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Title: Preliminary Validation of a Facial-Expression and Movement Analysis Algorithm During Emotion Elicitation Tasks in Healthy Adults

Authors and Affiliations:

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Author Questionnaire

- 1. Microscopy:** Does your protocol require the use of a dissecting or stereomicroscope for performing a complex dissection, microinjection technique, or something similar? **No**
- 2. Software:** Does the part of your protocol being filmed include step-by-step descriptions of software usage? **Yes, all done**
- 3. Filming location:** Will the filming need to take place in multiple locations? **No**
- 4. Testimonials (optional):** Would you be open to filming two short testimonial statements **live during your JoVE shoot**? These will **not appear in your JoVE video** but may be used in JoVE's promotional materials. **Yes**

Current Protocol Length

Number of Steps: 12

Number of Shots: 19 (15 SC)

Interviews

Videographer: Obtain headshots for all authors available at the filming location.

Authors: Please note that **the questions will not appear on screen**. Please answer in **stand-alone full sentence with sufficient context**

INTRODUCTION:

~~**REQUIRED:** Summarize your research focus and the main questions it aims to answer.~~

- 1.1. **Rishikesh Behere**: This study examined whether the facial-expression and movement analysis algorithm detects navarasa-specific emotional changes elicited by standardized facial emotion stimuli.
 - 1.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

~~**Describe the research contexts or systems in which this protocol can be applied.**~~

- 1.2. **Sandeep Pendurkar**: This protocol has potential applications in medical practice across specialties, clinical psychology, robotics, and other emotion-sensitive settings.
 - 1.2.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

CONCLUSION:

~~**What does this protocol allow researchers to study or measure?**~~

- 1.3. **Rishikesh Behere**: The study observed stimulus concordance between FEA-algorithm scores and emotion recognition accuracy in healthy adults, with modest sensitivity in discriminating between emotional states.
 - 1.3.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

~~**Describe the most important consideration or challenge when performing this protocol.**~~

- 1.4. **Saurabh Shaligram**: The most important consideration when conducting the study is to ensure accurate emotion elicitation, consistent facial recording conditions, and participant comfort.
 - 1.4.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

~~How can future studies build on this work? Describe the questions or research directions that can be investigated next.~~

- 1.5. **Rishikesh Behere:** Future iterations of the algorithm aim to improve its discriminatory power across all emotional categories by incorporating additional physiological or contextual data.
 - 1.5.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

Videographer: Obtain headshots for all authors available at the filming location.

Testimonial Questions (OPTIONAL):

Videographer: Please capture all testimonial shots in a wide-angle format with sufficient headspace, as the final videos will be rendered in a 1:1 aspect ratio. Testimonial statements will be presented live by the authors, sharing their spontaneous perspectives.

- Testimonial statements will **not appear in the video** but may be featured in the journal's promotional materials.
- **Provide the full name and position** (e.g., Director of [Institute Name], Senior Researcher [University Name], etc.) of the author delivering the testimonial.
- Please **answer the testimonial question live during the shoot**, speaking naturally and in your own words in **complete sentences**.

What problem in your field of research does your JoVE article address?

- 1.6. **Dr. Rishikesh V Behere, Senior Psychiatrist**: (authors will present their testimonial statements live)
 - 1.6.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

How does the video format of your article help you to share your work with the broader scientific community?

- 1.7. **Sandeep Pendurkar, Co-Founder, Emoscope**: (authors will present their testimonial statements live)
 - 1.7.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

Ethics Title Card

This research has been approved by the Sushruta Hospital's Ethics Committee

Protocol

***Videographer:** Please always record an audio slate while filming each shot mentioned in the shotlist.*

2. Participant Setup and Baseline Recording

Demonstrator: Yashashree Joshi

Authors: I have retained some steps of this section to give a full context as per our journal guidelines

