Psychophysiological Specificity of Four Basic Emotions Through Autobiographical Recall and Videos

Alice Chirico[1(✉)], Pietro Cipresso[1,2], and Andrea Gaggioli[1,2]

[1] Department of Psychology, Università Cattolica Del Sacro Cuore, Milan, Italy
{alice.chirico, andrea.gaggioli}@unicatt.it
[2] Applied Technology for Neuropsychology Lab, Istituto Auxologico Italiano, IRCCS, Milan, Italy
{p.cipresso, a.gaggioli}@auxologico.it

Abstract. Current theories of emotion generally agree that basic emotions involve several systems with a considerable degree of specificity at the psychophysiological level. Analyzing the psychophysiological profiles of emotions allowed to understand if individuals felt the target emotional states or if they perceived it into the emotional material. Here, we explored the sensitivity of autobiographical recall and videos in reproducing emotional psychophysiological specificity even in the lab. We recorded 40 participants' psychophysiological profiles of anger, fear, joy, sadness elicited through videos and autobiographical recall, following a within subject design, in a counterbalanced order. We assessed the autonomic responding (i.e., heart rate) during each emotion induction (3 min length) using a ProComp Infinity 8-channel (Thought Technology Ltd, Montreal, Canada). The sampling rate was set at 256 Hz. We followed the guidelines of Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, to extract typical temporal and spectral HRV measures and to evaluate the response of the autonomic nervous system. Specifically, we classified the rhythms as very low frequency (VLF, <0.04 Hz), and high frequency (HF, 0.15 to 0.4 Hz) oscillations. Results showed that emotions induced through autobiographical recall could be better differentiated than those elicited using videos. We found significant interaction effects of 4 emotions × 2 conditions (video vs. autobiographical recall) measuring both sympathetic (VLF) and parasympathetic activity (HF). Autobiographical recall could recreate a differential activation of the sympathetic and parasympathetic nervous system for each emotion, which was mostly in line with existing literature. However, videos did not allow discriminating different emotional states clearly at the psychophysiological level. These findings suggested autobiographical recall as a more suitable technique to recreate basic emotions' psychophysiological activation in the lab. Finally, these results offered some insights into the issue of whether emotions induced in the lab are perceived or really felt by participants.

Keywords: Psychophysiology · Patterning · Basic emotions · Videos
Autobiographical recall · Emotion specificity

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1 Introduction

Even if researchers are far from providing a consensual definition of "emotion", most of them agree that emotions are complex processes involving different systems, such as the motivational, experiential, behavioral and physiological one [1–4]. Several scholars focused on the psychophysiological activation occurring during an emotional episode and conceived it as an adaptive response triggering the best behavior to face the eliciting situation [5–8]. Given the great interest in this component, researchers have developed several perspectives to explain its role in the emotional process. One of the longest-lasting perspective concerns the extent to which the Autonomous Nervous System (ASN) could be differentially activated in different emotions (see [8–11]). In other words, this view investigates if and to what extent different emotions are characterized by differential somato-visceral activations.

Despite many controversies still exist on the extent of patterning of the ANS in emotions, several studies have shown a considerable degree of specificity regarding psychophysiological activation related to basic emotions of joy, fear, sadness and anger [9, 10, 12, 13]. With this regard, the temporal regulation of the cardiac function has resulted as a reliable measure to differentiate patterns of autonomous activity related to basic emotions with respect to a neutral stimulus, and elicited through autobiographical recall technique [14]. This measure allows for detecting both the parasympathetic and the sympathetic nervous system activation by computing R-R intervals during a continuous tachogram. Anger emerged as characterized by an increasing heart rate but little fluctuations in high frequency (HRV). Happiness, fear and sadness reported an increase of sympathetic activation but a decrease in parasympathetic activation. Fear was also characterized by co-occurrent changes in respiration, while sadness and happiness were not.

In other words, these findings evidenced that it is possible to differentiate emotions according to their psychophysiological profile. However, an open issue concerns the extent to which the emotions recalled through autobiographical recall technique could be closer to the equivalent real ones. It is widely known that memory implies a reconstruction of past events, since it is not a mere copy of them [15]. This would lead to inaccurate and less intense relived emotional experiences, even in the lab [16, 17]. To address this issue, researchers have focused also on other emotion-inducing techniques such as videos, which are able to induce real-time emotions (e.g., [18, 19]. However, the ability of these two conventional techniques (i.e., videos and autobiographical recall) to discriminate among different emotions at the psychophysiological level has to be tested yet.

This is far more relevant if considering that measuring psychophysiological profile of emotions could be a measure of the emotionally *lived* experience besides of the *reported* one. In other words, the assessment of psychophysiological profiles of emotions allowed detecting felt emotions and not only reported ones [20].

