Multimodal Expressions of Stress during a Public Speaking Task: Collection, Annotation and Global Analyses

Tom Giraud, Marie Soury, Jiewen Hua, Agnes Delaborde, Marie Tahon, David Antonio Gómez Jáuregui, Victoria Eyharabide, Edith Filaire, Christine Le Scanff, Laurence Devillers, et al.

Multimodal Expressions of Stress during a Public Speaking Task

Collection, Annotation and Global Analyses

Tom Giraud, Mariette Soury,
LIMSI-CNRS
Orsay, France
{tom.giraud, soury}@limsi.fr

Jiewen Hua,
CIAMS, Université Paris-Sud
Orsay, France
jiewen.hua@u-psud.fr

Agnes Delaborde, Marie Tahon,
LIMSI-CNRS
Orsay, France
{agnes.delaborde, marie.tahon}@limsi.fr

David Antonio Gomez Jauregui, Victoria Eyharabide
LIMSI-CNRS
Orsay, France
{ Gomez-jau, victoria.eyharabide}@limsi.fr

Edith Filaire
CIAMS, Université Paris-Sud
Université Orléans. UFR STAPS
Orsay, France
edith.filaire@univ-orleans.fr

Christine Le Scanff
CIAMS, Université Paris-Sud
Orsay, France
christine.le-scanff@u-psud.fr

Laurence Devillers
LIMSI-CNRS, Université Paris-Sorbonne
Orsay, France
laurence.devillers@limsi.fr

Brice Isableu
CIAMS, Université Paris-Sud
Orsay, France
brice.isableu@u-psud.fr

Jean Claude Martin
LIMSI-CNRS
Orsay, France
martin@limsi.fr

***Abstract*— Databases of spontaneous multimodal expressions of affective states occurring during a task are few. This paper presents a protocol for eliciting stress in a public speaking task. Behaviors of 19 participants were recorded via a multimodal setup including speech, video of the facial expressions and body movements, balance via a force plate, and physiological measures. Questionnaires were used to assert emotional states, personality profiles and relevant coping behaviors to study how participants cope with stressful situations. Several subjective and objective performances were also evaluated. Results show a significant impact of the overall task and conditions on the participants' emotional activation. The possible future use of this new multimodal emotional corpus is described.**

Keywords— databases, stress, emotion, multimodality, individual differences

I. INTRODUCTION

"Emotion" refers to a collection of psychological states including subjective experience, expressive behavior (e.g., facial, bodily, verbal), and peripheral physiological responses (e.g., heart rate, respiration) [1]. In Affective Computing, the recognition or the modeling of these complex states necessitates the collection of human databases [2].

One issue when collecting data of emotional events is naturalism. Past researches often relied on professional actors playing emotional expressions in stereotyped situations [3]. Recent approaches in collecting naturalistic data follow two perspectives. First, considering emotion expressions as communication acts, some protocols put the participant in a typical intention of communication (GEMEP Corpus) [4]. Second, considering emotion expressions as spontaneous reactions in a given situation, multiple protocols are proposed for eliciting emotions. Different materials and tasks exist such as films, affective pictures, games or dyadic tasks [5].

Stressful situations are good examples of emotional situations that people come across in everyday life with potential affective computing applications [6], [7]. Lazarus defines psychological stress as the result of the comparison between the power of the environment demands (stressor or load) and the psychological resources of the person to manage these demands [8], [9]. Stress is therefore mediated by an appraisal process with individual differences. Three type of psychological stress are proposed: harm/loss, threat and challenge which result from different situation appraisals. Psychological stress and emotions are interdependent yet not often studied together. Different emotions can arise from stressful situations such as anxiety, fright, guilt, shame, frustration and sadness [9]. Defined as such, stressful situations encompass a wide variety of situations eliciting a panel of negative emotions. In this paper, we focus on a public speaking task known to be experienced as a stressful situation [10]. We propose a protocol to collect a multimodal database which will enable in future studies to answer questions such as: How do people differ in terms of how they can cope with this stressful situation? What emotions are elicited in this situation? What are the dimensions of personality that might explain individual differences? What are the relevant modalities to collect for studying stress behaviors? Which questionnaires should be used to assess participant's stress-related emotions?

