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Research Paper

Revisiting 26/11: A Forensic Voice Analysis of Ajmal Kasab's Confession

Savithri K.K.[1]*, Dr. H. Sylaja[2], Dr. C. Jayan[3]

ABSTRACT

The 26/11 Mumbai terror attack was one of the deadliest incidents in India's history. Ajmal Kasab, the only attacker captured alive, provided crucial details about the attack's planning and execution. This study uses Layered Voice Analysis (LVA) to examine Kasab's voice from publicly available sources. By detecting deception patterns, stress markers, and psychological cues, the research evaluates LVA's effectiveness in forensic investigations related to terrorism. Using a case study approach, the findings offer insights into terrorist psychology and discuss the potential role of LVA in counterterrorism strategies.

Keywords: *Terrorism, Forensic Voice Analysis, Layered Voice Analysis (LVA), Psychological Profiling*

Terrorism is one of the biggest challenges that the world faces, systematic use of violence over a country or a particular group/community to instil fear to achieve specific political objectives by a particular group or a population. Various groups such as political groups, nationalistic movements, and some religious factions have practiced terrorism as a means to achieve their agendas. The term "terrorism" was first used in the 1790s during the French Revolution, when the revolutionary government instilled fear in people and suppressed the opposition. Over a period, its image was altered by considering motivations, doers, religious and political organizations' objectives, etc. Defining terrorism is complex and it is controversial.

In 2008, Mumbai city was attacked by terrorists in a series of coordinates from November 26th to 28th of November. A Pakistan-based Militant group Lashkar-e- Taiba targeted and attacked several spots including the Taj Mahal Palace Hotel, Oberoi Trident Hotel, Nariman House, and the Chhatrapati Shivaji Maharaj Terminus railway station. Ten terrorists were behind the execution of these attacks for Lashkar-e-Taiba. The aftermath of these attacks resulted in the deaths of 174 people consisting of security personnel and foreign nationals. 300 more left injured. Investigations unveiled that these groups got rigorous training and preparation. Later they hijacked an Indian Fishing trawler and travelled to Mumbai by sea from Karachi, Pakistan. Ajmal Kasab was the only alive militant left from this attack.

[1]Research Scholar, Dept. of Psychology, University of Kerala, Kariavattom Campus
[2]Professor & Head, Dept. of Psychology, University of Kerala, Kariavattom Campus
[3]Visiting Professor, Dept. of Psychology, University of Kerala, Kariavattom Campus
*Corresponding Author

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Terrorism always had been a significant challenge for India's Internal security. In 2021, the union territory of Jammu & Kashmir reported 153 terrorist attacks. Resulted in 274 fatalities. The South Asia Terrorism Portal provides a comprehensive picture of terrorism attacks that happened in India, according to them, there were 1,910 incidents of killing, resulting in 1,260 civilian deaths, 573 security personnel fatalities, and 2,260 terrorist/insurgent deaths, totalling 4,121 fatalities. These all happened in 2000. The Global Terrorism Index (GTI) indicates that India has shown improvement in its rankings. The country reported a decrease of 18 deaths from terrorism in 2022-2023, following a decrease of 45 deaths in 2021-2022, and 49 in 2020-2021.

The Ministry of Home Affairs of India formulated the Counterterrorism and Counter Radicalization division to curb terrorism and radicalization. Under the Unlawful Activities (Prevention) Act, of 1967, the division listed all organizations which are identified as terrorist entities. Despite these actions, in 2024, terrorist activities surged in J & K. The Indian government continues to adapt its counter-terrorism strategies to address these evolving threats, focusing on strengthening security infrastructure, enhancing intelligence capabilities, and promoting international cooperation to ensure the safety and security of its citizens.

Horgan (2005) emphasizes that individuals are not born terrorists but are shaped by a combination of personal experiences, social dynamics, and ideological influences. He identifies key stages in the pathway to terrorism: involvement, engagement, and disengagement.

Certain personality traits may predispose individuals to radicalization such as narcissism, authoritarianism, and a propensity for aggression. (Borum,2004)

McCauley and Moskalenko (2008) explore the role of ideology in terrorist behaviour, highlighting that strong ideological commitment can lead to cognitive biases and moral disengagement.

