The International Journal of Indian Psychology
ISSN 2348-5396 (Online) | ISSN: 2349-3429 (Print)
Volume 13, Issue 2, April- June, 2025
DIP: 18.01.202.20251302, DOI: 10.25215/1302.202
https://www.ijip.in

Research Paper

Ingressive Psychological Techniques in the Audio Analysis of Mimicry Voice

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ABSTRACT

Forensic sciences, as a field is an amalgamation of various different fields; that all work complimentary to each other. However, with the recent advancements in the fields of Auditory Analysis and Deception Detection Techniques, it has been seen that usage of complimentary techniques is an aspect of forensics that needs a far more focused approach; for a multidisciplinary approach always looks at the issue from several angles and strives for a solution. In the current study, the authors have attempted to understand the complimentary integration of two different analytical techniques, forensic psychology and audio forensics, on the issue of voice disguise by mimicry. For Auditory analysis, Phonetic analysis of the mimicked and natural speech samples of the mimicry artist, was used to establish the similarities of the speaker. At the same time, the Deception Detection Techniques of Layered Voice Analysis (LVA), Polygraph and Brain Electrical Oscillation Signaling (BEOS) were used to determine the deception patterns within the emotional, psycho - physiological and neurological analysis of the mimicry artists w.r.t. the samples of mimicry artist in their normal and disguised voice when in comparison with the target voice sample. The results were analyzed and discussed from a forensic perspective. Conclusions regarding the implications of the complimentary usage of audio forensics and forensic psychological techniques proposed the admission of psychological evidences in addition to auditory analysis evidence to the judicial system.

Keywords: *Audio analysis, Polygraph, BEOS, Layered voice analysis, mimicry*

It has been seen in recent years, that the trend and the types of crimes being committed has increased exponentially. This increased trend has come with its own challenges for the investigators, for the number of crimes has constantly increased in proportion to the number of pending cases for trial. However, with integration of internet access, there is a stark contrasting difference between current crime trends and those in the past. This is clearly shown in the simple fact that perpetrators have been known to leave little to no physical evidence at the crime scenes. The investigating authorities have to constantly struggle to get evidence linking to the offender. Additionally, the investigating agencies may

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Received: February 25, 2025; Revision Received: May 22, 2025; Accepted: May 25, 2025

enumerate potential suspects in a case; nonetheless, it is the prosecution who must establish the suspects' involvement in the crime in court.

When it comes to voice crimes, such as extortion, ransom, threatening, kidnapping, and bribe-demanding calls, the offenders employ a number of camouflaged tactics to enable them to simply and unintentionally evade detection. In such circumstances, speech becomes the only available evidence. There are multitudes of ways like semi-automatic method, auditory analysis, automatic analysis wherein the audio investigative analysis on the recordings of suspected voices, in the forensic set up that can be used to analyze and conclusively identify a suspected voice sample. If an analyst, however, is unable to recognize and match the accused's disguised voice, there are currently no other means of identifying the offender.

However, in India's judicial system, it is the recent establishment of Forensic Psychological Techniques, as an alternative to the third degree methods of investigation that has recently seen the shift to the Scientific Tools for Investigation. These Scientific Tools currently used in Indian Investigative Scenarios include, Polygraph, BEOS (Brain Electrical Oscillation Signature Profiling), Narco-analysis and LVA (Layered Voice Analysis). The use of these tools have grown exponentially in the recent times; with even Indian Judicial System accepting the reports of the experts using these techniques in multitude of cases when convicting or exonerating the accused.

It is no secret that the modern day criminal differs entirely from the traditional criminals. One of the major reasons is because today's criminals have become astute enough to be more accurate in their planning and execution of crimes, making it more difficult to acquire evidence for an investigation. This is in part due to the rapidly growing trends in technology and their easy accessibility. It is in such difficult situations that the expertise of a Forensic Psychologist, and with the use of Forensic Psychological Investigative Techniques becomes of utmost importance. For both separately and in combination, these scientific techniques have been employed in numerous instances for a variety of objectives, including screening possible criminals, identifying deception in both suspects and offenders, and checking the experiential knowledge of an accused/suspect about the crime that has happened.

It was in 1923, the polygraph made its first major connection with the court system when in United States [1]. The polygraph test is an interview including of multiple relevant, irrelevant, and comparison questions to which the subject must respond with a yes or no. The physiological information obtained by the polygraph is assessed at the post-test stage. In the judgement [2] of the murder case of an Editor of Dakshin Gujrat Vartaman, honourable court endorsed the reports of the psychological techniques employed. The case reported in Kolkata city, in which the victim was shot dead, was under the investigation of CID first. In the polygraph test conducted on accused, indication of deception was observed and hence trial was transferred to CBI from CID [3]. Polygraph test was accepted with constraints of subjects volunteering for the examination of their own free will, in the case of Selvi & Ors vs State Of Karnataka & Anr on 5 May, 2010 [4].