II. BACKGROUND

Studying stress is relevant from an affective computing point of view. Finding proper solutions for the management of stress in companies is considered as a main societal challenge (The World Health Report, 2001). There are multiple possible applications in terms of training people how to cope with stressful situations in their everyday professional life (e.g. public speaking, conflicts during meetings) or in exceptional situations (e.g. crisis training). Systems can be used to monitor participants' reactions in different modalities, warn them when they are becoming or expressing signs of stress, and help them regulate the associated emotions [7], [11]. In a system for training team leaders, virtual agents might display a variety of stress related behaviors that the leader has to manage as she would have to in a real team. Past researches on stress in affective computing have dealt with a variety of situations such as driving [6], practicing physical activity [12], interacting with an e-learning environment [13] or presenting in a public speaking task [14].

Psychological studies have shown that stress is highly multimodal, leading to discriminative expressions in speech [15], posture [16], facial expressions [17], physiological signals [18] and self-report [19]. Studies have also shown that there are individual differences in terms of how people appraise, regulate, and express their emotions during a stressful task (collection of data limited to speech) [20]. Yet, databases of non-acted multimodal expressions of emotions collected during stressful situations are not available.

Several studies use a public speaking task to elicit stress. The Trier Social Stress Test (TSST) was introduced in 1993 by Kirschbaum, Pirke and Hellhammer [18] for the induction of moderate psychological stress in a laboratory setting for psychological studies. The TSST test consists of a simulation of a job interview: the participant prepares during ten minutes a free five minutes presentation speech and then says it in front of a jury of experts. One of the jury provided negative feedback. Finally the other jury provided positive feeback. This protocol has been shown to induce stress impacting physiology, behaviors and cognition as a function of individual differences [10]. Public speaking is also considered in affective computing research. Pfister and Robinson designed a classifier for speech coaching [14]. Their classifier is trained on the Mind Reading acted corpus of emotions [3] and then applied on the Speech Tutor corpus. This public speaking corpus is composed of 31 speaking participants. Virtual assessors are also used in a virtual reality setting to elicit stress by displaying irritation or boredom while the user is speaking [21], [22].

Existing databases on public speaking tasks are few and do not enable a full-fledge study of stress because 1) they do not contain records of all the above mentioned modalities, 2) they do not contain detailed information about the individual coping profile of the recorded participants, and 3) they are not conducted during a task. Few databases with naturalistic expressions of emotions exist but they do not feature the three above mentioned characteristics altogether [23], [24].

In this paper, we describe how we collected a database of multimodal expressions of emotions during a public speaking task adapted from the TSST. Section III explains the method and the different modalities that were recorded. Collected data which assess participant subjective and objective performances and multimodal expressions are presented. Section IV presents the results of global analyses of the collected data. Section V describes the future directions and the possible applications for affective computing research.

III. METHOD

A. Participants

19 participants were recruited from University of Paris-Sud (male n=7, 37%; female n=12, 63%). 7 of the participants were doctoral students (37%), 11 were master students (58%), and one was undergraduate student (5%). The average age of participants was 26 years (SD= 6.1). All participants were volunteers and signed an informed consent designed in collaboration with the administrative heads of the partners' laboratories.