In forensic voice analysis applications in counterterrorism contexts, Layered Voice Analysis is also exercised to screen the suspects. Morrison et al. (2019) examined the reliability and admissibility of forensic voice comparison in legal settings, especially regarding the psychological factors influencing speech. In India, while applying forensic psychological techniques in investigations, constitutional protection is provided to citizens against self-incrimination. In the context of the 26/11 attacks, this research uses a forensic tool called LVA to assess the psychological patterns of Ajmal Kasab such as Speech patterns, Deception indicators, stress level, and verbal responses.

A Brief History of Layered Voice Analysis (LVA)

Layered Voice Analysis (LVA) is a forensic tool designed to measure perpetrators' emotional and psychological states through their vocal parameters during interrogation. It records involuntary changes in voice, like microtremors when the suspect is under stress, cognitive load, or deception. These vocal parameters were analyzed based on the researcher's objectives, and LVA hits upon elicited emotions and potential deceit. This forensic technique pertains to different sectors, such as law enforcement, security, and corporate integrity tests. (Nemesysco. (n.d.))

Harnsberger et al. (2009) evaluated the effectiveness of LVA in detecting stress and deception. Their study involved a controlled setting where participants were subjected to varying levels of stress and instructed to deceive. The findings indicated that LVA's accuracy in distinguishing between truthful and deceptive speech was comparable to chance.

In 2013, Horvath et al. evaluated LVA in police interrogation with lie and truthful detection. LVA performed at 48% accuracy in truthful statements and 25% accuracy in deceptive statements, the study showed. In this study, LVA did not outperform random chance in these conditions.

Voice analysis contains voice signature, speech-to-text, and emotional analysis. Layered Voice Analysis (LVA) is conducting an emotional analysis of the participant. Basically, LVA is not based on any classical theories of psychology or criminology etc. Layered Voice Analysis developed by Amir Liberman in Nemesysco, an Israeli Company. LVA is a technology, that detects to measures emotional and psychological responses by analyzing various vocal parameters such as stress levels, cognitive processes, and emotional reactions elicited from the voice of the participant. The Key elements that the layered voice analyzer detects are

- **Global Stress** means the state of fear or negative arousal when the question is raised. Generally, it is based on the fight or flight syndrome. Usually, this stress is found when the participant raises a problem a flight, or a bad memory. If Global stress is been indicated high then there is a possibility of deception in content or traumatic content. This indicator uses JQ in the raw graph.
- **EMO Stress** is Emotional stress where the emotional content is evoked by the questions related to close friends and family members. EMO is also evoked when there are sexual-oriented questions that excite the subject. High levels of EMO emphasize the indication of deceptive or traumatic content. Strong reaction EMO graph after strong arousal in COG graph points to deception in most cases. In the raw graph, SPJ denotes the EMO stress.
- **COG stress** implies the subject is facing cognitive dissonance which means there is a contradiction between what he is saying and what he is thinking. Simply COG stress is a logical conflict between the mouth and brain, two non-complimentary logical processes. The subject is giving the information which is not sure by that individual. SPJ denotes COG stress in the Raw Graph.
- **Thinking Level** denotes the thinking pattern of an individual from what he/she says. AVJ indicates the thinking level of the subject in the raw value graph.
- **Anticipation Level** designated for the subject's anxiety or fear when they reach to particular question or a phrase. In deceptive subjects' Anticipation level would be pinpointed at certain questions and in deceptive subjects' it will not be seen or will be random.

Raw value graphs of the LVA

SPT	Measures high-frequency ranges, linked with emotional (EMO) levels.
SPJ	Measures low-frequency ranges, tied to cognitive (COG) levels.
JQ	Reflects global stress based on low-frequency uniformity.
AVJ	Average low-frequency range associated with thinking and mental effort.
SOS (SFLC)	Changes in SPJ and SPT in a single sentence. Can indicate fear or

	hesitation (e.g., unwillingness to speak).
LJ (DJQ)	Very low frequency range, connected to visual memory or imagination. High scores may suggest deceptive behaviour.
Fmain	Most significant frequency, linked to concentration, rejection, or tension.
FX	Measures overall spectral contribution; values above 6 indicate potential deception.
FQ	Similar to FX, high values (above 6) may also suggest deception and assess spectrum uniformity.
Fflic (Harmonic)	Measures harmonics uniformity; high scores indicate deception, embarrassment, or internal conflicts (shaky voice).
ANT(Anticipation)	Reflects the subject's expectations and is often linked to deception.
COG. Modulation	Information derived from SPJ to reflect cognitive changes.
FRQ. Modulation	Evaluates all frequency parameters (16 in total).