Brain Electrical Oscillation Signature Profiling (BEOS) developed by Prof. C. R. Mukundan is an advanced technology that helps in detecting whether there is any memory related to the crime/event in the brain of the subject. This technique involves the subject actively listening to the probes including those that refer to a particular activity in context of the events while recording electrical oscillations from a subject's brain in order find an indicator of

remembering. [5][6][7] & [8]. This indicator is referred as experiential knowledge (EK) of the remembrance related to the activity to which a probe (a short verbal statement presented in auditory mode) is related. Probes that are created based on scenarios are listened to by subjects. An EK observed to a particular probe indicates the remembrance of an event. In the realm of criminal justice, voluntary administration of the polygraph, BEOS testing is allowed as long as sufficient safety measures remain in place [9].

However, it is the introduction of one of the most recent technique: known as the Layered Voice Analysis that has had quite the implications for the field of Forensic Psychological Techniques and its evidentiary value in the judiciary. LVA is supposed to assist in identifying lies and screening suspects. The LVA technique has been put into use by state and central FSL for last several years. LVA carries out the emotional analyses of human voice [10], by capturing the voice live (online mode) or by extracting the emotional content from the recorded speech (offline mode) [11]. Author in [12] claimed some of the aspects of the LVA technology are need to be researched for better understanding.

There have been multitude of judicial cases where all the above techniques have been accepted within the judicial system. The Polygraph and BEOS of a suspect in a murder case indicated deception and experiential knowledge of the events related to murder. With a clear indication towards planning of the murder, the Hobble Court admitted the reports into evidence and used them when convicting the accused with life time imprisonment. [13].

In another judgment, Hon'ble Court opined that *"in present days the technics used by the criminals for commission of crime are very sophisticated and modern. The conventional method of questioning may not yield any result at all. That is why the scientific tests like polygraph, brain mapping, Narco-analysis, etc. are now used in the investigation of a case. When such tests are conducted under strict supervision of the expert, it cannot be said that there is any violation of the fundamental rights guaranteed to a citizen of India."* [14]

Like above, there are multiple examples of the admissibility of the LVA report in the court. The Layered Voice Analysis report & Forensic Psychological Assessment Report established and corroborated the facts and role of accused in the criminal conspiracy case [15]. In the judgment passed by honorable court stated that [16] the layered voice analysis technique proved the involvement of the petitioner in the crime. In the case Anju Das vs State Of Nct Of Delhi & Ors. on 2 November, 2023 [17] both the polygraph and the LVA were used and the same revealed the truthfulness of the responses.

If we consider impersonation of voices, mimicry artists encompass their own special place in the realm of entertainment. Imitation is a kind of a vocal disguise which involves someone changing their voice to seem like someone else. Currently, it's seen that some voice imitators make use of their talent not for entertainment but far more nefarious reasons. They tend to use their talent for personal gain and most times, with immoral intentions. Whilst mimicking on stage, it's been seen that actors emphasize on distinguishing characteristics [18]. Since biological differences between speakers cannot be altered, it is challenging to mimic the voice and speech of another person perfectly [19]; despite the fact that excellent voice imitation might deceive the audience [20].

In our previous study [21]; we compared the mimicked voice to the target voice and the impersonator's natural voice. By studying the parameters like speech rate, dialect, fundamental frequency, word duration, manner and place of articulation, glottal leakage,

jitter & shimmer etc. we came to the conclusion that the imitated voice and the mimicry artist's real voice were probably derived from the same source and differed greatly from the target speaker. As discussed in the above-mentioned study, formant frequencies of the speech samples in each scenario failed to match and hence we depended on the auditory and phonetic analysis.

Consider a case wherein we have two speech samples of a same person, one is his natural voice and another wherein the voice is suspected to be a mimicry of a celebrity or another individual. Even though these two speech samples have same dialectical, phonetical similarities their formant frequencies will not match [21], meaning that it can be said for sure that, auditory these are same speakers however, we are unable to prove the same spectrographically In such situations, if there is possibility of using Forensic Psychological Techniques to corroborate the deception in mimicked voice samples, then it would be another evidence that would strengthen the criminal investigation. The reports of the psychological tests can be substantial and corroborative evidences in the court of law.

The current study proposes that the Forensic Psychological Techniques of Polygraph, Layered Voice Analysis and BEOS can be definitely used to identify deception in mimicked/disguised voices of subjects, as corroborating evidences, when there has been a phonetic and auditory match of voice samples.

MATERIALS AND METHODS

The current research has undertaken the voice samples of one mimicry artist, in both normal and mimicked voice. The mimicry artist was asked to record part of a very public speech of a former Prime Minister of India both in his normal voice and the mimicked voice of the former PM. This speech was chosen as in part as it is readily available across the internet, if so required. Thus, making the content of the recording neutral before analyzing the recording, via audio matching and Layered Voice Analysis. Both the audio recordings were recorded in the laboratory conditions. The original part of the speech by the former PM of India was also procured and analyzed as part of the current research.

