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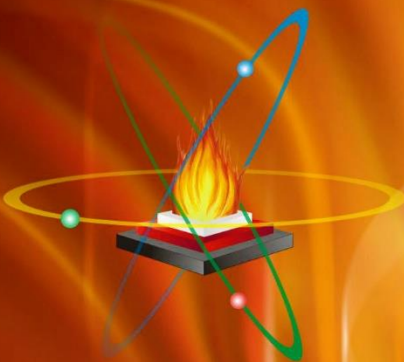
ISSN: 2581-4885



# INTERDISCIPLINARY JOURNAL OF YAGYA RESEARCH

Peer Reviewed Research Journal

VOLUME 2 ISSUE 1



**PUBLISHED BY:**

DEV SANSKRITI VISHWAVIDYALAYA, Shantikunj, Haridwar - 249411 (UTTARAKHAND)

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*OPEN ACCESS ONLINE JOURNAL*

**Research Article**

## Galvanic Skin Response (GSR) signals reduced from Gayatri Mantra fire oblations during Yagya

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**Abstract.** Galvanic skin response (GSR) is the measurement of the autonomic activation of sweat glands in the skin for depicting stress, emotional arousal and relaxation pattern. Yagya is a Vedic ritual composed of rhythmic chanting of various mantras along with the mantra infused oblations in the designated sacrificial fire altar. Since Vedic times, it is widely and traditionally performed for various purposes including peace, happiness and mental and physical wellbeing. Hence, the present study attempted to explore the GSR pattern during Yagya ritual. The study measured GSR pattern in the 12 participants during Yagya ritual and evaluated changes in GSR signal during chanting of different mantra of the Yagya ritual. The result indicated GSR signal during Yagya ritual followed a defined pattern. Median GSR signals were decreased after fire ritual i.e. later-half of the Yagya compared to

first-half of the Yagya (median fold change decrease 1.38; n=12; p=0.0010). Interestingly, this decrease in GSR was achieved significantly during oblations to fire with Gayatri Mantra (median fold change decrease 1.35; n=12; p=0.0024), and remained low compared to that of in starting phase of Yagya ritual, indicating significance of Gayatri mantra in Yagya ritual to achieve relaxation state. Overall, the study indicated the tremendous potential of Vedic traditional ritual of Yagya. In our studies, Yagya came across as a winner in marking a positive effect in terms of relaxation in our emotional state.

**Keywords** - Yagya, Gayatri mantra, Galvanic Skin Responses (GSR), stress, emotional arousal, Vedic

## Introduction

Galvanic skin response (GSR) is the measurement of the autonomic activation of sweat glands in the skin. The sweating on hands and feet is triggered by emotional stimulation of both kinds i.e. positive or negative. The changes in skin sweat gland conduction also known as electrodermal activity (EDA) are measured through electrodes (1).

A group of Stéphanie Khalfa et al. from Department of Psychology, University of Montreal, Canada has studied changes in GSR level when music of four types of emotional arousals was applied. They found GSR signals during stimulating emotions, fear and happiness were found to be greater than as compared to the relaxing emotions, sadness and peacefulness (2). GSR signal is lowered when person is relaxed with unfamiliar relaxing music compared to unfamiliar arousal music indicating GSR is serving as measurement of the arousal and relaxation with specific type of music (3).

Besides music, mantra-meditation and chanting also induced relaxation and calm indicated by some studies. M. Shobitha (2013) has shown that 5 minutes of “Aum” mantra chanting induced relaxation as well as mental alertness in subjects with significant decrease in the GSR level (4). Loo Fung Ying et al. from University of Malaya performed the study on the effect of Imee Ooi’s Buddhist Music and mantra on relaxation. By performing musical analysis, discussion of theories from scholars and feedback from interviewees and listeners they found that studied music was able to induce calmness, at least, to a majority of listeners (5).

Yagya is an Indic Vedic ritual composed of various rhythmic chanting of mantra along with the mantra infused oblations in the designated sacrificial fire altar. It has been widely and traditionally performed by Indians who believe in Vedas - for various purposes including peace, happiness and mental wellbeing (6). Few studies, previously showed to help reduce mental and emotional stress, also supported this scriptural indication. A PhD dissertation at Dev Sanskriti Vishwavidyalaya by Sharma studied the

effect of 120 days of Yagya on depression, anxiety and several other parameters of mental health of 100 students of 8th and 9th grade, and found encouraging results including reduction in anxiety and depression, and increase in emotional stability (7). In addition, another study by Sushrutha et al. (2014) found that Yagya reduced stress level in participants (8). Hence, it would be of interest to note the GSR pattern during Yagya to explore relaxation pattern. The present study, hence, measured GSR pattern in the 12 participants during Yagya and correlated the GSR pattern to the mantras chanted during Yagya.

