

GSR article

Galvanic Skin Response (GSR): A Short Overview

An Argument for Using Biometrics to Investigate Audience Engagement with Performance Stimuli.

Neurophysiologists agree that emotions can “exist outside of consciousness” (1, p. 1846), and the skin can reveal information about an individual’s emotional state during a specific event. To capture this, Galvanic Skin Response (GSR)—also referred to as Electrodermal Activity (EDA) or Skin Conductance (SC)—measures changes in the skin’s electrical conductance associated with autonomic arousal by recording sweat gland activity concentrated on the palms, fingers, soles, forehead, and cheeks (2). Although the main purpose of sweat emission is thermoregulation, it can also be triggered during emotional arousal, which arises involuntarily under sympathetic control and can occur even when perspiration is not visibly apparent (3). This is particularly important because by measuring GSR, researchers can record ‘unconscious behaviour that is not under cognitive control, [which] offers undiluted insights into [the] physiological and psychological processes of a person’ (3, p. 5).

GSR can be measured in real time using two non-invasive surface electrodes—typically on the non-dominant hand—while a small constant voltage is applied, and the resulting current is used to compute conductance (3). An example of such devices is Consensys GSR by Shimmer (4), and more sophisticated devices such as wearable watches can also record and transmit GSR data in real-time such as the Embrace Plus by Empatica (5). The chronologically recorded GSR signals consist of Skin Conductance Level (SCL) and phasic Skin Conductance Responses (SCRs) that mark transient arousal peaks aligned to stimuli (3). However, because similar conductance increases can be elicited by both pleasant and unpleasant events, GSR amplitude alone does not specify positive or negative emotional responses (3). Intuitively we associate engagement with positive valence, but an attentive audience may also be experiencing negative emotions such as disgust, fear etc. (1). Therefore, as GSR alone does not provide clarity on an individual’s emotional responses to stimuli, its real power is in combination to other forms of data capture, such as quantitative and qualitative participant questionnaires.

These two data capture methods complement each other. GSR requires a participants direct response for greater clarity, while traditional questionnaires alone have several well known pitfalls. Self-reporting is subjective, often time-lagged, requires cognitive appraisal and can be influenced by social and cultural pressures (6). Additionally, post-event questionnaires are susceptible to peak-end bias, which can distort retrospective ratings relative to continuous physiological traces (1). This is because the participants’ overall experience is highly influenced by the peak-emotion or that which is experienced at the end

of the event (1). Whereas GSR offers an objective, time-stamped index of arousal, that can be recorded while participants move naturally in applied settings.

Audience engagement is multifaceted and difficult to measure because the collected data can be interpreted in multiple ways (1). The measurement of arousal has been commonly used as a good indicator to represent an audience member's perceived experience of a performance (7). However, as discussed, participant responses alone do not provide the most robust data-sets to interpret. By using a hybrid methodology of combined GSR with video and interviews, Wang et al. (7) found positive correlations between self-reported arousal and physiological arousal in their study, supporting its use to characterise audience experience. Similarly, Latulipe et al. (1) also acknowledged such strong correlations in their study, supporting skin conductance as a reliable indicator of audience engagement. Warp et al (8), used biometric data to AB test visual stimuli with either spatialised or mono audio, where results demonstrated greater engagement in the spatialised audio group. In all these studies, the authors highlighted that using biometric data to monitor audience engagement is a novel and valuable methodology in research involving stimuli. Furthermore, Warp et al (8, p. 265) recommend the usage of such technological innovations to 'validate creative approaches' and create more 'effective experience's'. This may be particularly relevant in new approaches, where audiences have had limited to no exposure of the new applications, and creators may still be in the experimental stages.

Pairing physiology with qualitative methods—e.g., interviews, behavioural observations, and video—helps contextualise arousal patterns and relate them to audience accounts of engagement (6). This methodology was highlighted as far back as 1989 by S. VanderArk who in the publication *Self-Esteem, Creativity, and Music: Implications and Directions for Research*, suggested that "for research involving music and emotions, both biochemical and physiological variables should be analyzed in addition to self-report measures" (9). Joint analysis of GSR with self-reporting, while acknowledging potential biases, can test convergent validity between subjective and physiological indicators of audience experience (1). This methodology provides greater clarity on an individual's perceived engagement when participants can view their recorded arousal levels chronologically alongside the stimuli and confirm GSR spikes at specific moments in the performance (1).

For researchers such as myself who seek to explore the potential of immersive audio and spatialisation techniques, specifically in live music performance - a field arguably in its infancy - this methodology may provide important insight into the success of the employed delivery formats and applied performance techniques. The audience is central to understanding and developing new delivery methods; therefore, both their conscious and unconscious responses are of great value to creators and their practice.

It is important to note that music experts and non-experts often exhibit distinct difference in responses, as the latter lack formal training in critical listening and fundamental understanding of the practice. GSR testing has validated these differences (9), reinforcing the importance of participant data in better understanding audience engagement with emerging performance mediums—particularly because they have had limited to no prior exposure to such stimuli.

Note - For analysts using biometric devices such as GSR, standard protocols typically involve a brief period of silence in a dimly lit room to establish an arousal baseline before presenting the stimulus. Researchers must also account for the usual 1–5 second latency between stimulus onset and conductance response (7, 1). To ensure robust findings, it is recommended that participant recruitment be as broad and representative as possible.

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