B. Measures

1) Personality questionnaires

We selected several personality questionnaires which feature potentially relevant dimensions for stress studies. We considered the personality profiles that might have a positive impact on the performance (e.g. extroversion, agreeableness, conscientiousness and functional copings), but also those that might be unfavorable for the performance (e.g. neuroticism, alexithymia, trait anxiety, vulnerable narcissism, and dysfunctional copings). We selected the following questionnaires: the Big Five, the State Trait Anxiety Inventory, the Toronto Alexithymia Scale and the Hypersensitive Narcissism Scale. The Big Five is the most widely used and extensively researched model of personality [25]. It is a hierarchical model of personality traits with five broad factors: Extraversion (E), Agreeableness (A), Conscientiousness (C), Neuroticism (N), and Openness to experience (O). The French version (Big Five Inventory Francais; (BFI-Fr)) is a 45-item questionnaire scored on a 5-point scale [26]. Trait anxiety was evaluated by The Spielberger's State Trait Anxiety Inventory; STAI [27] (French version: [28]). The trait subscale includes 10 items on a 4-point Likert scale (STAI-T) which assess the feelings of stress and worry on a day to day basis. Alexithymia was measured by the 20-item Toronto Alexithymia Scale (TAS-20: [29], [30]; French version: [31]). It is an inventory consisting of 20 items on a 5-point Likert scale which assess a general deficit in experiencing and processing emotions. The scale measures three dimensions of the construct: Difficulty Identifying Feelings (DIF), Difficulty Describing Feelings (DDF) and External Oriented Thinking (EOT). Vulnerable narcissism, also referred to as covert narcissism, was measured by the HSNS [32]. It consists of 10 affirmations on a 5-point Likert scale.

2) Appraisal, Coping and Affect questionnaires

Threat and challenge (ThCh) appraisals were measured just before the task by 4 questions on a 7-point Likert scale [20]. Two items assess the primary appraisal which is how important and stressful participants perceive the event (Threat). The other two assess the secondary appraisal which is how well participants think they will cope with the task (Challenge). A ratio of the two scores

(primary/secondary) generate appraisal scores, where higher scores denote threat (Apprai R). Coping strategies for this specific situation were assessed using the Brief COPE (an abbreviated version of the COPE [33]; French version: [34]). This questionnaire includes 28 questions on a 4-point Likert scale. Considering that some items are not proper in the experimental context (e.g. I use alcohol or other drugs to make myself feel better), therefore they have been excluded and 22 items (11 subscales) remained. In the present study, we report two summary scales. First, functional coping (COfun) is the results of the addition of the active coping, use of instrumental support, positive reframing, planning, humor, acceptance subscales. Second, dysfunctional coping (COdys) is the results of the addition of the denial, behavioral disengagement, venting, religion, self-blame subscales. We also measured emotional states at two times during the experiment (before and after the task) with two questionnaires. State anxiety was evaluated by The Spielberger's State Trait Anxiety Inventory (STAI-S) ([35]; French version: [28]). For the assessment of current mood states, we used the widely used Positive and Negative Affect Schedule (PANAS; [36]; French version [37]). The scale consists of two 10-item scales rated on a 5-point Likert for the Positive Affect (PA) and Negative Affect (NA), respectively.

3) Physiological measures

The Autonomous Nervous System (ANS) is known to be closely associated with participant's arousal [38]. Thus, four kinds of the ANS variables were to be recorded during the session: electrodermal skin conductance (SC), skin blood flow (SBF), skin temperature (ST) and cardiac rate (instantaneous heart rate (IHR), and heart rate variability (HRV)). These variables were recorded on the left hand of the participant (SC, SBF, ST) and on the chest (IHR, HRV). Salivary samples were collected at different time before and after the task to enable hormones analyses such as levels of Cortisol.

4) Subjective performance

Baggett, Saab and Carver [19] proposed items to assess the perception of the participant of their own performance in a speaking task through a self-report which features nine questions and corresponding 5-point Likert scales. In the current study, we selected the five relevant items out of these nine items to measure: motivation, perceived frustration, stress, difficulty and subjective performance of the task.

5) Objective performance

Task performance was evaluated by three judges. The three judges are professors at the university. They have a long experience in evaluating public presentations. Each judge evaluated alone based on the videos the performance of the participant using an evaluation grid composed of four subscales: the content of the speech (Cont, 6 items), the delivery of the speech (Del, 7 items), and the quality of the answer in the feedback session for the negative phase (Qual-, 3 items) and for the positive phase (Qual+, 3 items). Each item is a 5-point Likert scales. Then, the three judges met to operate a majority voting for each subscale to reach a consensus. The overall performance is the average of the four subscales.