The mimicry artist underwent Polygraph Examination on the issue of his mimicking voice of famous personalities in Directorate of Forensic Science, Mumbai and Central Forensic Science Laboratory, Pune. The artist was intentionally asked to lie about the mimicry talent on the questions asked during the polygraph examination proper.

The artist also underwent Brain Mapping Examination in Directorate of Forensic Science, Mumbai wherein he was showed stimulus in relation to his mimicking the voice of the former PM of India.

Thus, the following hypotheses were then formulated for the study:

- That there will be a phonetic and auditory match between the normal and mimicked recordings.
- That there will be a graphical match for both normal and mimicked recordings, on the five parameters, i.e. Global Risk, Emotional, Cognitive, Thinking and Anticipation Level on LVA, thus indicating clear deception for the artist.
- That there will be no graphical match for both mimicked recordings and original speech, on the five parameters, i.e. Global Risk, Emotional, Cognitive, Thinking and Anticipation Level on LVA, thus indicating deception on part of the mimicry artist.

- That there will be deception indicated in Polygraph Examination of the mimicry artist.
- That there will be indications of experiential knowledge in the brain mapping examination of the artist regarding the mimicry of the former PM of India.

Observations:

Audio Analysis - Phonetic and Auditory Analysis

Semi-automatic method [22] of audio analysis comprises of aural and spectrographic analysis. As discussed in our previous study [21], spectrographic and formant analysis of the same vowels segregated from mimicked speech and normal speech of the mimicry artist, revealed no frequency match. To seek the auditory equivalence in the speech samples they were critically listened. First impression while listening the mimicked and normal speech recordings of the mimicry artists was that the pauses taken by mimicry artist in both the speech samples were almost same. The speech rate of the mimicry artist in mimicked recording was 94 words per minute and in normal speech it is 95 words per minute. The stress on particular cluster in the word was also same. This preferable indicated that the mimicry artist was so much prone to the style of speaking of the target speaker. In the first window (1a) of the figure spectrograph showed that there was a similar type of articulation used in uttering particular words like “Vyathit nahin hoon”. The same amount of stress applied on consonant /t^h/ is nicely depicted in the spectrograph. The transition from vowels /Ə/ to /i/ up to /u/ can be clearly seen. In second window of the figure (1b) spectrograph and formants for the word “Virodhi paksh” is given. Stress on consonant /dh/ seen before vowel /i/ and on consonant /p/ before vowel /Ə/ is observed in the figure.