A Brief History and Evolution of Lie Detection

In India, LVA was first introduced in May 2012 under the "MERI AWAAZ HI PEHCHAAN HAIN" initiative by the Directorate of Forensic Science, Gujarat. Since then, the instrument has been adopted by various government agencies for screening and investigation purposes.

Many cultures developed creative ways to identify deception throughout history. The ancient Chinese used the "cup of rice" method, where suspects held rice in their mouths to detect dryness or wetness. The Bedouins relied on heated swords to force confessions. In India, suspects were floated in water to determine guilt. Other methods included religious rituals or physical torture to extract admissions of wrongdoing. In the 19th century, Angelo Mosso used a plethysmograph to measure emotional responses, and Cesare Lombroso adapted medical instruments to monitor blood pressure and pulse. These tools would become the basis for modern methods of detecting lies.

Lie detection further evolved in the twentieth century. Vittorio Benussi found variations in breathing patterns while humans lie. Dr. William Marston used a systolic blood pressure measure, which led to the progress of polygraphs. The U.S. Army psychologists invented Voice Stress Analysis (VSA) to measure stress in prisoners of war in 1960. The invention of VSA led to the discovery of Layered Voice Analysis (LVA) (Haddad et al, 2011). LVA was first used in Israeli borders to dissect the voice spectrum of suspects. Functional MRI (fMRI) scans and facial expression analysis now have been used to detect physical and emotional changes caused by stress. While no tool can directly detect lies, combining psychological observation with physiological monitoring helps improve lie detection accuracy.

Speaking mechanism of Humans

The process of speaking is one of the most complex body functions. It is closely controlled by the brain, making it sensitive to sensations and thoughts. The basic frequency of a voice changes depending on the position of the speech organs. These changes result in various modulations and harmonics in speech.

When we speak, the brain also controls facial expressions and body gestures. Additionally, it performs "quality control" over the voice to ensure proper speech delivery.

Several factors can influence how sound is produced:

- Physical conditions, such as blockages in the airways.
- External stimuli (visual or physical) trigger internal responses.
- Internal stimuli like sensations, memories, imagination, or expectations lead to reactions.
- These factors can disrupt the synchronization between speech organs, affecting speech fluency.

Speech is controlled by several brain regions the prefrontal cortex, cerebral cortex, amygdala, cerebellum, Broca's area, Wernicke's area, and hippocampus. When the amygdala recognizes a threat, control is transferred to the cerebellum. The amygdala and cerebellum are responsible for survival responses. This can include increased heart rate, blood pressure, and muscle tension, but communication is frequently hampered during times of acute stress. Stress, whether from survival situations or social demands, has an impact on speech. Acute stress can inhibit vocal expression, resulting in brief, unpredictable gaps in speech. The Layered Voice Analysis (LVA) system uses these breaks to calculate stress levels.

It is simpler to fake excitement in a speech than to control genuine excitement. When people are sincerely aroused, it becomes difficult to totally control their voice. LVA measures High-pitched sounds using specific metrics known as "Thorns". Confusion or mental conflict affects the voice and leads to a plateau state. These are difficult to manage by humans and are monitored by LVA using rate and structure metrics. They demonstrate mental effort, reluctance, conflict, and stress.

Objective of Study: Analyze Kasab's confession using Layered Voice Analysis (LVA) to detect stress, deception, and psychological markers.

METHODS

This research employed a case study design to analyze Ajmal Kasab's confessions. *Layered Voice Analysis (LVA) 6.50 – Investigation Focus tool* used to assess stress, deception, and emotional patterns. The case study method enabled the study to understand individual behaviour, emotions, and cognitive processes in high-stress situations.

The primary Data was obtained from the National Investigation Agency's interrogation of Kasab. Ajmal Kasab's interrogation Video was publicly available on Social Media Platforms. This would ensure ethical transparency. The voice of the perpetrator was extracted from the video. The extracted audio was in *.MP3* form and later it was converted to a supported file *WAV* form. There were eight video confessions of Kasab in which clear and unaltered speech samples were selected for Layered Voice Analysis to ensure the accuracy of results. Segments related to operational details, accomplice identification, and discussions of weapons were extracted and marked in LVA for analysis. Speech segments were categorized based on LVA output into high-risk, medium-risk, and truthful categories.