6) Collected behaviors

Several behavioral channels were recorded to enable future multimodal analyses. Voices were recorded thanks to a wireless microphone system. Whole body movements were recorded by a camera and a Kinect. Facial expressions were recorded by another camera. Postural control was recorded by a force plate under participant's feet hidden in a platform. Seated assessors behaviors were recorded by one camera. We did not use motion capture to record the movements of the participants because we believe that this might have refrained participants from behaving spontaneously.

C. Procedure

Job interviews are quite relevant for eliciting social stress because the participant has to present himself and talk about personal matters.

Ethical issues call for a simulation of the job interview rather than recording real job interviews. Thus, the instructions that we defined and provided to participants were as follows: "You are applying to a job that is particularly important to you. You will have five minutes to present yourself in front of a camera and describe your personal characteristics (e.g. personality, skills, and experiences) that you view as strengths and that would allow you to be relevant for this job. You must also indicate those characteristics that might be perceived as weaknesses and how you did or are willing to improve them. Be as sincere as possible. This is an important prerequisite for this position."

Table I summarizes the steps in the experiment. After physiological and psychological measures were collected before the task, the participant entered the experimental room and stood in front of the camera. The room was sound attenuated and light kept constant throughout the experimental session. After two-minute reading and five-minute speaking, two judges started to provide feedback about the performance of the participant and asked questions. The first judge provided a negative feedback. The second judge provided a positive feedback. This order was selected for ethical reasons: the sessions ended on a positive feedback so as to avoid leaving the participant in a negative mood. Gender of jury providing negative feedback was counterbalanced across participants. Before leaving the experimental room, the participant was asked to rate his own performance on a scale along with his current emotional state and coping strategies.

TABLE I. EXPERIMENTAL STEPS

Time	Content
1 week before	Personality questionnaires
Arrival	Physiological measures
10 mn before task	Instructions Affective state and appraisal questionnaires
Public speaking task	2 mn reading of a 1 page text 5 mn speaking 5 mn questions and feedback from assessors
After task	Affective state questionnaires Brief COPE Self-evaluation Psychological support Physiological measures

The participants was thanked for his participation and allowed to leave the experiment room. The participant was debriefed and was interviewed by a psychologist to ensure he left the lab in a positive state.

D. Materials

Participants' behaviors were recorded by five devices (Fig. 1). For the voice, we used a wireless microphone system attached on the participant's clothes. We collected audio with lapel-microphone (AKG PT40 FLEXX with Signal/noise ratio: 110 dB) at 16kHz. The gain was adapted manually. Whole body behaviors were recorded by one Sony HDR-CX550 camera at 25fps in full HD and one Kinect in front of the participant. Postural control was recorded with an Accugait AMTI force plate at 50Hz. The force plate was hidden within a stage covered by a blue sheet. A similar blue sheet was also placed on the wall behind the stage to provide a uniform background.

Participants were asked to stand close to a white cross in the middle of the force plate. Assessors' facial expressions and speech were recorded with a Sony HDR-CX550 camera. Sound, video and force plate data were synchronized manually according to two time markers: a kick on the ground and a clap with hands. For cardiac measurements, the Polar system (S810, Polar, Finland) was fixated to the chest of the subject at the level of the lower third of the sternum.

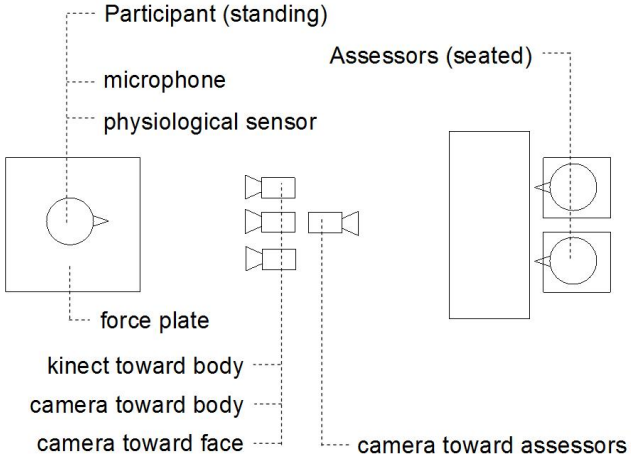

Fig. 1. Top view representation of the setup organization

Fig. 2. Frame from a participant's body. The participant is wearing a micro for the voice and a wristwatch for physiological measures. A force plate is hidden under his feet.