## Methods

### *Procedure of Yagya*

Yagya was performed as previously described in the book ‘Sankshipt Gayatri Hawan Vidhi’ by Pt Shriram Shamra Acharya as previously described (9). Yagya was performed with Hawan Samagri (Shantikunj, Pharmacy). Mango-wood used was dry and free from dust and infestations. The fire pit or the sacrificial fire altar was set up with the help of clay and bricks. In the present study Yagya ritual was performed with 24 oblations of herb-mix in the fire along with recitation of Gayatri Mantra.

### *Participants and recording of GSR*

Sample of 12 volunteer students of age group 17 to 24 were selected to participate in the study. Male students of first semester of under-graduation program of Dev Sanskriti Vishwavidyalaya, with no past experience of regular participation in Yagya were selected. All 12 participants used to perform Yagya daily in the evening but recording was taken one at a time. Throughout Yagya, one participant was asked to sit still, not participating in the activity at all.. Yagya was performed for a total of 12 times. Each time participant was made to wear GSR electrodes on the index and middle fingers as per the manufacturer protocol. GSR biofeedback machine electrodes were applied to the participant’s left. GSR signal pattern for emotional changes were measured through biofeedback machine (Medicaid-2006; SAS Nagar Mohali-160055, India).

| Cluster | Code | Yagya Ritual                     |
|---------|------|----------------------------------|
| M1-M3   | M1   | Start - <i>Guru Ish vandana</i>  |
|         | M2   | <i>Sadhanadi Pavitrikaranam</i>  |
|         | M3   | <i>Mangalacharanam</i>           |
| M4-M8   | M4   | <i>Pavitrikarnam</i>             |
|         | M5   | <i>Aachanam</i>                  |
|         | M6   | <i>Prithvipoojanam</i>           |
|         | M7   | <i>Chandan Dharnam</i>           |
| M9-M10  | M8   | <i>Rakshasutram</i>              |
|         | M9   | <i>Kalash Prarthana</i>          |
| M11-M12 | M10  | <i>Devavahanam</i>               |
|         | M11  | <i>Agnisthapanam</i>             |
| M13-M15 | M12  | <i>Agnipradipnam</i>             |
|         | M13  | <i>Samidhadhanam</i>             |
|         | M14  | <i>Jalprasechanam</i>            |
| M16     | M15  | <i>Ajyahuti</i>                  |
| M16     | M16  | <i>Gayatrimantrahuti</i>         |
| M17     | M17  | <i>Mahamrityunjay mantrahuti</i> |
| M18-M20 | M18  | <i>Swishtakrut homa</i>          |
|         | M19  | <i>Purnahuti</i>                 |
|         | M20  | <i>Vasodhara</i>                 |
| M21-    | M21  | <i>Arti</i>                      |
| M22-M23 | M22  | <i>Ghritavghranam</i>            |
|         | M23  | <i>Bhasma dharanam</i>           |
| M24-M29 | M24  | <i>Kshama Prarthana</i>          |
|         | M25  | <i>Shastang namaskar</i>         |
|         | M26  | <i>Shubhkamana</i>               |
|         | M27  | <i>Shanti abhisinchanam</i>      |
|         | M28  | <i>Visarjanam</i>                |
|         | M29  | End                              |

**Table 1:** List of mantra session of the Yagya ritual used in the study. M1 to M28 are code given to each mantra session. Cluster is the ritual-theme based grouping of mantra session for analysis

### *Evaluation of GSR pattern with Yagya ritual events*

Recording of the Yagya-ritual including all mantras were done through mobile phone. GSR biofeedback machine was connected with the laptop; time per second of GSR was matched with the time per second of mantra recording, and then event of Yagya ritual were pointed out at GSR pattern exported on the graph. These events of Yagya ritual had separate mantras and their titles were described in the Table 1. Some of them are Guru Ish Vandna (Salutations to Master and supreme power), Kalash prathana (prayers to universal deities), Dev avahanam (inviting universal deities), Agni sthapanam (fire ignition), Ajyahuti (prayers to fire), Gayatri mantra ahuti (Fire offering with Gayatri Mantra) followed by 5 times Mahamrityunjay Mantra ahuti, Dev dakshina purnahuti (final-fire offering), Kshama prarthana (prayers seeking forgiveness), Shubhkamna (prayers to universal welfare), Visarjanam (farewell to universal deities). Ahuti here implies mantra infused herb-mix oblations to the fire in the sacrificial altar.