RESULTS AND DISCUSSION

Image 1 shows the automatic result of Layered Voice Analyser conducted on the Ajmal Kasab's voice which indicates that High risk probability in specific questions.

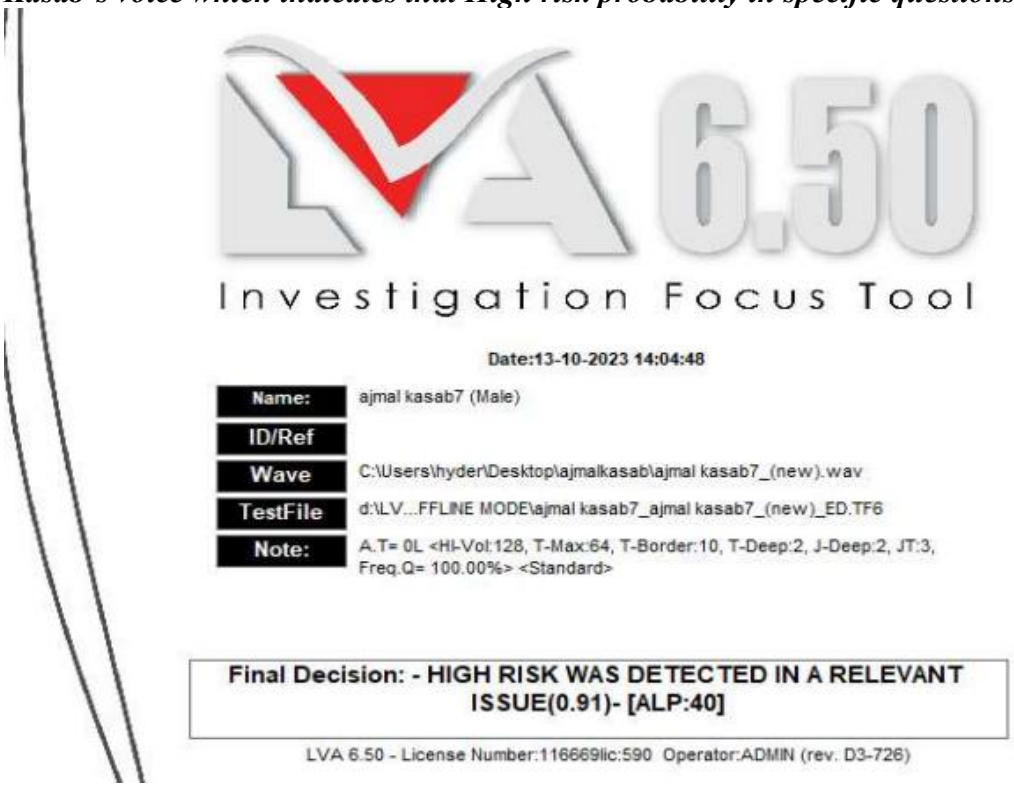

Image 1

1. Emotional and Cognitive State

- Emotional Instability: The analysis revealed fluctuating emotional states across the confession segments. Emotional instability was especially apparent in segments that involved identifying other people, handling weapons, or describing the planning of the attack.
- Cognitive Instability: Minor cognitive reactions were detected indicating Kasab experienced moments of hesitation or confusion during the confession. This could imply difficulty recalling events accurately or intentional deception.

2. Stress Indicators

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>> High Risk and Suspected Segments >>
 *> Inconclusive results for segment No. 5 (Issue:'saade 8 )
 *> Inconclusive results for segment No. 14 (Issue:'udar saaman uthara)
 *> Inconclusive results for segment No. 26 (Issue:)
 *> Inconclusive results for segment No. 30 (Issue:haaa)
 *> Inconclusive results for segment No. 33 (Issue:'me aapko shakali bata sakta huum)
 *> HIGH RISK Result on Segment No. 38 (Issue:'abdurahman ki nishaani me aapko
batavunga)
 *> Inconclusive results for segment No. 51 (Issue:'iss bhai ke tarah he)
 *> Inconclusive results for segment No. 63 (Issue:3 REL.)
 *> Inconclusive results for segment No. 70 (Issue:'ye log na)
 *> Inconclusive results for segment No. 81 (Issue:'haa)
 *> Inconclusive results for segment No. 94 (Issue:)
 *> HIGH RISK Result on Segment No. 101 (Issue:)
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Image 2