TABLE II. COLLECTED DATA

	Number of participants	Total Duration
Audio data	19 (7H, 12F)	4 h 14
Video body	18 (7H, 11F)	3h58
Video face	18 (7H, 11F)	3h58
Video Assessors	18 (7H, 11F)	3h58
Kinect	19 (7H, 12F)	4h14
Force plate	17 (6H, 11F)	3h42

E. Collected database

The resulting database contains about four hours of data in each modality as shown in Table II. Some samples and subjects were not included due to technical problems.

IV. PRELIMINARY RESULTS

This section presents results which describe the database. First we present descriptive statistics for all questionnaire scales. Second, results about participants' emotional experience either evaluated by questionnaires or by physiological measures are presented.

A. Descriptive statistics for all scales

Table III presents the range, the mean and the standard deviation (Sd) for all questionnaires and their subscales on our 19 participants population.

TABLE III. DESCRIPTIVE STATISTICS

n = 19				
Personality Profiles				
		Range	**Mean**	**Sd**
Big Five	**O**	10-50	37.84	5.36
	C	9-45	32.74	5.63
	E	8-40	26.16	5.58
	A	10-50	39.58	5.39
	N	8-40	22.32	8.51
STAI-T		20-80	41.42	12.96
TAS-20	**DDF**	5-25	12.63	4.50
	DIF	7-35	16.53	5.81
	EOT	8-40	17.68	4.18
	Alex T	20-100	46.84	9.94
HSNS		9-45	25.32	6.43
Subjective Experience				
		Range	**Mean**	**Sd**
Brief COPE	**COdys**	8-40	14.21	3.52
	COfun	8-40	25.00	5.74
ThCh	**Threat**	2-14	6.89	2.69
	Challenge	2-14	9.68	2.61
	Apprai R	0-7	0.79	0.41
STAI-S 1		20-80	40.00	13.47
STAI-S 2		20-80	44.16	14.68
PANAS 1	**NA 1**	10-50	16.79	8.65
	PA 1	10-50	29.63	6.24
PANAS 2	**NA 2**	10-50	18.21	11.21
	PA 2	10-50	27.16	9.03
Subjective Performance				
		Range	**Mean**	**Sd**
Frustration		1-5	2.79	1.27
Motivation		1-5	3.74	1.10
Stress		1-5	3.47	1.07
Difficulty		1-5	3.68	1.11
Subjective Performance		1-5	2.42	1.07
Objective Performance				
		Range	**Mean**	**Sd**
Objective Perf	**Cont**	1-5	3.08	0.85
	Del	1-5	2.87	0.81
	Qual-	1-5	2.71	1.08
	Qual+	1-5	3.11	1.06
	Total	1-5	2.84	1.13

B. *Emotional experience of participants*

First, we analyzed physiological measures to assess if the task has been experienced as a stressful situation as compared to a baseline. We chose three ANS relevant variables. Heart rate is a measure known to increase in stressful situations [39]. Another relevant measure is the skin temperature which is known to decrease at extremities during stressful situation as a consequence of vasoconstriction [40]. Finally skin conductance is also known to increase as arousal increases [41]. For each variable, we applied a dependent t-test (parametric test for paired samples) to compare the means of the baseline condition and the task condition (values averaged for the reading, speaking and questions sessions). Heart rate did significantly increased ($t(18) = -10.208$, $p < 0.0001$), skin temperature did significantly decreased ($t(18) = 4.827$, $p < 0.0001$) and skin conductance did significantly increased ($t(16) = -2.383$, $p < 0.05$) . Together, these physiological measures show a significant impact of our protocol on the participant state as it has been traditionally shown with the Trier Social Stress Test [10].

