Sensing Audience Response – Beyond One Way Streaming of Live Performances

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ABSTRACT
During a live theatre performance, Galvanic Skin Response (GSR) of 15 audience members was measured simultaneously and synchronized with video footage of performers and audience. Questionnaires explored emotions evoked during the play. The research is part of an EU Framework 7 program to support remote and interactive performances.

Keywords

Human Factors; psychology; GSR sensors; performance arts

1. INTRODUCTION
One of the aims of the Vconect program [5] is to support the area of interactive mediated performance through videoconferencing technologies, featuring automated editing (orchestration) and composition of multiple live audio-video streams onto multiple screens based on cues originating from directional audio, face detection and physiological sensors. Currently, live performances are reaching a wider audience by streaming to cinemas and audiences at home [3]. However, there are no possibilities for remote audience feedback.

Galvanic Skin Response (GSR) measures excitation of the sympathetic nervous system and has been applied to measure audience engagement [4,2]; usually experiments in which a single person watches a video recording of a performance. We measured simultaneously the GSR of 15 people watching a live theatre performance. The readings were synchronized with video recordings of the performance and the audience. The audience filled out questionnaires aimed to evaluate the emotions that the performance evoked.

2. METHOD
Seven Females (mean age 28.29) and eight males (mean age 23.13) took part in the experiment. They were the audience for a short theatre performance and their GSR was monitored throughout.

The GSR measurement system consisted of 15 GSR sensors. Five sensors were connected to three Arduino[1] UNO boards (sample rate 1Hz). Xbee[2] RF modules were used to create a wireless network such that the GSR data were sent directly to a laptop. This ensured the synchronization of all GSR readings. Cameras recorded the audience and the performance. Video streams were synchronized (post production) with GSR data.

Student actors devised a 28 minute comedy play that was aimed at audience participation and produced occasional audience "shocks" (e.g. popping balloons) to elicit the occurrence of GSR spikes during the performance.

Before the performance participants filled out a short questionnaire about the type and intensity of emotions they had experienced during the day. Afterwards, participants filled out a questionnaire about emotions experienced during the play.

The participants were seated in three rows of five seats each arranged in a semi-circle around the stage. GSR modules were attached to the palm of the right hand. In a meditation exercise participants were asked to relax for five minutes such that a baseline GSR measurement could be established.

Questionnaires ratings and GSR readings were analyzed using ANOVA, correlations and Multi-Dimensional Scaling (MDS). The synchronized GSR and video streams enabled us to relate events during the performance to events in the GSR readings.

3. RESULTS
We found that GSR readings of ten participants correlated closely (on average $r = .86$, $p<.01$), showing an initial rise in GSR followed by a flattening towards the end of the performance. Spikes were identified that corresponded to the intended "shocks", e.g. balloon popping. Five participants displayed different patterns: two showed an initial rise in GSR followed by a decrease; two showed an initial lack of rise in GSR followed by an increase and one participant displayed a consistent drop in GSR. We derived a MSD-solution on the inter-correlations of GSR readings across the performance (Figure 1). For each minute the GSR readings were averaged for each participant. Here MDS yields an unfolding chronologically (anti-clockwise in Figure 2) up to minute 19. Using the video footage we were able to identify the clusters based on the content of the performance.

The analysis of the questionnaire resulted in a range of interesting findings. For the purpose of this poster we restrict these to findings with a direct relevance to GSR data.