- High-Risk Segments: *Segment No. 38 ("abdurahman ki nishaani me aapko batavunga")* and *Segment No. 101 were indicated high-risk with potential deception.*
- Highly Stressed and High-Tension Segments: Multiple segments exhibited signs of elevated stress, particularly when discussing ammunition and roles during the attack.
- Medium Risk: *Segments such as No. 14 ("udar saaman uthara") and No. 30 ("haaa")* were categorized as medium risk, suggesting partial truthfulness or confusion.

3. Truthful Segments

- Voice segments about money transactions and descriptions of certain events (e.g., Segment No. 17: "kyaa (how much paid for taxi by Ismail?)") were showed truthfulness. These segments showed minimal stress and emotional reaction.

4. Inaccuracy and Excitement Detection

- Segments related to amunition showed inaccuracies or excitement markers. Segment No. 8 ("saat mein ammunition tha") and Segment No. 27 ("8 handgrenades") were identified as misleading.
- Excitement was detected in statements about movement during the attack and descriptions of events, potentially indicating an adrenaline-fueled recollection.

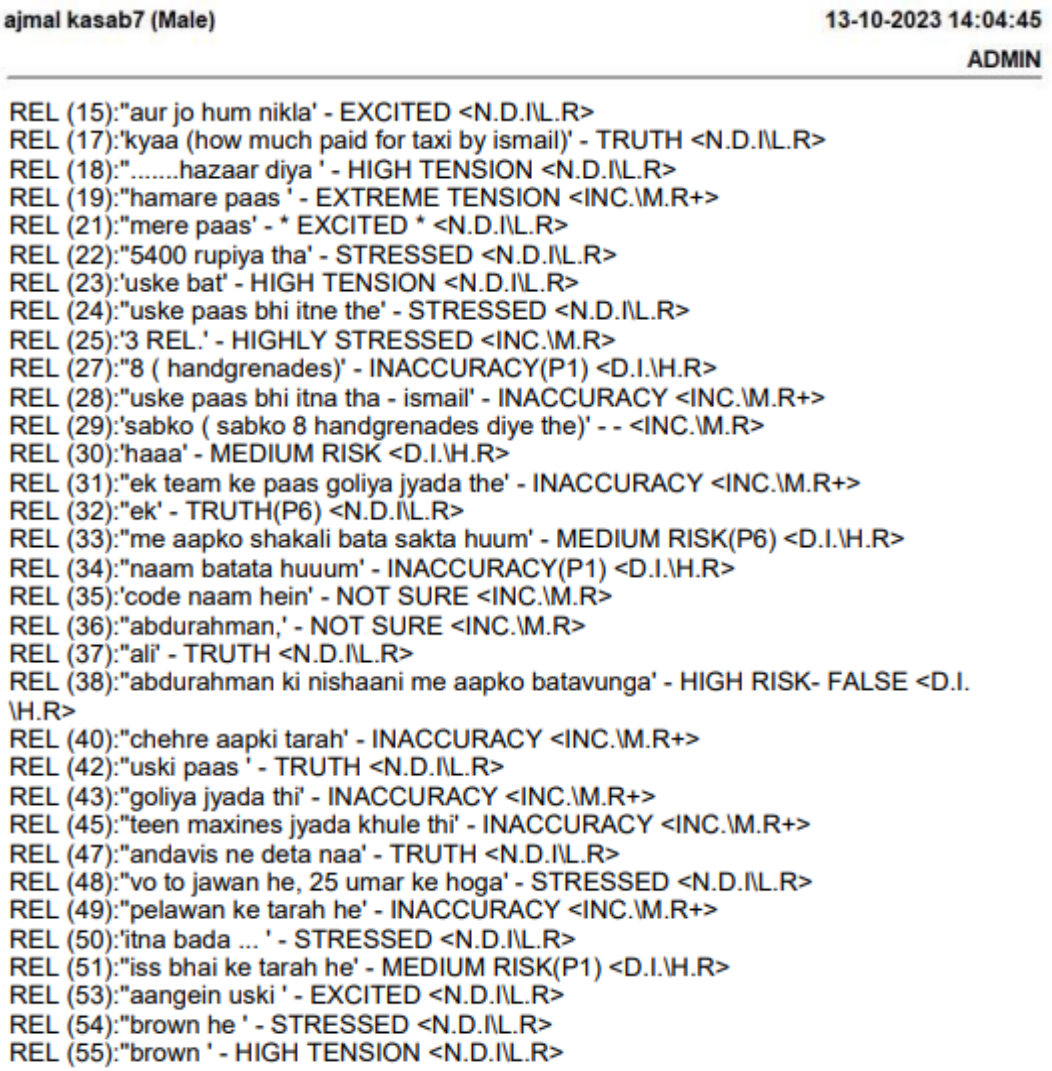

Image3

5. Guilt and Anticipation

- Guilt Indicators: A slight guilt complex was detected in specific segments suggest psychological conflict during certain statements.
- Anticipation: High anticipation levels were observed in segments reflecting Kasab's awareness of significant or incriminating details.

The analysis of Ajmal Kasab's confessions using Layered Voice Analysis (LVA) revealed emotional and cognitive instability in critical segments about operational details, accomplices, and weapons. Cognitive instability indicates memory lapses or intentional attempts to fabricate information. The detection of high-risk and medium-risk segments in the confession emphasizes LVA's ability to mark potentially deceptive behaviour. Statements indicated as high-risk, such as "*abdurahman ki nishaani me aapko batavunga*,"(he will give identification marks of Abdurahman) give focal points for deeper investigation.

Truthful segments identified by LVA that help establish credibility for certain parts of Kasab's confession particularly those related to minor operational details and financial transactions, these truthful statements provide a baseline for evaluating the overall reliability of the confession and can offer corroborative evidence. However, even truthful information be used to manipulate or obscure critical details. Therefore, while LVA plays a valuable role in identifying truthfulness, caution is necessary to avoid over-reliance on the technology for determining overall honesty.

Limitations