We second tested differences in self-reported affect states and anxiety between the measures before and after the task. Three Wilcoxon signed-rank tests (nonparametric test for paired samples) showed no significant differences between the two times for negative affects (NA, $Z=-0.476$, $p=0.634$), positive affects (PA, $Z=-1.209$, $p=0.227$) and anxiety (STAI-S, $Z=-1.876$, $p=0.061$). These results show that participants were in the same state before and after the task. As physiological measures showed, this is not due to a non effect of the task on participants' state. This might be due to the fact that participants' states were collected just before and just after the task. Thus participants could have been anxious at both moments. Another reason could be our choice to not counterbalance the two feedback sessions: finishing by positive feedback ensures a diminished residual negative experience at the end of the session.

V. Discussion and Conclusions

In this paper, we presented a protocol for collecting multimodal non-acted emotional expressions in a stressful situation. This protocol was a modified version of the widely used Trier Social Stress Test known to induce moderate stress in laboratory settings. To enable in future studies a complete analysis of emotion expressions, regulations and coping in this situation, our protocol included a wide variety of measures: questionnaires about personality and coping styles to have individual profiles, questionnaires about emotional and anxiety states, appraisal of the situation and subjective performance to have the self-reported experience of the participant, multimodal behavioral measures to capture non-verbal expressions of participants (voice, face, body) and physiological variables to have indicators of the activation level of the participant. Descriptive statistics are provided for the 19 first participants. Since the submission date of this article, 24 more participants have done this task increasing the size of the database to 43 participants.

Findings from emotional and anxiety states showed no differences before and after the task which is an ethical necessity. Also, the first results provided about physiological measures showed a significant impact our protocol on the participant activation suggesting that it succeeded to induce stress. This database can now be used for the study, recognition and modeling of emotional expressions, regulations and coping in a public speaking task.

Future works will explore how performance, subjective experience and multimodal behaviors are related to physiological variables, coping behaviors and personality traits. Another perspective is to use the collected data to compare different algorithms for multimodal fusion for emotion detection. Finally, analyses on specific synchronized segments can outline dynamical aspects of emotion expression and regulation. This includes for example the analysis of interaction patterns between the participant and the assessors.

These results encourage us to increase the size of the existing database in order to enable conducting analyses which consider individual differences. Induced stress does not always impair performance as it depends on situation appraisals.

Parts of this database which preserve the identity of the participants will be made publicly available.

VI. Aknowledgments

Part of the work described in this paper was funded by Agence Nationale de la Recherche (référence ANR-11-EMCO-0007, projet COMPARSE).

References

[1] J. J. Gross and L. F. Barrett, "Emotion Generation and Emotion Regulation: One or Two Depends on Your Point of View," *Emotion Review,* vol. 3, no. 1, pp. 8-16, 2011.

[2] R. Cowie, E. Douglas-Cowie, J.-C. Martin and L. Devillers, "The essential role of human databases for learning in and validation of affectively competent agents," in *Blueprint for Affective Computing. A sourcebook*, New York, Oxford University Pres, 2010, pp. 151-165.

[3] S. Baron-Cohen, O. Golan, S. Wheelwright and J. J. Hill, Mind Reading: The Interactive Guide to Emotions, University of Cambridge: Jessica Kingsley Publishers, 2004.

[4] T. Bänziger, M. Mortillaro and K. R. Scherer, "Introducing the Geneva Multimodal Expression corpus for experimental research on emotion perception," *Emotion,* vol. 12, no. 5, pp. 1161-1179, 2012.

[5] J. A. Coan and J. Allen, The handbook of emotion elicitation and assessment, New York: Oxford University Press Series in Affective Science, 2007.

[6] J. Healey and R. Picard, "Detecting stress during real-world driving tasks using physiological sensors," *IEEE Transactions on Intelligent Transportation Systems, ,* vol. 6, no. 2, pp. 156 - 166, 2005.