### **Results**

Yagya ritual was divided into 28 sections. Each section had different sets of mantras for defined purpose as described in Table 1. All sessions (1-28) were marked on the GSR graphs of all 12 participants (Figure 1A-D; Supplemental Table 1). These sessions were further grouped into clusters based on the similar subtheme of Yagya ritual. For example, M1-3 was mainly prayers for starting an auspicious event, while M4-M8 is preparing oneself before inviting different divine energies (M9-M10). Afterwards M11 is the ignition of fire ritual and offering of initial sacrifices (M11-M15). M16 is the main fire-sacrifice of Gayatri Mantra, followed by Mahamrityunjay Mantra (M17). M18-M20 are mantras for final fire-sacrifice. M21 is again prayers to all divine powers with rhythmic chanting, while M22-M23 is ritual of absorbing the blessings of them divine. M24-M28 is sequence of the mantras for humble and heartfelt farewell of the invited divine energies. The whole Yagya ritual is a systemic sequence of prayers for a well-defined prayer.

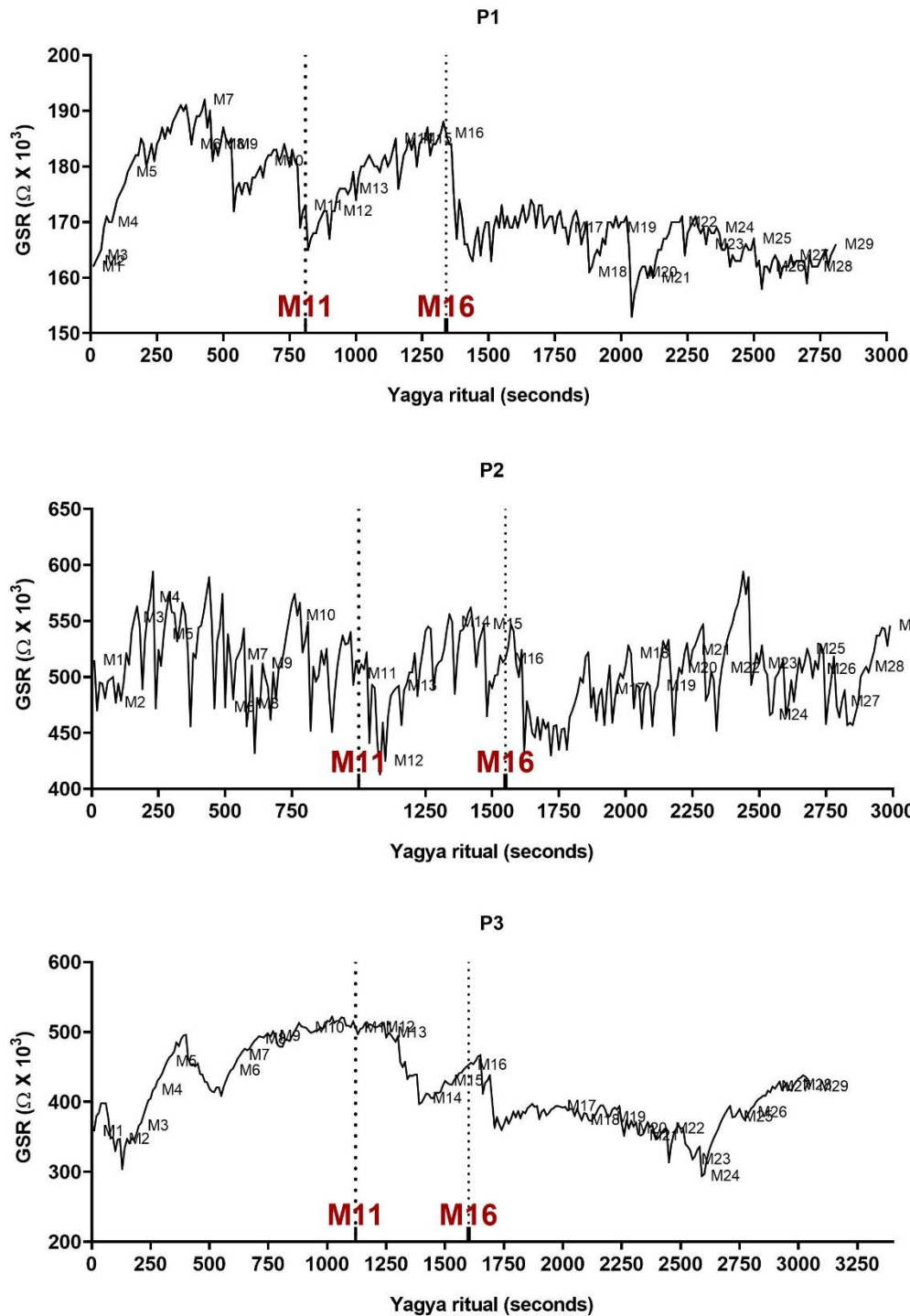


Figure 1A. GSR graph of participants 1 to 3 (A) Yagya ritual was divided into 28 sections M1 to M28. Each section had different set of mantras for defined purpose as described in Table 1 and supplemental table 1; P denotes participant. X axis is time duration in seconds and Y axis is raw GSR value. M11 denotes start of *Agnisthapanam* (fire ignition); M16 denotes start of *Gayatri Mantrahuti* (Gayatri Mantra oblation)

