

## **Voiceprinting in the Age of Artificial Intelligence: From Linguistic Authentication to Linguistic Forgery**

**Nadia Charef**

Abou Bekr Belkaïd University, Tlemcen, Algeria

[sabrineleterature@gmail.com](mailto:sabrineleterature@gmail.com)

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### **Abstract**

This study aims to uncover the impact of generative artificial intelligence on the voiceprint in falsifying vocal and linguistic identity, an issue that has become a pressing challenge in the fields of security, linguistic content production, cinematic production, and banking and financial transactions. It does so by reviewing the concept of the voiceprint and its levels, and by focusing on the most significant technical challenges posed by generative artificial intelligence. The study also addresses the principal methods used in detecting voice forgery and cloning. Methodologically, the study relies on the descriptive approach in collecting and analyzing material related to generative artificial intelligence in the domain of voiceprint cloning. The findings show that the application of artificial intelligence constitutes a technical challenge on its darker side, and confirm the importance of addressing these technical challenges through urgent legislation to control this technological revolution, and through the establishment of regulatory frameworks and methods that protect individuals from digital abuses — particularly those related to the hacking of vocal identity, linguistic forgery, and the production and cloning of voices identical to the intended human voice — while also making use of artificial intelligence technologies and applications, with an emphasis on their positive aspects and the avoidance of their negative effects.

**Keywords:** Voiceprint, Artificial Intelligence, Forensic Linguistics, Linguistic Identity, Linguistic Forgery.

### **1. Introduction**

The human voice is a mirror reflecting identity and the earliest tool of communication that has distinguished humankind throughout history. The voice is no longer merely a means of conveying ideas; in the digital age it has become a unique personal identifying document known as the “voiceprint,” one that carries physical and linguistic characteristics that cannot be identical between any two individuals.

In recent years, a vast technological revolution led by artificial intelligence has thrust the voiceprint into an arena of radical and divergent transformations. On the one hand, these technologies have opened new horizons in linguistic documentation and have contributed to the

preservation of languages threatened with extinction, as well as to the highly precise analysis of vocal data in the service of security systems and criminal justice.

Yet this rapid and accelerating development carries within it a dark and frightening face, embodied in “linguistic forgery,” or what is known as “audio deepfakes.” Software has become capable of cloning any human voice with terrifying accuracy and making it utter words its original owner never spoke. This dangerous shift now threatens cybersecurity, undermines confidence in forensic evidence, and opens the door to fraud as well as political and intellectual disinformation.

On this basis, the present research seeks to highlight the dimensions of the voiceprint under artificial intelligence, and to discuss the extent to which the voice has shifted from a trustworthy tool of linguistic and legal documentation into a systematic digital weapon of forgery and fraud. The research problem therefore centers on the transformation of the human voice from a stable linguistic document and decisive proof of evidence into flexible digital material susceptible to modification and distortion, and is articulated in the following questions:

- How has generative artificial intelligence reshaped the concept of the voiceprint and blurred the boundaries between a speaker’s linguistic identity and a forged identity?
- How has artificial intelligence succeeded in penetrating and simulating the voiceprint (vocal and linguistic forgery)?
- What new computational-linguistic criteria can be relied upon to distinguish an original human identity from one that has been digitally forged?

## **2. The Voiceprint and Linguistic Documentation**

### **2.1 The Concept of the Voiceprint in Linguistics**

The genetic fingerprint is defined as “the genetic structure that indicates the identity of each individual specifically; research and scientific studies have shown that, in practical terms, it is a highly precise means that facilitates the task of forensic medicine, and can be obtained from any human cell — blood, saliva, semen, urine, or otherwise.”<sup>1</sup> God Almighty has also made a precise reference in the Qur’an to the fingerprint using the term “*banan*” (fingertip), saying: “Yea, We are able to put together in perfect order the very tips of his fingers” (Al-Qiyamah, 4). Indeed, in modern science, no two fingerprints are identical or coincide.