One key limitation of Layered Voice Analysis (LVA) is its potential for false positives, as emotional or cognitive reactions may not always stem from deceit. Therefore, LVA has to corroborate with other evidence. Still, it can be used as a screening test. The second key limitation of this research is that it extracted audio recordings from publicly available sources, which affects the sound quality. The 3rd key limitation of LVA is its sensitivity to different languages in multilingual contexts of India. This has to be curated by conducting more research.

Implications

The forensic tool LVA can be used as a screening tool for counterterrorism combat of the country across borders. The tool is capable enough to differentiate between potential deception and stressed speech. Investigators can deep dive into the case and cross-examine the facts. LVA can also be used in psychological profiling to identify the manipulation patterns and emotional states.

CONCLUSION

This study used LVA to examine Kasab's recorded confessions from the 26/11Mumbai terror attacks interrogation. When discussing attack plans, weapons, and associates Kasab showed signs of emotional stress, and Segment 38 and Segment 101 were found to be high-risk and potentially deceptive. Segment 17 was detected as a truthful statement for the answer to how much was paid for the taxi. Segments related to this specific statement are marked as truthful and have minimal emotional stress by LVA. Ammunition details regarding grenades and attacking movements in the 26/11 attacks were found to be in exciting voice patterns. That was a bit exaggerated to mislead the investigating agency by the perpetrator. LVA provides insights into the mental state of Ajmal Kasab and gives clarity about the attack that happened in Mumbai in 2008. However, LVA is not considered

a stand-alone forensic technique. It is used as corroborative evidence to be combined with other forensic psychological tools like Polygraphs and brain Electrical Oscillation Signature Profiling. This research aims to show how layered voice analyzers can be utilized for counterterrorism efforts to screen suspects and restrain them to protect national security.

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

Declaration
I hereby declare that the research work presented in this study, titled *"Revisiting 26/11: Forensic Voice Analysis of Ajmal Kasab's Confessions,"* is my original work. All data collected and analyzed in this study were sourced from publicly available recordings, and no unauthorized sources were used. The analysis was conducted using Layered Voice Analysis (LVA) to assess emotional and cognitive stress markers in Kasab's speech. All findings, interpretations, and conclusions are based on my independent research, and due credit has been given to all referenced works in accordance with academic integrity principles. This study has not been submitted for consideration or publication elsewhere.

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