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[1] http://www.arduino.cc/

[2] http://www.digi.com/xbee/

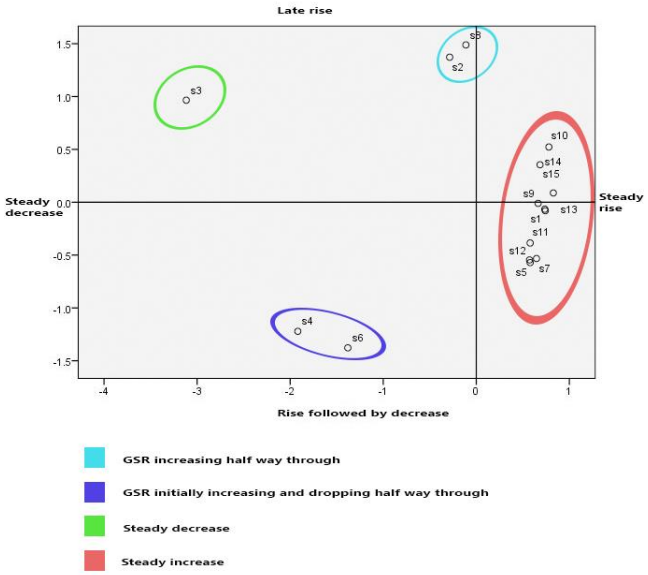

Fig 1: Audience clusters for raw GSR data

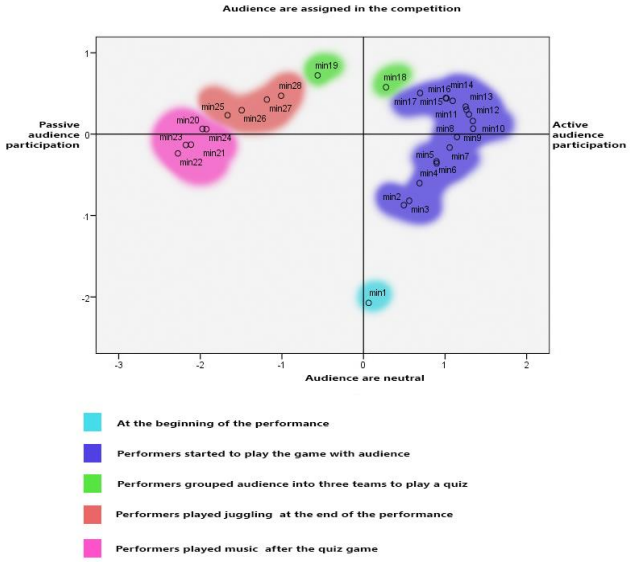

Fig 2: GSR data averaged across minutes

Subject 3 (S3) was identified as someone who did not enjoy the performance, S4 and S6 both enjoyed the performance but from the questionnaire we found that S4 had received sad news during the day and S6 was (pleasantly) surprised that he knew one of the actors, as such half way through the performance they might have become distracted for personal reasons. S2 and S8 were initially slightly confused about the purpose of the performance and as such it took them a while to get into the performance. The remaining ten participants all enjoyed the performance in a similar manner, i.e. rated the cheerfulness and enjoyment of the play high.

The minute average GSR readings correlated positively with participants being (very) cheerful (on average r = .619, p<.05) and correlated negatively with participants being sad (on average r = -.595, p<.05) at different stages of the performance, in particular from minute 16 onwards the average GSR readings showed strong correlations with audience's "Cheerful" ratings.

4. DISCUSSION

This poster shows a system we developed to measure GSR of 15 people simultaneously as they watched a short comedy live. Video recordings were synchronized with the GSR readings to link particular GSR events to the live theatre events. In addition we analyzed questionnaire responses about the play in conjunction with the GSR data.

We found that GSR readings of most of the audience were closely correlated, following a curve where in the initials stages readings were low and as the play progressed this increased steadily, most likely reflecting an increase in engagement with the play across time. Questionnaire analysis suggests that Cheerfulness and Enjoyment were the main (more) emotional components linked to the GSR data. Questionnaire data complemented GSR data and helped to identify outliers in the audience who for different reasons were less engaged with the play.

It is possible to scale-up GSR measurements of a co-present or remote audience during a live performance by using wireless GSR "wristbands", e.g. to use the aggregate response of those who are deeply engaged in a performance to provide visual, auditory or even haptic feedback to performers. In addition such a larger scale system opens up a range of creative possibilities which could play to the strength of Vconect's composition and orchestration technologies. There are small scale examples of such applications, e.g. using brainwave sensors to alter a narrative [1]. In addition, the easily replicable GSR system as well as our method of using synchronized video streams and questionnaires to complement GSR data is a powerful tool for further audience research.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] Grant, Colin 2013: http://www.bbc.co.uk/news/technology-21429437

[2] Latulipe, C., C. Carolina, E.A. Carroll & D.Lottridge *Love, Hate, Arousal and Engagement: Exploring Audience Responses to Performing Arts* (2011) Performance sessions, 1845-1854, CHI 2011 Vancouver, BC, Canada

[3] National theatre Live: http://www.nationaltheatre.org.uk/

[4] Radbourne, J. K. Johanson, H. Glow & T. White. *Audience experience: measuring the quality in the performing arts*. International Journal of Arts Management, 11(3): 16-29, 2009

[5] Vconect: http://www.vconect-project.eu/