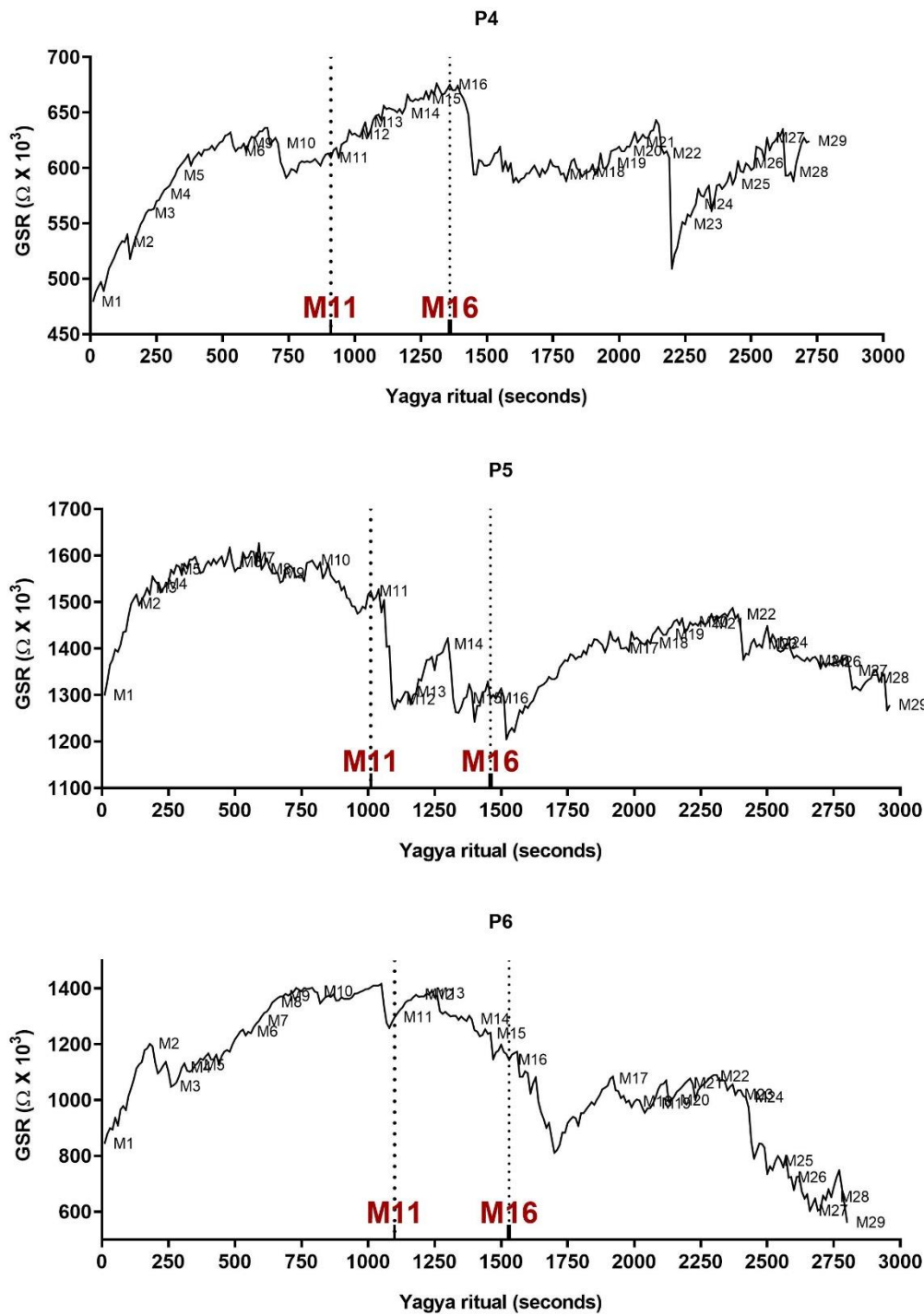


Figure 1B. GSR graph of participants 4-6 (B). Yagya ritual was divided into 28 sections M1 to M28. Each section had different set of mantras for defined purpose as described in Table 1 and supplemental table 1; P denotes participant. X axis is time duration in seconds and Y axis is raw GSR value. M11 denotes start of *Agnisthapanam* (fire ignition); M16 denotes start of *Gayatri Mantrahuti* (Gayatri Mantra oblation)