- 2.1. To begin, seat the participant 60 to 70 centimeters from the camera, with the camera positioned at the eye level [1]. Open the FEA application on the laptop, check the participant's name and details. Ask them to review the consent form [2-TXT].
 - 2.1.1. WIDE: Talent assisting the participant in sitting with the camera/laptop positioned at eye level and 60 to 70 centimeters away.
 - 2.1.2. SCREEN: 70843_Test2---Trim_Final.mp4 00:16-00:22. **TXT: FEA: Facial-Expression and movement Analysis**
- 2.2. Let the application continuously record the video data throughout the experiment for subsequent analysis of the facial expressions and micro-movements [1]. Instruct the participant to relax and refrain from overt expressive behaviors [2]. Record a 60-second baseline [3].
 - 2.2.1. SCREEN: 70843_Test2---Trim_Final.mp4 00:32-00:40.
 - 2.2.2. The talent instructs the participant with gestures, and the participant sits still with a relaxed facial expression during the baseline recording.
 - 2.2.3. SCREEN: 70843_Test2---Trim_Final.mp4 00:51-00:54.
- 2.3. Exit the room before the recording sessions to reduce distraction [1]. Monitor the experiment remotely using the mobile application [2].
 - 2.3.1. Talent leaving the experimental room before the recording session.
 - 2.3.2. Over the shoulder shot of talent looking at the mobile application displaying the ongoing experiment for remote monitoring.

3. TRENDS Images Paradigm

- 3.1. Present a blank screen for 60 seconds before displaying the emotional stimuli selected from the TRENDS tool [1-TXT].

3.1.1. SCREEN: 70843_screenshot_2.1.2_updated_version_blurr.mp4 00:21-00:24.

TXT: TRENDS: Tool for Recognition of Emotions in Neuropsychiatric Disorders

- 3.2. Present a total of 20 images representing neutrality, happiness, sadness, anger, and fear across 2 genders and 2 age groups. Display each image for 5 seconds [1].

3.2.1. SCREEN: 70843_screenshot_2.3.1_updated_version_blurr.mp4 00:08-00:14.

- 3.3. Insert a 10-second blank screen interval between consecutive images [1]. During this period, ask the participant to identify the preceding emotion by selecting one of five labels on the screen [2].

3.3.1. SCREEN: 70843_screenshot_2.3.1_updated_version_blurr.mp4 00:14-00:17.

3.3.2. SCREEN: 70843_screenshot_2.3.2_updated_version_blurr.mp4.

- 3.4. Continue until all 20 images and the corresponding blank intervals are complete. The paradigm lasts 300 seconds [1].

3.4.1. SCREEN: 70843_screenshot_2.4.1_updated_version_blurr.mp4. 00:00-00:15

4. Navarasa Paradigm

- 4.1. After a brief resting period, present the emotional stimuli based on the Navarasa framework [1].

4.1.1. SCREEN: 70843_screenshot_3.3.1_updated_version_blurr.mp4 00:05-00:09.

- 4.2. Show each image for 5 seconds [1-TXT].

4.2.1. SCREEN: 70843_screenshot_3.3.1_updated_version_blurr.mp4 00:10-00:12..

- 4.3. Insert a 10-second blank screen interval between consecutive images [1]. During this period, ask the participant to classify the emotion depicted in the preceding image by selecting one of the three classifications among **Neutral**, **Pleasant**, or **Unpleasant** [2 AND 3].

4.3.1. SCREEN: 70843_screenshot_3.3.1_updated_version_blurr.mp4 00:13-00:17.

4.3.2. SCREEN: 70843_screenshot_3.3.2_updated_version_blurr.mp4.

4.3.3. TEXT ON PLAIN BACKGROUND using split screen with 4.3.2

Navarasa emotions:

Neutral: Shanta

Pleasant: Haasya, Veera, Shringara, Adbhuta

Unpleasant: Krodha, Vibhitsu, Bhayanaka, Karuna

4.4. Continue the presentation until all 18 images have been displayed with the corresponding blank screen intervals, resulting in a total paradigm duration of 270 seconds [2].

4.4.1. SCREEN: 70843_screenshot_3.4.2_updated_version_blurr.mp4 00:00-00:10.

4.5. After analyzing the data, visualize the emotion intensity values as time-series plots showing the evolution of each emotion throughout the video [1]. Use the plots to examine the transient changes, peak activations, and recovery or de-escalation phases in emotional arousal [2-TXT].