Indeed, studying emotion in real context has always been a relevant issue due to the fleeting nature of the emotional states [21]. Conversely, reproducing emotions in the lab allows controlling for their effect on other psychological processes [22], as well as for investigating hidden mechanisms underlying these phenomena (e.g., [23]).

Here, we explored the sensitivity of two conventional emotion-induction techniques (autobiographical recall and videos) to reproduce emotional psychophysiological specificity of *felt* joy, anger, fear, sadness even in the lab. This allowed also monitoring each ongoing emotional experience during its occurrence, thus focusing on the experienced emotions and not on the self-reported or perceived ones.

2 Methodology

2.1 Sample and Procedure

The study sample comprised 40 adults (21 women) volunteers from Italy. Their mean age was 20.07 (S.D. = 1.42). We chose a within-design in which each participant was exposed to joy, anger, fear, sadness inducing stimuli conveyed both through videos and autobiographical recall in a counterbalanced order. Upon arrival to the lab, participants signed formed consent, and the physiological monitoring equipment was installed. Each emotional induction and concurrent psychophysiological measurement lasted 3 min. At the end of each session, participants fixed a graphical quadrant depicting each of the four basic emotions in terms of intensity and type of emotion. This was taken as a measure of the extent to which participants felt the target emotion.

2.2 Measures and Instruments

Psychophysiological Measures. We assessed the autonomic responding (i.e., heart rate) during each emotion induction (3 min length) using a ProComp Infinity 8-channel (Thought Technology Ltd, Montreal, Canada). The sampling rate was set at 256 Hz. We followed the guidelines of Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology [24], to extract typical temporal and spectral HRV measures and to evaluate the response of the autonomic nervous system. Specifically, we classified the rhythms as very low frequency (VLF, <0.04 Hz), and high frequency (HF, 0.15 to 0.4 Hz) oscillations.

Videos. According to guidelines provided by literature [25], we exposed participants to four emotional contents conveyed through videos (1 joy-inducing stimuli; 1 anger-inducing stimulus; 1 fear stimulus; 1 sadness stimulus) displayed on a LCD monitor. The joy-inducing video showed a scene from the film "*Pretty woman*". The anger-inducing video was taken from the film "*Total Recall*". The fear-inducing video displayed a scene from the film "*The ring*". The sadness-inducing video featured a scene from the film "*The pursuit of happiness*". Each video lasted 3 min (Table 1 and Fig. 1).

Table 1. The table reports the content of each video.

Stimuli	Content
Joy inducing stimulus	The final scene in which Richard Gere says, "I love you" to Julia Roberts
Anger inducing stimulus	The main character (Arnold Schwarzenegger) underwent a inevitable procedure and his anger explodes
Fear inducing stimulus	Samara (the ghost) comes out of the tv
Sadness inducing stimulus	The main character and his son shut themselves in a public toilet to sleep but someone tries to enter, thus they try to keep it closed and they cry

Fig. 1. The four film clips. Joy (Top-left), Sadness (top-right); Fear (bottom-left); Anger (bottom-right).

Autobiographical Recall. Participants were required to recall joyful, anger-related, fearful and sad autobiographical emotional episodes while watching at a black screen monitor with a cross at the centre of it. After, we started recording psychophysiological signals. Participants were required to close their eyes and relive the target emotion as vividly as they could while remembering the target event. We followed the same procedure described in [14].

3 Data Analysis

We carried out two separated repeated measure ANOVAs 2 (condition: autobiographical recall vs. video) × 4 (content: joy vs. anger vs. fear vs. sadness) for each of the three indexes of sympathetic (Low Frequency- LF; Very Low Frequency-VLF) and parasympathetic activation (High Frequency-HF).

4 Results

Results showed that emotions induced through autobiographical recall could be better differentiated than those elicited using videos. Specifically, we found significant interaction effects of 4 emotions × 2 conditions (video vs. autobiographical recall) measuring both sympathetic (through VLF) [$F(3,117) = 4.148$; $p < .01$; $\eta^2 = 0.096$] and parasympathetic activity (through HF) [$F(3,117) = 3.824$, $p < .05$; $\eta^2 = .089$] (Table 2 and Figs. 2 and 3).