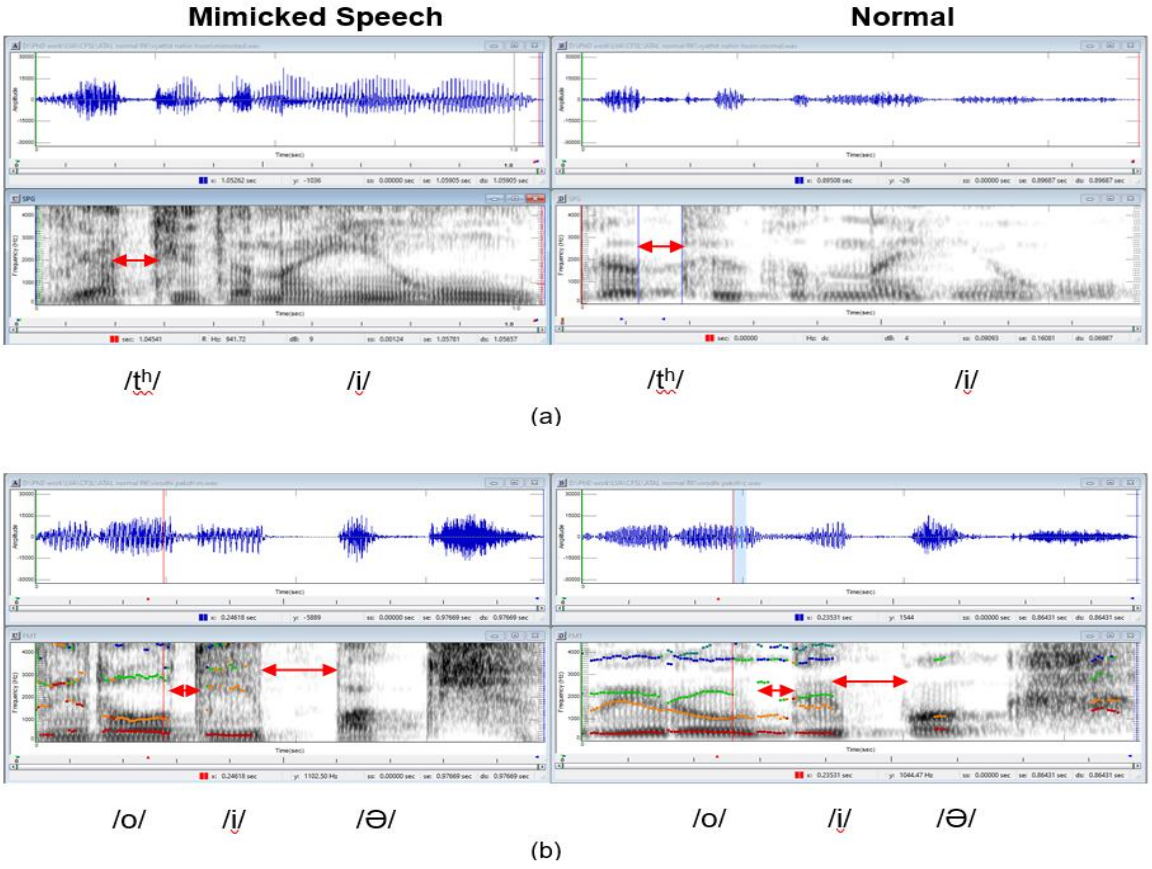

Figure 1 showing the spectrograph of the words (a) “Vyathit nahi hoon” & (b) “Virodhi

The jitter and shimmer values were obtained using PRAAT software for mimicked as well as natural voices of mimicry artist and also for target voice. Jitter and shimmer parameters are the measures of cycle-to-cycle variations in fundamental frequency and amplitude, respectively, which have been largely used for the description of pathological voice quality [23, 24]. From the Table 1 below it is evident that the values for both mimicked and natural voices of the mimicry artist were almost similar. The higher values of jitter and shimmer indicate the old age [25]. Thus, higher Jitter and shimmer values showed a clear indication of the old age of the target speaker. The speech of former PM was downloaded from the internet when he was 72 years old. The age of the mimicry artist was 44 at the time of his voice recording. These facts indicated that the speech samples obtained from the mimicry artist were similar on the basis of auditory and phonetic analysis. We conducted the psychological testing on the mimicking artist mentioned below in order to corroborate these results.

Table 1: Showing the Jitter & Shimmer values for mimicked, natural voices of the artist and for the target speaker voice

Jitter and Shimmer measurements	Mimicked	Natural	Target
Jitter (Local)	2.90%	2.57%	4.87%
Shimmer (Local)	8.77%	8.83%	18.95%

Layered Voice Analysis (LVA)

Layered Voice Analysis, as discussed before, assesses the emotional stressors in the voice of the individual when they narrate an event that has a particular emotional connection with the subject under examination. In the current study, the authors asked a mimicry artist to record part of a speech by former PM of India, both his own normal voice as well as mimicking the voice of the original speaker.

For mimicry artists, the talent of being able to disguising their voice as a well-known celebrity is a talent they are not only proud of, but also one that they have formed their own profession around. Thus, it is in no way a stretch to understand the emotional connection that the artist will have to this talent of theirs.

Hence, it is also not a stretch to believe that the emotional connection is to their voice; not to the content of the speech. This is what the current research is trying to focus on with respect to the mimicked voices; that if the subject is speaking in his original voice as well as in the mimicked voice; the emotional stressors be in the similar range if the speaker is the same.

For the current study, the normal voice recordings and the mimicked voice recordings of the artist are marked as N1, N2, N3 and M1, M2, M3 respectively. The graphical analysis and comparison is shown below in Figures 2, 3 and 4.