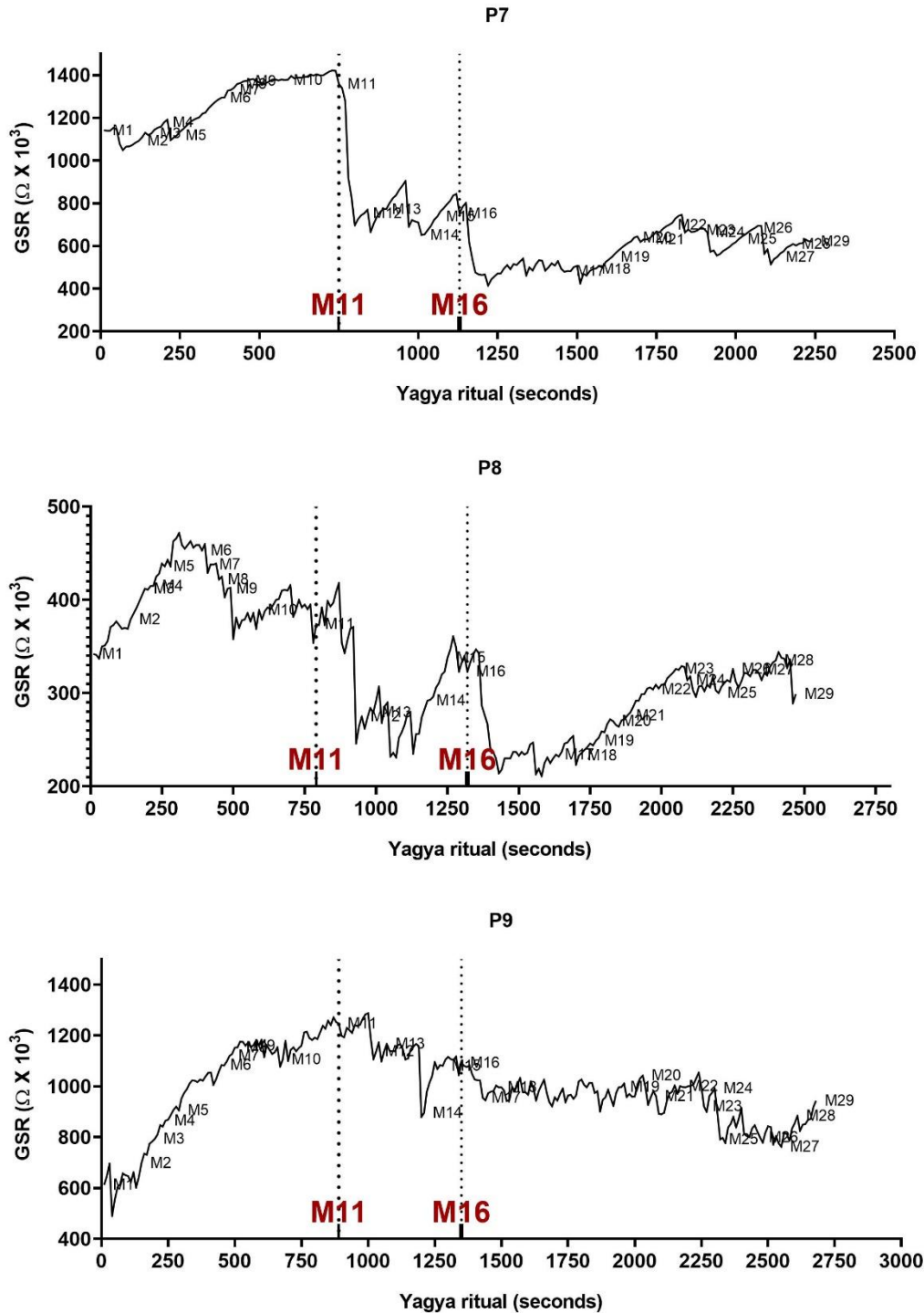


Figure 1C. GSR graph of participant 7 to 9 (C). Yagya ritual was divided into 28 sections M1 to M28. Each section had different set of mantras for defined purpose as described in Table 1 and supplemental table 1; P denotes participant. X axis is time duration in seconds and Y axis is raw GSR value. M11 denotes start of *Agnisthapanam* (fire ignition); M16 denotes start of *Gayatri Mantrahuti* (Gayatri Mantra oblation). M11 denotes start of *Agnisthapanam* (fire ignition); M16 denotes start of *Gayatri Mantrahuti* (Gayatri Mantra oblation)