Table 2. Descriptive statistics for VLF and HF for each emotion

	VLF				HF			
	Autobiographical recall		Video		Autobiographical recall		Video	
	Mean	Std. Err.	Mean	Std. Err.	Mean	Std. Err.	Mean	Std. Err.
Anger	18.45	1.33	21.94	1.56	1270.34	307.85	315.12	79.02
Fear	22.73	1.71	20.23	1.48	1017.90	213.02	288.64	73.84
Joy	24.73	1.54	21.77	1.44	545.44	100.00	241.37	47.42
Sadness	29.29	2.28	23.04	1.74	520.14	110.93	222.84	39.24

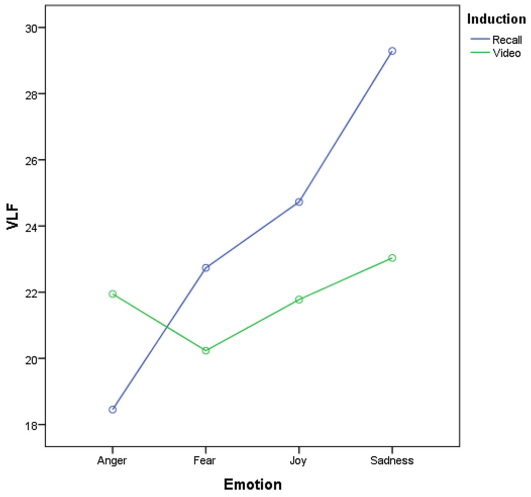

Fig. 2. Interaction effect 4 emotions × 2 conditions (video vs. autobiographical recall) measuring both sympathetic with VLF as a measure.

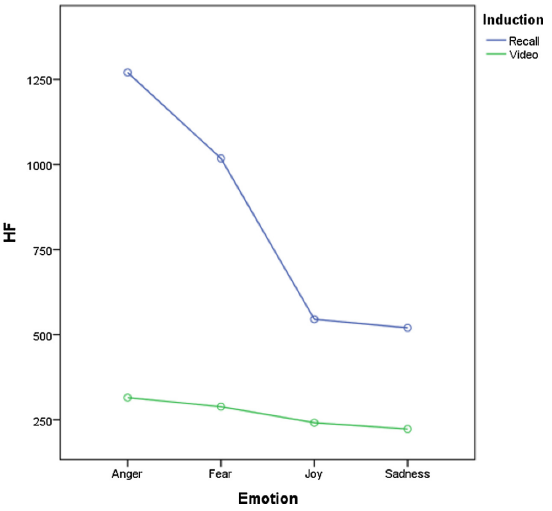

Fig. 3. Interaction effect 4 emotions × 2 conditions (video vs. autobiographical recall) measuring both sympathetic with HF as a measure.

5 Discussion and Conclusion

Emotion-induction studies relied on the need to overcome limitations related to studying emotions *in vivo* [21]. However, recreating emotional states in the lab has always been a challenge [26, 27].

Despite a wide array of emotion-induction techniques exist, their potential and limitations are still to be deeply analyzed yet.

An open issue concerns the extent to which the emotions recalled by an autobiographical technique could be closer to the equivalent real ones, compared to real-time emotions induced by means of videos. In this study, we demonstrated that videos could induce real-time emotions that can be better differentiated at a physiological level. Maybe, the reconstruction of events required by memory during a recall would lead to, at least, different, and less intense relived emotional experiences, even in the lab [16, 17]. This, in turn, would affect their psychophysiological profile. Results demonstrated that emotions induced through autobiographical recall could be better differentiated than those elicited using videos, as shown by the two significant interaction effects for VLF and HF. Specifically, (see descriptive statistics), Autobiographical recall resulted as able to recreate a differential activation of the sympathetic and parasympathetic nervous system for each emotion, which was mostly in line with existing literature [14]. However, videos did not allow to discriminate different emotional states clearly at a psychophysiological level. These findings suggested autobiographical recall as a more suitable technique to recreate basic emotions' psychophysiological activation in the lab. To address this issue, researchers have focused also on other emotion-inducing techniques such as videos, which are able to induce real-time emotions.

These results are promising regarding the adoption of a specific emotion-induction methodology in the lab. Indeed, it emerged that the differential psychophysiological activation of different emotions was reproduced. Specifically, *felt* emotions were better reproduced by means of autobiographical recall, instead of videos. Although an integrated assessment of psychophysiological measures and self-reported ones would be useful to draw conclusions regarding differences between felt and reported emotions, these results suggest that more advanced techniques should be adopted to study real-time emotions. With this regard, it would be useful to integrate peripheral measures of emotions with neural ones to obtain a more comprehensive model of how emotional processes take place, even in the lab.

All these findings help gain new knowledge about the impact of a specific emotion-induction technique on the subsequent *felt* emotional state, thus allowing for the exploration of impact on other psychological processes, such as attention, prosocial behaviors, health and well-being. One possibility is Virtual Reality [28–31] and 360° immersive videos, which proved as effective tools to induce even complex emotional states in the lab [32, 33]. Finally, psychophysiological indexes could be useful also to assess the effectiveness of emotion-regulation trainings (e.g., [34]) since they target really felt emotions.

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