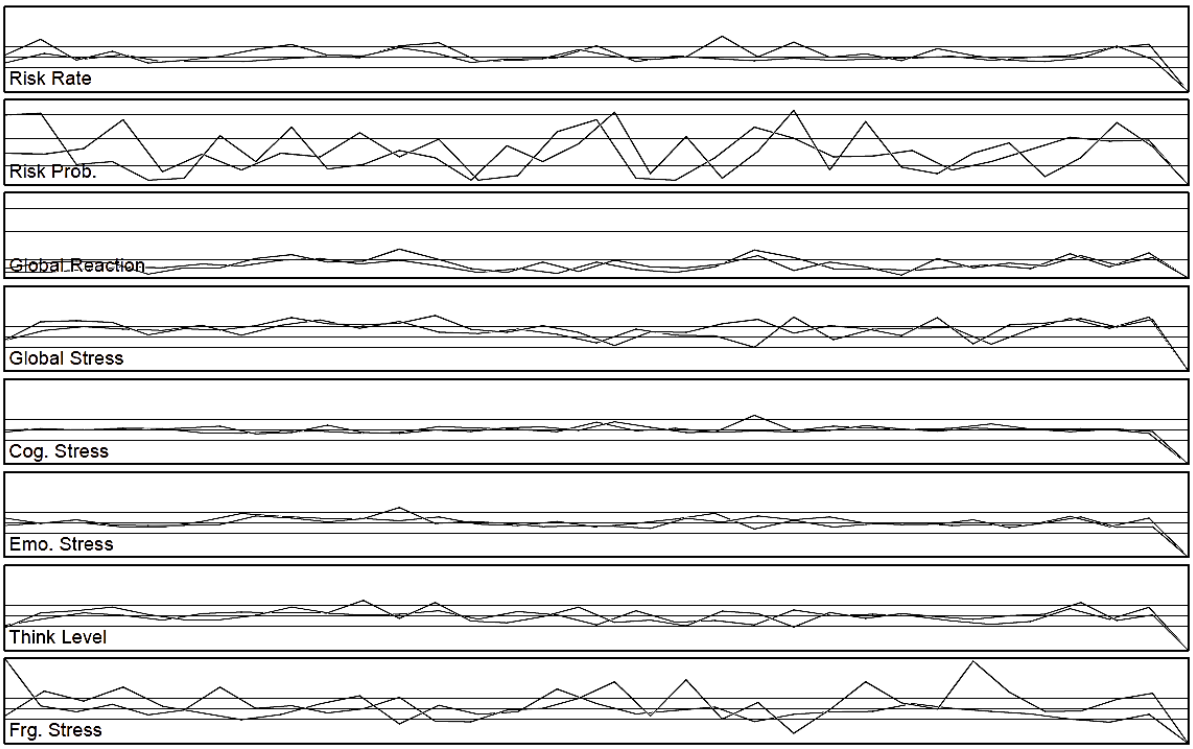

Fig. 2. The graphical comparison of the Normal Voice (N1) and Mimicked Voice Recordings (M1)

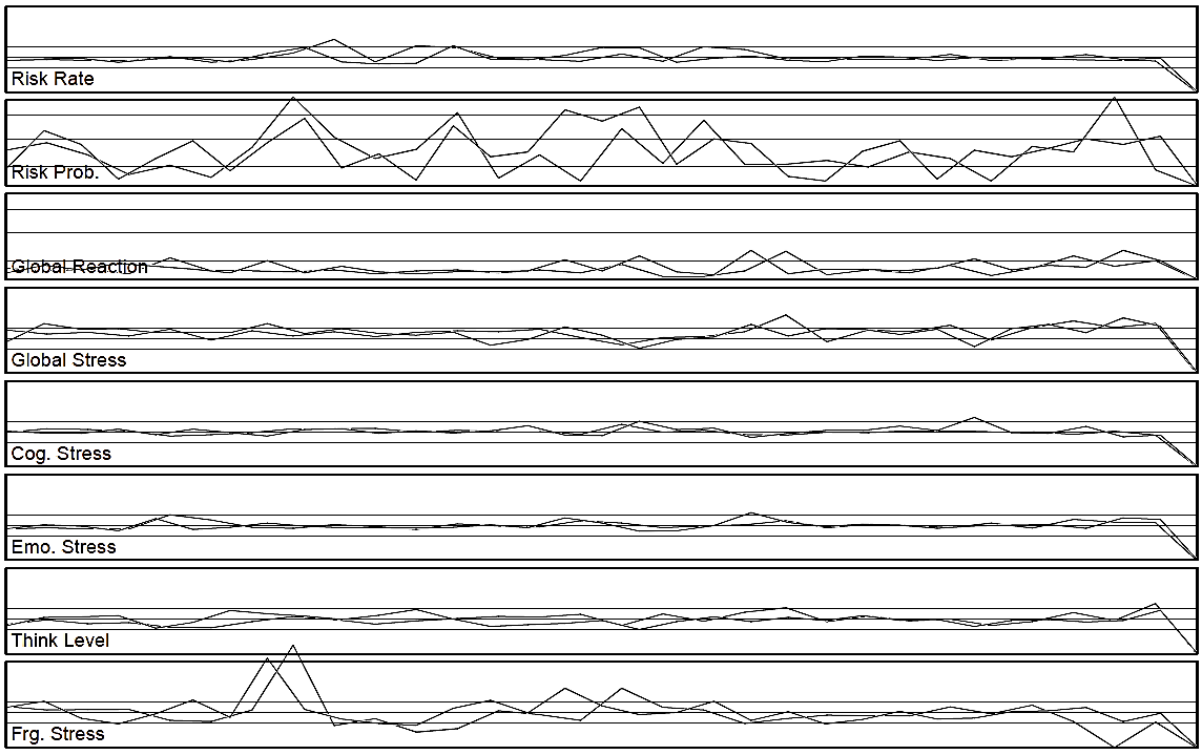

Fig. 3. The graphical comparison of the Normal Voice (N2) and Mimicked Voice Recordings (M2)