4.5.1. SCREEN: 70843_screenshot_6.2.1_6.2.2_updated_version_blurr.mp4.

4.5.2. Talent looking at the time-series plots on the computer. **TXT: Refer to the text protocol for data analysis**

Results

5. Results

5.1. The FEA-algorithm-derived measures demonstrated statistically significant changes from the baseline to T-max for the TRENDS emotion images [1] and the Navarasa emotion images [2].

5.1.1. LAB MEDIA: Figure 4.

5.1.2. LAB MEDIA: Figure 5.

5.2. The highest area under the curve was observed for the Shanta score in response to neutral facial-emotion stimuli [1], followed by the score for happiness [2].

5.2.1. LAB MEDIA: Table 3. *Video editor: Highlight the rows for 'Shanta' in panel A under column AUC.*

5.2.2. LAB MEDIA: Table 3. *Video editor: Highlight the rows for 'Happy-haasya' in panel A under column AUC*

5.3. The sensitivity for the neutral and positive emotions was 70 to 80% [1], whereas the sensitivity for the negative emotions was 60 to 70% [2].

5.3.1. LAB MEDIA: Table 3. *Video editor: Highlight the sensitivity% values for the neutral and happy rows in panel A and Shanta and Pleasant rows in panel B.*

5.3.2. LAB MEDIA: Table 3. *Video editor: Highlight the sensitivity% values for fear and anger rows in panel A and unpleasant row in panel B.*

5.4. The receiver operating characteristic curve for the FEA-algorithm Shanta score in response to the neutral emotion images showed an area under the curve of 0.665 [1].

5.4.1. LAB MEDIA: Figure 6. *Video editor: Highlight the box displaying 'AUC = 0.665'.*

1. FEA

Pronunciation link: No confirmed link found

IPA: /,ɛf.i:'eɪ/

Phonetic Spelling: ef·ee·ay

2. Facial-Expression

Pronunciation link: https://www.merriam-webster.com/dictionary/facial(https://www.merriam-webster.com/dictionary/facial)

IPA: /'feɪʃəl ɪk'spreʃən/

Phonetic Spelling: fay-shuhl ik-spresh-uhn

3. Micro-movements

Pronunciation link: No confirmed link found

IPA: /'maɪkroʊ ,mu:vmənts/

Phonetic Spelling: my-kroh moov-muhnts

4. Baseline

Pronunciation link: <https://www.merriam-webster.com/dictionary/baseline>

IPA: /'beɪs.laɪn/

Phonetic Spelling: bays-line

5. Stimuli

Pronunciation link: <https://www.merriam-webster.com/dictionary/stimuli>

IPA: /'stɪmjə.laɪ/, /'stɪmjə.li:/

Phonetic Spelling: stim-yuh-lye / stim-yuh-lee

6. TRENDS

Pronunciation link: No confirmed link found

IPA: /trɛndz/

Phonetic Spelling: trendz

7. Neuropsychiatric

Pronunciation link: <https://www.merriam-webster.com/dictionary/neuropsychiatry>

IPA: /,nʊrəʊ,sɑːki'ætrɪk/, /,njʊrəʊ,sɑːki'ætrɪk/

Phonetic Spelling: nur-oh-sy-kee-AT-rik / nyur-oh-sy-kee-AT-rik

8. Neutrality

Pronunciation link: <https://www.merriam-webster.com/dictionary/neutrality>

IPA: /nu:'træləti/, /nju:'træləti/

Phonetic Spelling: noo-TRAL-uh-tee / nyoo-TRAL-uh-tee

9. Paradigm

Pronunciation link: <https://www.merriam-webster.com/dictionary/paradigm>

IPA: /'pærə,daim/, /'pærə,daim/
Phonetic Spelling: pair·uh·dime / par·uh·dime

10. Navarasa

Pronunciation link: No confirmed link found

IPA: /,nɑ:və'rɑ:sə/

Phonetic Spelling: naa·vuh·RAA·suh

11. Shanta

Pronunciation link: No confirmed link found

IPA: /'ʃɑ:ntə/

Phonetic Spelling: SHAAN·tuh

12. Haasya

Pronunciation link: No confirmed link found

IPA: /'hɑ:sjə/

Phonetic Spelling: HAA·syuh

13. Veera

Pronunciation link:

<https://www.howtopronounce.com/veera>

IPA: /'vi:rə/

Phonetic Spelling: VEE·ruh

14. Shringara

Pronunciation link:

<https://www.howtopronounce.com/shringara>

IPA: /ʃrɪŋ'gɑ:rə/

Phonetic Spelling: shring·GAA·ruh

15. Adbhuta

Pronunciation link: No confirmed link found

IPA: /əd'bʰu:tə/

Phonetic Spelling: ud·BHOO·tuh

16. Krodha

Pronunciation link:

<https://www.howtopronounce.com/krodha>

IPA: /kr'ɑ:dhə/

Phonetic Spelling: krah·DHUH

17. Vibhitsa

Pronunciation link: No confirmed link found

IPA: /vɪˈbʰiːtsə/

Phonetic Spelling: vih·BHEET·suh

18. Bhayanaka

Pronunciation link: No confirmed link found

IPA: /bʰəˈjɑːnəkə/

Phonetic Spelling: bhuh·YAA·nuh·kuh

19. Karuna

Pronunciation link: No confirmed link found

IPA: /kəˈruːnə/

Phonetic Spelling: kuh·ROO·nuh

20. Time-series

Pronunciation link: No confirmed link found

IPA: /ˈtaɪm ˌsɪrɪz/

Phonetic Spelling: time·seer·eez

21. Transient

Pronunciation link: <https://www.merriam-webster.com/dictionary/transient>

IPA: /ˈtrænjənt/, /ˈtrænzɪənt/, /ˈtrænsɪənt/

Phonetic Spelling: TRAN·shuhnt / TRAN·zee·uhnt / TRAN·see·uhnt

22. Activations

Pronunciation link: <https://www.merriam-webster.com/dictionary/activation>

IPA: /ˌæktəˈveɪʃənz/

Phonetic Spelling: ak·tuh·VAY·shuhnz

23. De-escalation

Pronunciation link: <https://www.merriam-webster.com/dictionary/de-escalation>

IPA: /ˌdiːˌɛskəˈleɪʃən/

Phonetic Spelling: dee·es·kuh·LAY·shuhn

24. Arousal

Pronunciation link: <https://www.merriam-webster.com/dictionary/arousal>

IPA: /əˈraʊzəl/

Phonetic Spelling: uh·ROW·zuhl

25. FEA-algorithm-derived

Pronunciation link: No confirmed link found

IPA: /,ɛf.i:'eɪ'ælgə,rɪðəm dɪ'raɪvd/

Phonetic Spelling: ef·ee·ay AL·guh·rith·uhm dih·RYVD

26. Algorithm

Pronunciation link: <https://www.merriam-webster.com/dictionary/algorithm>

IPA: /'ælgə,rɪðəm/

Phonetic Spelling: AL·guh·rith·uhm

27. Statistically

Pronunciation link: <https://www.merriam-webster.com/dictionary/statistically>

IPA: /stə'tɪstɪkli/

Phonetic Spelling: stuh·TIS·tik·lee

28. AUC

Pronunciation link: No confirmed link found

IPA: /,eɪ.ju:'si:/

Phonetic Spelling: ay·yoo·see

29. Sensitivity

Pronunciation link: <https://www.merriam-webster.com/dictionary/sensitivity>

IPA: /,sɛnsə'tɪvəti/

Phonetic Spelling: sen·suh·TIV·uh·tee

30. Receiver operating characteristic

Pronunciation link: No confirmed link found

IPA: /rɪ'si:vər'ɑ:pə'reɪtɪŋ,kærəktə'rɪstɪk/

Phonetic Spelling: rih·SEE·ver OP·uh·ray·ting kair·ik·tuh·RIS·tik