[7] M. E. Hoque, M. Courgeon, B. Mutlu, J.-C. Martin and R. W. Picard, "MACH: My Automated Conversation coacH," in *ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp 2013)*, (in press).

[8] R. S. Lazarus, "Progress on a cognitive motivational relational theory of emotion," *American Psychologist,* vol. 46, no. 8, p. 819–834, 1991.

[9] R. Lazarus, Stress and Emotion - A New Synthesis, New York: Springer, 2006.

[10] B. Kudielka, D. Hellhammer and C. Kirschbaum, "Ten Years of Research with the Trier Social Stress Test--Revisited," in *Social neuroscience: Integrating biological and psychological explanations of social behavior*, New York, Guilford Press, 2007, pp. 56-83.

[11] A. Kapoor, W. Burleson and R. Picard, "Automatic prediction of frustration," *International Journal of Human-Computer Studies,* vol. 65, no. 8, pp. 724-736, 2007.

[12] J. Hong, J. Ramos and A. Dey, "Understanding physiological responses to stressors during physical activity," in *Proceedings of the 2012 ACM Conference on Ubiquitous Computing*, 2012.

[13] M. Rodrigues, F. Fdez-Riverola and P. Novais, "An approach to assess stress in e learning students," in *Proceedings of the 11th European Conference on E-Learning*, 2012.

[14] T. Pfister and P. Robinson, "Real-Time Recognition of Affective States from Nonverbal Features of Speech and Its Application for Public Speaking Skill Analysis," *IEEE Transaction on Affective Computing,* vol. 2, no. 2, pp. 66-78, 2011.

[15] L. Streeter, N. Macdonald, W. Apple, R. Krauss and K. Galotti, "Acoustic and perceptual indicators of emotional stress," *Journal of the Acoustical Society of America ,* vol. 73, no. 4, pp. 54-60, 1983.

[16] K. Roelofs, M. Hagenaars and J. Stins, "Facing freeze: social threat induces bodily freeze in humans," *Psychological Science,* vol. 21, no. 11, pp. 75-81, 2010.

[17] H. G. Wallbott and K. R. Scherer, "Stress specificities: differential effects of coping style, gender, and type of stressor on autonomic arousal, facial expression, and subjective feeling," *Journal of Personality and Social Psychology,* vol. 61, no. 1, pp. 147-156, 1991.

[18] C. Kirschbaum, K. M. Pirke and D. H. Hellhammer, "The 'Trier Social Stress Test'—a tool for investigating psychobiological stress responses in a laboratory setting," *Neuropsychobiology,* vol. 28, no. 1-2, pp. 76-81, 1993.

[19] H. L. Baggett, P. G. Saab and C. S. Carver, "Appraisal, Coping, Task Performance, and Cardiovascular Responses During the Evaluated Speaking Task," *Personality and Social Psychology Bulletin,* vol. 22, no. 5, pp. 483-494, 1996.

[20] T. R. Schneider, T. A. Rench, J. B. Lyons and R. R. Riffle, "The influence of neuroticism, extraversion and openness on stress responses," *Stress and Health,* vol. 28, no. 2, pp. 102-110, 2012.

[21] D. P. Pertaub, M. Slater and C. Barker, "An experiment on public speaking anxiety in response to three different types of virtual audience," *Journal Presence: Teleoperators and Virtual Environments,* vol. 11, no. 1, pp. 68-78, 2002.

[22] M. Slater, D.-P. Pertaub, C. Barker and D. M. Clark, "An experimental study on fear of public speaking using a virtual environment," *CyberPsychology & Behavior,* vol. 9, no. 5, pp. 627-633, 2006.

[23] R. Cowie, E. Douglas-Cowie, M. McRorie, I. Sneddon, L. Devillers and N. Amir, "Issues in Data Collection," in *Emotion-Oriented Systems*, Springer, 2011, pp. 197-212.

[24] A. Kleinsmith and N. Bianchi-Berthouze, "Affective Body Expression Perception and Recognition: A Survey," *IEEE Transactions on Affective Computing,* vol. 4, no. 1, pp. 15-33, 2013.