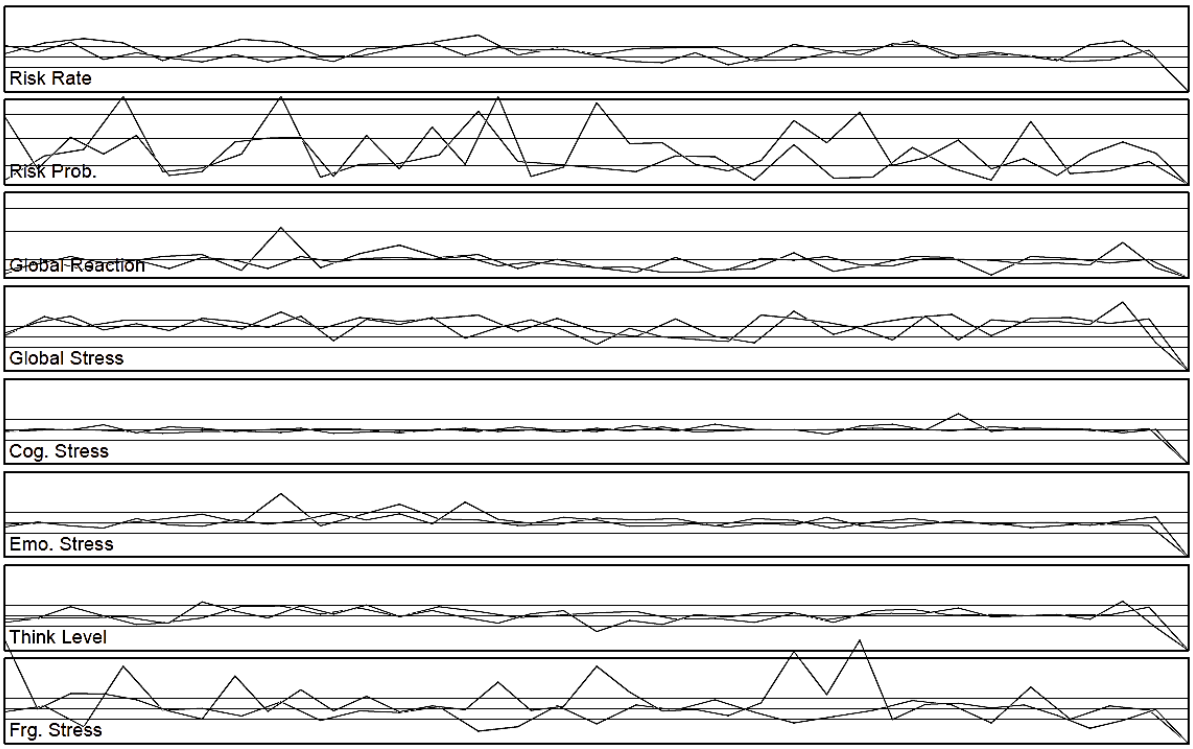

Fig. 4. The graphical comparison of the Normal Voice (N3) and Mimicked Voice Recordings (M3)