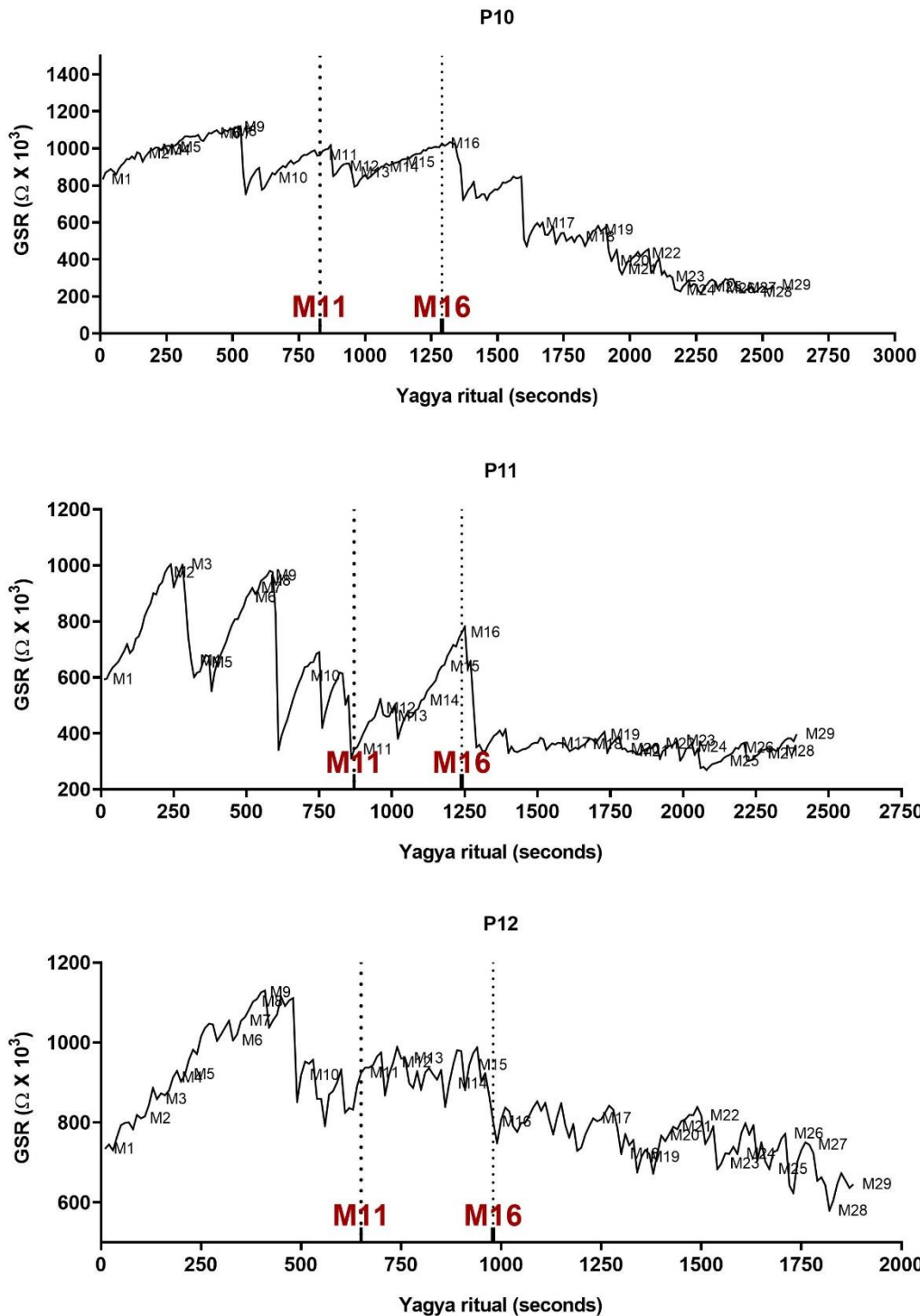


Figure 1D. GSR graph of participants 10 to 12 (D). Yagya ritual was divided into 28 sections M1 to M28. Each section had different set of mantras for defined purpose as described in Table 1 and supplemental table 1; P denotes participant. X axis is time duration in seconds and Y axis is raw GSR value.