[25] O. John and S. Srivastava, "The Big Five trait taxonomy: History, measurement, and theoretical perspectives," in *Handbook of Personality: Theory and Research*, The Guilford Press, 1999, pp. 102-138.

[26] O. Plaisant, R. Courtois, C. Réveillère, G. Mendelson and O. John, "Validation par analyse factorielle du Big Five Inventory français (BFI-Fr). Analyse convergente avec le NEO-PI-R," *Annales Medico-Psychologiques,* vol. 168, no. 2, pp. 97-106, 2010.

[27] C. D. Spielberger, R. L. Gorsuch, R. Lushene, P. R. Vagg and G. A. Jacobs, Manual for the State-Trait Anxiety Inventory, Palo Alto: CA: Consulting Psychologists Press, 1983.

[28] M. Bruchon-Schweitzer and I. Paulhan, Le manuel du STAI-Y de C.D. Spielberger, adaptation française, Paris: France: ECPA., 1993.

[29] R. Bagby, J. Parker and G. Taylor, "The Twenty-Item Toronto Alexithymia Scale -- I. Item selection and cross-validation of the factor structure," *Journal of Psychosomatic Research,* vol. 38, no. 1, pp. 23-32, 1994.

[30] R. Bagby, G. Taylor and J. Parker, "The Twenty-Item Toronto Alexithymia Scale -- II. Convergent, discriminant and concurrent validity," *Journal of Psychosomatic Research,* vol. 38, no. 1, pp. 33-40, 1994.

[31] G. Loas, J. D. A. Parker, O. Otmani, A. Verrier and D. Fremaux, "Confirmatory Factor Analysis Of The French Translation Of The 20-Item Toronto Alexithymia Scale," *Perceptual and Motor Skills,* vol. 85, pp. 1018-1018, 1997.

[32] H. Hendin and J. Cheek, "Assessing Hypersensitive Narcissism: A Re-examination of Murray's Narcissism Scale," *Journal of Research in Personality,* vol. 31, no. 4, pp. 588-599, 1997.

[33] C. Carver, "You want to measure coping but your protocol's too long: consider the brief COPE," *International Journal of Behavioral Medicine,* vol. 4, no. 1, pp. 92-100, 1997.

[34] L. Muller and E. Spitz, "Multidimensional assessment of coping : validation of the Brief COPE among French population," *L' Encéphale,* vol. 29, no. 6, pp. 507-518, 2003.

[35] C. D. Spielberger, R. L. Gorsuch, R. Lushene, P. R. Vagg and G. A. Jacobs, "Manual for the State-Trait Anxiety Inventory. Palo Alto, CA: Consulting Psychologists Press.," 1983.

[36] D. Watson, L. A. Clark and A. Tellegen, "Development and validation of brief measures of positive and negative affect: The PANAS scales," *Journal of Personality and Social Psychology,* vol. 54, no. 6, pp. 1063-1070, 1988.

[37] P. Gaudreau, "Vers une version française du PANAS : analyses en composantes principales avant, pendant et apres une compétition sportive," in *Congrès International de la SFPS*, Paris, 2000.

[38] W. Boucsein, Electrodermal Activity, Springer, 1992.

[39] M. Johnson, T. Chahal, A. Stinchcombe, N. Mullen, B. Weaver and M. Bédard, "Physiological responses to simulated and on-road driving," *International Journal of Psychophysiology,* vol. 81, no. 3, pp. 203-208, 2011.

[40] P. Boudewyns, "A comparison of the effects of stress vs. relaxation instruction on the finger temperature response," *Behavior Therapy,* vol. 7, no. 1, p. 54–67, 1976.

[41] J. Tomaka, J. Blascovich, R. M. Kelsey and C. L. Leitten, "Subjective, physiological, and behavioral effects of threat and challenge appraisal," *Journal of Personality and Social Psychology,* vol. 65, no. 2, pp. 248-260, 1993.