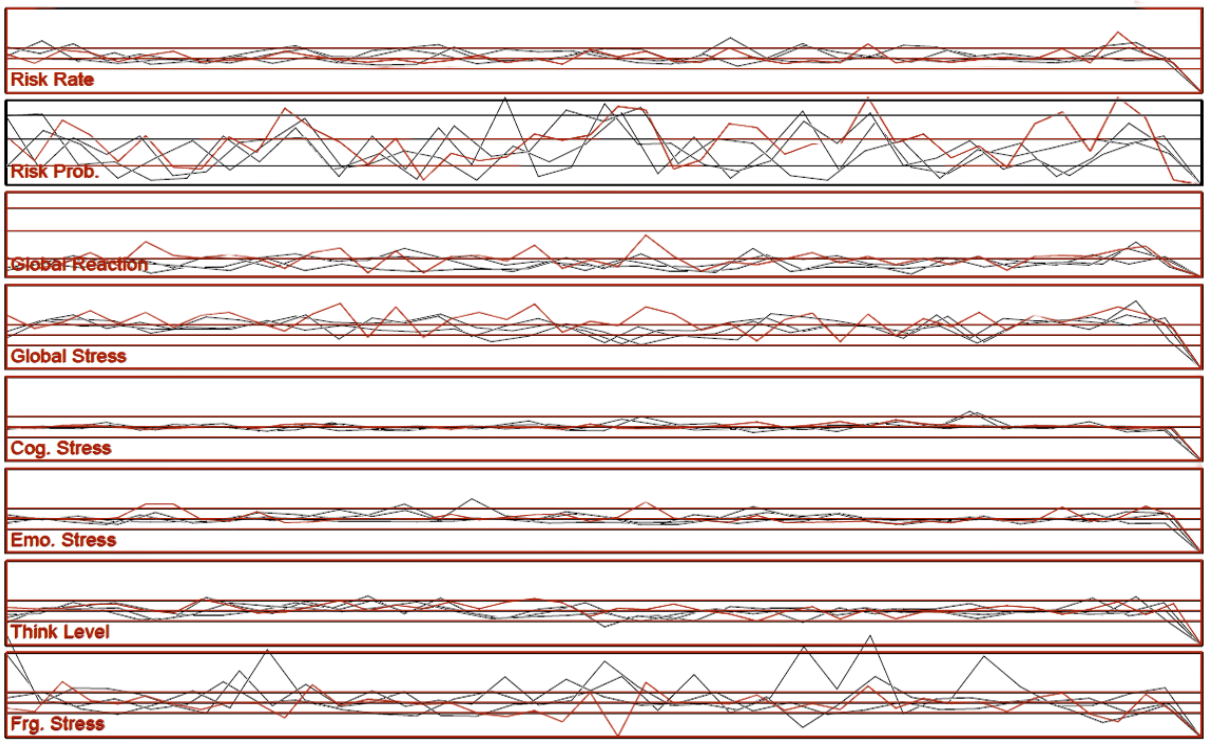

Fig. 5 The graphical comparison of the Target Voice (T) and Mimicked Voice Recordings (M1, M2 and M3).

The above figures (2,3 & 4) clearly show that there similarities in the basic five parameters of emotional stressors on Layered Voice Analysis, i.e. Global Risk, Emotional Stress,

Cognitive Stress, Thinking Level and Anticipation Level across all the six different recordings taken on three different occasions.

On the other hand, the original speech by the former PM of India marked as (T) was also analyzed using the LVA on the same parameters, i.e. Global Risk, Emotional Stress, Cognitive Stress, Thinking Level and Anticipation Level. This graphical analysis was then compared with the mimicked voice recordings (M1, M2 and M3) as shown in Figure 5 with the Target Voice's graphical analysis shown in red. As can be seen, that while there are similarities within the graphical analysis on LVA for M1, M2 and M3 the T (in red color) shows difference in the graphical analysis especially in areas of Emotional, Global Reaction and Global Stress.

However, a clear implication to be kept in mid, while comparing these graphs is the fact that the Target voice was acquired from the internet; so the artifacts might have created interferences during actual analysis. Therefore, further investigations, preferably with original recording samples of Targets need to be conducted before a conclusive result can be reached.

Polygraph

The artist also underwent a polygraph examination in the Forensic Psychology Divisions, of both Directorate of Forensic Science, Mumbai and Central Forensic Science Laboratory, Pune. The issues that were focused on during the polygraph examination are shown in Table 2:

Table 2: Questionnaire used in Polygraph examination

Issue	Type of Question
Kya tumne Kirit Somaiyya ki awaaz ki mimicry kari hai?	Relevant
Kya tumne kabhi Atal Bihari Vajpayee ki mimicry kari hai?	Relevant
Kya tumne mimicry ki performance karne ke liye kabhi paise liye hain?	Relevant
Kya tumne kabhi Atalji ki mimicry phone par kari hai?	Relevant

As per the scoring analysis of the polygrams, it was shown that deception was indicated in the relevant issues. As part of the examination, a secondary test known as Card or STIM test was also conducted. This test is usually conducted to enhance the guilt complex in the guilty individuals or to relax the innocent individuals. The deception was detected in the relevant issues on the polygrams, as can be seen below in Figure 6.

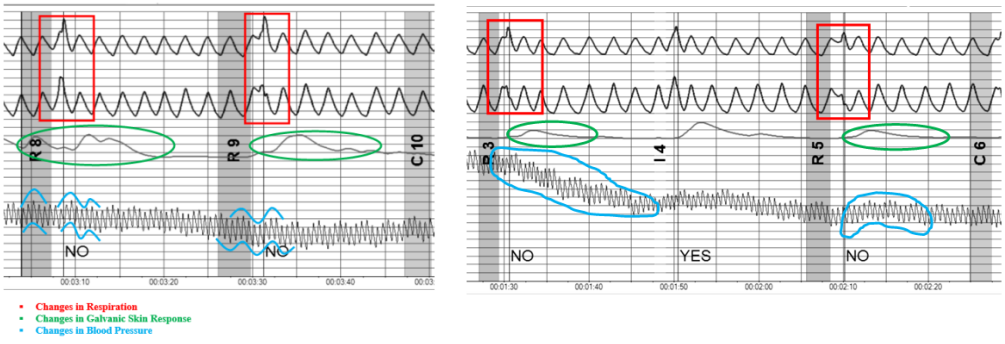

Fig. 6 The Indicators of Deception on the Polygram Charts for the relevant issues.

BEOS

As discussed, Brain Electrical Oscillation Signature Profiling (BEOS) is an advanced technology that detects memory related to a specific event within the brain of the individual. The probes are articulated, and the subject has to listen to stimulus in relation to the specific event.

In this study, the artist was made to listen to the probes related to his mimicking voices of the former PM of India as well as his talent of mimicking different celebrities as shown in the Table 3.