As for the voiceprint, it is a vocal identification of a person based on a spectrographic output or similar output; the term has been likened to the “fingerprint,” given the established fact that a person’s voice — in certain respects — is as unique as a fingerprint. Indeed, numerous legal cases have relied on voiceprints as evidence of a speaker’s identity, the voiceprint being treated as forensic evidence on the basis of the theory of forensic individualization, just as with fingerprints. It is well established that every voice has individual characteristics. Omar Musbah affirms this, stating: “The existence of two individuals sharing the same capacity and manner of

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<sup>1</sup>Hossam Al-Ahmad, *Genetic Fingerprinting and Its Evidentiary Value in Criminal Proof and Paternity*, Halabi Legal Publications, Beirut, Lebanon, 2010, p. 20.

articulation through the movement of the tongue, lips, and uvula is virtually impossible to occur, for words are composed of a sequence of sounds emitted by a given person, and this sequence is the result of changes occurring at precise moments in the shape of the mouth, the control of air pulses leaving the larynx, the manner of the various resonating cavities, the rate of airflow from the lungs, the position of the tongue, and other organs of the speech apparatus, all of which give rise to distinct acoustic currents.”<sup>2</sup> It is clear that the human voice is stable and does not change, bearing in mind that the stability of the voiceprint does not mean the same kind of permanence that characterizes fingerprints, which remain fixed from childhood. Rather, what is meant here is the voice’s stability in the adult individual, and its resistance to change unless affected by factors impacting the respiratory or articulatory system.

## **2.2 The Linguistic Levels of the Voiceprint**

The voiceprint is characterized by several linguistic levels, among which we may note the following:

**The Phonetic Level:** This level studies the places of articulation and the qualities of sounds, and the distinctive phonemic units specific to each individual and unique to their voiceprint, in addition to frequency and resonance, as follows:

**Frequency** is measured by the number of vibrations and oscillations produced by the vocal cords per second.<sup>3</sup> The pitch of the voice rises as the vibrations become faster; the faster these vibrations, the finer the sound, and consequently the voice becomes deeper as the number of vibrations per second decreases. Ahmad Mukhtar Omar clarifies this, stating: “The difference between a tuning fork of high pitch and another of low pitch is that the former produces a greater number of vibrations per second.”<sup>4</sup> As for resonance, it is the passage of sound through the speech apparatus, or what is known as the human body’s natural “resonance box,” which includes the pharynx, the throat, the uvula, the nasal cavity, and the oral cavity.<sup>5</sup> Consequently, the size of these cavities and the shape of the bones and jaw (upper and lower) and the skull give each voice its own distinctive timbre that sets it apart from all others.<sup>6</sup> Likewise, the shape and size of the teeth, tongue, and lips affect the tone and quality of the voice, while the length and width of the vocal cords and their manner of vibration all contribute to distinguishing one person’s voice from another’s — even when two people share the same frequency, each will retain a unique manner of articulating sounds. Every one of us is born with a voice unique and different from any other, and, more remarkably, even identical twins each possess a voiceprint

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<sup>2</sup>Omar bin Abd al-Majid Musbah, "The Voiceprint and Its Role in Criminal Evidence," Center for Research and Studies (ed.), *Journal of Security Research*, vol. 21, no. 52, p. 22.

<sup>3</sup>See: Abd al-Rahman Ayyub, *Speech: Its Production and Analysis*, p. 235.

<sup>4</sup>See: Ahmad Mukhtar Omar, *A Study of Linguistic Sound*, p. 31.

<sup>5</sup>Shibl Awda Abdallah al-Lahham, *An Evaluative Study of Linguistic Sound Content in the Arabic Language Curriculum in Light of Required Standards*, supervised by Muhammad Shahada Zaqqut, Palestine, 1431 AH/2010 CE, p. 25.