*GSR signal during Yagya ritual followed a defined pattern*

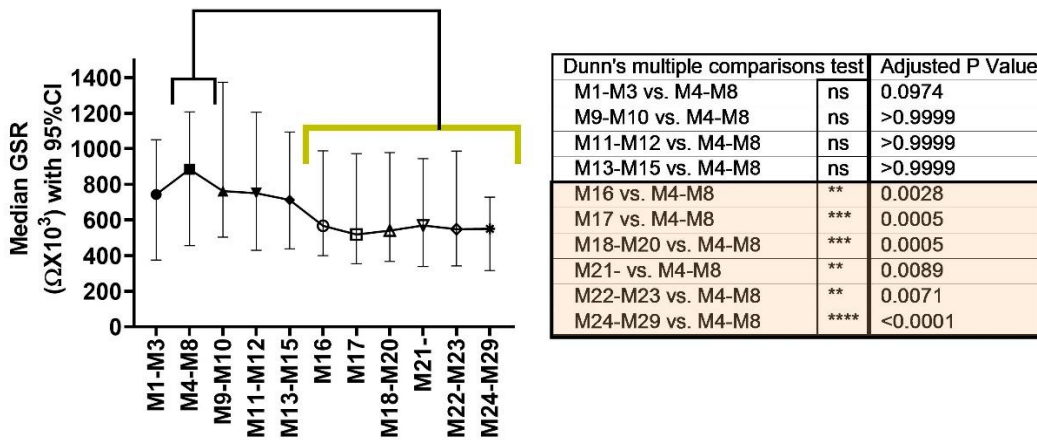
Yagya ritual included 28 types of ritualistic mantras (Table 1). They were divided into 11 clusters based on the ritual theme. GSR values were obtained every 10 seconds of biofeedback machine (~6.6 seconds of clock). Raw GSR values against time were plotted for each participant (Figure 1A-D). All sessions i.e. M1 to M28 were marked on each graph. Total number of raw GSR values varied for each session i.e. (M1 to M28) because, singing of each mantra took different duration as per length of the mantra. Hence, average of GSR values for each mantra session (i.e. M1 to M28) was taken. Therefore, for 12 participants, for each mantra session, there was total 12 values. Median of these 12 values for each cluster was plotted along with 99% confidence interval (Figure 2A).

The visual observation of the graph figure 2A- GSR seemed to decrease at the later-half of the Yagya ritual. It indicated that in later half of the Yagya Ritual when fire sacrifice starts, emotional arousal (GSR values) was relaxed. To confirm if there were any changes in the Yagya ritual after later half, comparison of M4-M8 cluster (Purification rituals) was done to M16 to M24-29 clusters (starting Gayatri Mantra sacrifice). The GSR signal significantly reduced after starting of Gayatri Mantra fire-sacrifice compared to M4-8 (preparation and purification mantras) (Figure 2A;  $n=12$ ,  $p= <0.0001$ ; One-Way ANOVA (non-parametric) (Friedman test with Dunn's multiple comparison test). To further confirm the observation, the whole Yagya Ritual was divided into 2 portion i.e. before (M1-M10) and after fire ignition (M11-M28) (Figure 2B). It was observed that GSR signal significantly reduced after fire ignition (median fold change decrease 1.38;  $n=12$ ;  $p=0.0010$ ) (Wilcoxon matched-pairs signed rank test).

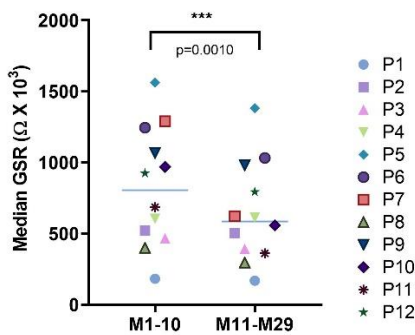
*GSR signal reduced significantly after Gayatri Mantra fire oblations but not after fire ignition*

Interestingly, M4-M8 cluster was not significantly different from M11-12 fire ignition cluster (Figure 1A;  $p=ns$ ), but it was significantly different from M16 cluster ( $p=0.0028$ ; Figure 2A) when Gayatri Mantra sacrifice started. Hence to find out exactly when in later half of Yagya, GSR values significantly dropped compared to its respective previous session, comparison between M10 (previous step of fire ignition) and M11 (fire ignition) and between M15 (previous session of Gayatri Mantra sacrifice) and M16 (Gayatri Mantra sacrifice) were carried out. GSR signal was unchanged between fire ignition (M11) to its previous step (M10) ( $p=ns$ ; Figure 2C) (Wilcoxon matched-pairs signed rank test).while it was significantly dropped, during Gayatri Mantra sacrifice (M16) compared to its previous step (M15) (median fold change decrease 1.35;  $n=12$ ;  $p=0.0024$ ) (Wilcoxon matched-pairs signed rank test; Figure 2D). This indicated that, during later-half of Yagya ritual, GSR values were low compared to first half of the Yagya ritual and the significant drop in GSR value were at Gayatri Mantra fire offering indicating achievement of the start of the relaxation.