Table 3: Some of the Probes used for BEOS examination which showed EK

Probes	Signature
Mala Lahanpanapasun mimicry karayla aawadte	Experiential Knowledge
Me Udit Narayan yanchimimicry karto	Experiential Knowledge
Me Uditji yanchi nakkal kelyamule Saumitra khup hasla.	Experiential Knowledge
Me Ramdas Aathwle yanchya aawajachi nakkal karto	Experiential Knowledge
Me mimicry artist aahe	Primary processing
Me keleli mimicry saglyana aawdli	Primary processing

RESULTS AND DISCUSSION

With digital evidence becoming the forefront of the forensic evidences in almost all the cases going to trial - understanding new and improved ways of providing conclusive corroborative evidence in trails becomes of utmost importance in current scenarios.

The current study, in its very pilot research, has tried to expound on the corroboration of auditory analysis of disguised or mimicked voices using the different Forensic Psychological Techniques in cases wherein there could be indications of deception in the subject related to a criminal investigation.

Auditory and phonetic analysis of the mimicked and natural voices of the mimicry artist could depict the similarities between the speakers. Study showed that a mimicry artist is so prone to speak in the style of target speaker. The time duration of particular words, speech rate of the mimicry speech and the normal speech of the mimicry artist are almost similar. Thus, our first hypothesis is, hereby, accepted.

As can be seen from Figures 2, 3 and 4, there is a clear a graphical match for both normal and mimicked recordings, on the five parameters, i.e. Global Risk, Emotional, Cognitive, Thinking and Anticipation Level on LVA, thus indicating clear deception for the artist. Thus, our second hypothesis is accepted.

Next as we move on to Figure 5, it becomes clear that there is no graphical match for both mimicked recordings and target voice (T), on the parameters, i.e. Emotional, Global Reaction and Global Stress on LVA, thus deception on part of the mimicry artist can be concluded, with reservations being that the Target Voice was retrieved from an open source; hence did contain artifacts that could have interfered in the proper analysis of the Target voice. Thus, our third hypothesis can be said to be partially accepted.

Following we move to the issues as asked during Polygraph Examination also show clear deception in the relevant issues (Table 2) pertaining to the artist's role in mimicking voices of celebrities. Thus, our fourth hypothesis that clearly states that there will be deception indicated in Polygraph Examination of the mimicry artist has also been accepted.

Lastly, the artist also underwent the Brain Electrical Oscillation Signature Profiling (BEOS) wherein he heard the probes related to his memory about mimicking the voice of the former PM of India as well as his role in mimicking voices of other celebrities, while the electrical waves of his brain in connection to his recognition pertaining to the Event Related Potential (ERP). The results in Table 3 clearly show that the artist has Experiential Knowledge in the specific probes related to his knowledge about the mimicry. Thus, the fifth and final hypothesis stating that here will be indications of experiential knowledge in the brain mapping examination of the artist regarding the mimicry of the former PM of India has also been accepted.

CONCLUSION

This current study has tried to understand how Forensic Psychological Techniques can corroborate auditory analysis for forensic evidence using the three different Forensic Psychological Techniques, i.e. Polygraph, Layered Voice Analysis and Brain Electrical Oscillation Signature Profiling (BEOS) on a sample of normal and mimicked voices of the mimicry artist.

The analysis showed that there was a graphical similarities on five psychological parameters of voice stress analysis can be found between the normal voice samples and the mimicked voice samples using the Layered Voice Analysis. There were also corroborations with "Deception Indicated" results on Polygraph Examination and "Presence of Experiential Knowledge" on BEOS when the tests were conducted on the mimicry artist.

While the current research was conducted with a foundation of more than fifteen years of experience combined in the field of Forensic Psychology and Forensic Physics; and this idea on a small scale with the hypothesizes put forth by the researchers were found to be accepted. However, we need to proceed with caution, for this research as this was only a preliminary study with voice samples by one mimicry artists.

There still needs to be a widespread research conducted focusing not just on mimicked voices; but also on real life case data wherein Audio Samples are brought in to the laboratories for audio matching. For these cases, first recommendations can be made for psychological and voice stress analysis may be done on such samples. If and when they do reveal indications for deception, then the investigators can also be recommended to have the subject's Polygraph and BEOS examination conducted. The current study, therefore has multiple implications for the criminal investigation process and forensic evidentiary process, in the current scenario where in there is a high pressure and specialized focus on forensic evidence.

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Acknowledgment
The author(s) appreciates all those who participated in the study and helped to facilitate the research process.

Conflict of Interest
The author(s) declared no conflict of interest.

How to cite this article: Marathe, P.S., Madhusudan, D.P., Kaashika & Nagare, B.J. (2025). Ingressive Psychological Techniques in the Audio Analysis of Mimicry Voice. *International Journal of Indian Psychology*, *13*(2), 2236-2248. DIP:18.01.202.20251302, DOI:10.25215/1302.202