2		6	4	9	9
Happy	Arousal	2	6	8	7	8	8	7
	Valence	5	5	6	7	8	9	8
	Dominance	9	5		3	2	4	7

Table 2: Cognitive assessment in the AVD dimensions from SAM rating questionnaire