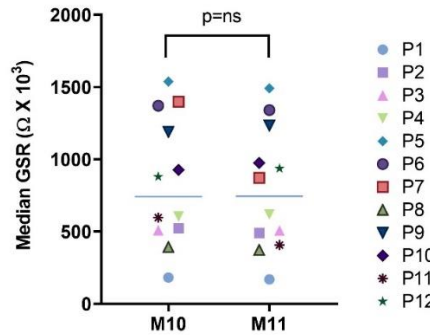
A



B



C



D

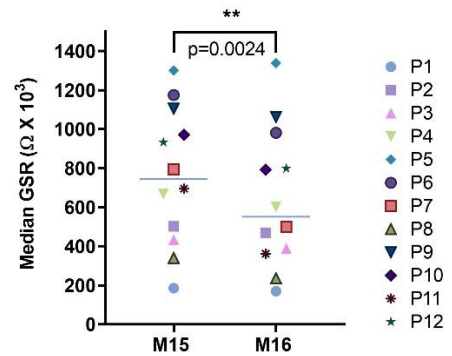


Figure 2. Median change in GSR values during Yagya ritual. Median change in GSR values during Yagya ritual divided in 11 clusters (A), Median GSR change between first half of Yagya ritual i.e. before agnithapana M1 to M10 and M11 to M29 (B), Median GSR between agnithapana (M11) and its previous step of Devavahanam (M10) (C), Median GSR between Gayatri Mantra fire sacrifice (M16) and its previous step Ajjahuti (M15) (D). P1 to P12 denotes participants; ns=not significant.

**Discussion**

Since millennia, Indians have been practicing the rite of Yagya right from birth to death marking celebrations and different phases of life. It is an integral element of the collective Indian cultural code. Ancient Indian texts and treatises provide remarkable details on the healing and therapeutic effects of Yagyas, on physical and emotional level. Vedas, Upanishads, Purana, etc. abound in instances about the various utilities of Yagya (10-12). Yagya's application for health (6), 13-15, environment 16-17, and spiritual and religious purposes (18) have already been documented. However, to our knowledge, Yagya ritual and its correlation with GSR has previously never been documented. The present study

documented evidence that Yagya ritual reduces GSR signal than compared to its level at the start of the Yagya (Figure 2A-D). Thus, indicating potential of Yagya ritual in achieving relaxed state.

The present study indicates the importance of steps of Yagya ritual and its association in GSR signal reduction. During Yagya ritual, at step of purification and preparation i.e. M4-M8 which slightly rises (not significant) than start of the Yagya M1-M3 (p=0.0974). This rise may be due to the steps involved for purification of all senses that demand cognitive alertness. Interestingly this rise (M4-M8) had significantly dropped at M16 (Gayatri Mantra fire oblations). It may be of interest in future to see if this



rise at M4-M8 is required for the decreased achieved at M16 after M15 mantras. Since the Vedic era, the sequence of M1-M28 is followed and it may be of interest to check the importance of the sequence for achieving the state of relaxation.

Previously, it was shown that the Yogic package, inclusive of Gayatri mantra meditation and listening of Gayatri mantra reduced stress level (19-20). Our observation also indicated significant drops in GSR level as soon as fire oblations with Gayatri Mantra were initiated (Figure 2D). The levels remained low compared to initial level (Figure 2A) indicating the rite of Gayatri Mantra fire oblations may be a crucial step in the Yagya ritual.

Gayatri mantra is very powerful Vedic mantra described in Rig Veda mandala 3.62.10. It is a prayer for Universal good, showing reverence to the formless Brahman, here referred as Savita. The mantra is “Om bhur buvah svah, tat savitur varenyam, bhargo devasya dimahi, dhiyo yonah prachodayat” - Rig Veda 3/62/10. Meaning of this mantra is “O, the brahman, the divine vital energy, destroyer of worldly sorrows, blissful, greatest being, luminous, destroyer of our sins, symbol of divinity, supreme soul, may we imbibe your qualities in our self, please guide us towards the path of divinity” (21,22) Per se, Super Science of Gayatri by SS Sharma, vocal rendition of the different syllables of Gayatri Mantra impress positively upon the 24 crucial points on our bodies(23).

Studies demonstrate, listening to Gayatri mantra activates the right insula, right temporal lobe, left inferior parietal lobule, bilateral superior temporal gyri, lateral globus pallidus and culmen of the cerebellum. It was found that listening of Gayatri mantra increases the domination of gamma waves in our brain (22, 23). It was also documented that Gayatri mantra increases the antimicrobial properties of Yagya smoke (24). In summary, it can be stated that the rite of Yagya along with Gayatri mantra helps achieve a state of relaxation (Figure 1 and 2) and shows a significant positive effect on our emotional state.

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