<sup>6</sup>Muhammad al-Saqqa Eid, "The Fingerprint: A Sign Confirming the Creator's Power," *Al-Jadid al-Misriyya Magazine*, Al-Alukah Network, p. 2.

distinct from the other's. Muhammad al-Saqqa alludes to this, stating: "Despite their being identical in everything — not only in tangible physical terms, but also in shape, height, hair and eye colour, and even in less tangible respects — their voices nevertheless differ."<sup>7</sup>

**The Stylistic and Semantic Level (Semantic Stylistics):** Every individual is distinguished by their own stylistic features — stress and intonation, linguistic habits, preferred sentence structures, verbal mannerisms, lexical repertoire, and manner of word delivery — all of which reflect the speaker's emotional and psychological state, social environment, and educational attainment. These capacities are acquired by the individual over the years, within a psychological and social environment unique to them. Dr. Muhammad al-Ghamdi holds that "the psychological state of the individual while speaking leaves its imprint on the frequency of the two vocal cords located in the larynx, which is what gives rise to the individual's distinctive vocal features."<sup>8</sup> He further confirms that nearly one hundred muscles control the human vocal apparatus, and that these muscles are governed by signals originating in the brain, based on a psychological makeup specific to the individual and shaped by several factors, such as language — with its structures and sentences — dialect, knowledge, manner of speech, and style of interacting with others.<sup>9</sup> The psychological factor thus has a profound influence on vocal characteristics; examples of such factors include feelings of anger, fear, comfort, and so forth, with the articulation of sounds varying according to psychological state. The importance of this factor lies in its role in differentiating voices, since the auditory impression of any vocal modulation is ultimately a matter of the brain's interpretation<sup>10</sup>, together with the role of the brain and neural signals in this process — without overlooking the environment in which the speaker lives, which affects their manner of speech and vocal tone. There is no doubt that each of our experiences with sounds in daily life, and what we are accustomed to hearing in our environment, and what has become familiar and repeated to our ears, differ from person to person, such that we differ markedly in these experiences. Ibrahim Anis points to this, stating: "The people of one environment may differ from those of another environment in such experiences according to differences in language, and according to differences in natural phenomena on the other hand; indeed, even the people of a single environment may differ from one another in these vocal experiences according to the differing circumstances that surround them."<sup>11</sup> This means that the natural environment, with its experiences and everything it encompasses of social and psychological circumstances, language, customs, knowledge, and so forth, governs members of a given environment, who consequently differ from members of their own or of another environment. Ahmad Mukhtar

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<sup>7</sup>Ibid., p. 36.

<sup>8</sup>See: Mansour bin Muhammad al-Ghamdi, "Speaker Recognition through Voice" (journal article), (Voiceprint), p. 25.

<sup>9</sup>See: Mansour bin Muhammad al-Ghamdi, "Speaker Recognition through Voice" (journal article), and Biometrics (Voiceprint), pp. 15–16, and Arabic Phonetics, p. 168.

<sup>10</sup>Ibrahim Anis, *Linguistic Sounds*, Anglo-Egyptian Library, Egypt, 5th ed., 1975, p. 151.

<sup>11</sup>Ibid., p. 150.

Omar offers further clarification, stating: “There is also a technical approach that carries the motto: ‘Where are you from?’ — an approach by means of which the small linguistic region to which the speaker belongs can be identified, potentially narrowing it down to within a radius of ten miles of their birthplace, through their distinctive speech characteristics.”<sup>12</sup>

He also makes an important further point, stating: “When you hear a person speaking, even without seeing them, we can generally identify a number of their characteristics even if they are a stranger to us — such as recognizing their age, sex, temperament, and social or cultural standing.”<sup>13</sup> We may therefore regard linguistic speech as the primary linguistic document and the fundamental building block from which the levels of language are constructed; the spoken is the original form of speech, while the written is merely an attempt to document this auditory trace. It may well be that technological and technical acceleration, on its darker side, has sought to falsify the attribution of linguistic ownership to its rightful owners, and to pirate vocal identity, or the identity of spoken texts.

On this basis, forensic phonetics experts analyze speech samples from an unknown speaker implicated in a crime, or characterize the speaker and enhance the clarity of speech recorded on digital media, and filter speech sounds or background noise in evidentiary recordings. In addition, they analyze patterns of particular language use — such as vocabulary, pronunciation, and dialect — which reveal the speaker’s national, regional, or social background, as well as establishing points of similarity or difference between the vocal recordings of suspects, and thereby determining their psychological or pathological state on the basis of physical vocal characteristics.<sup>14</sup>

On the whole, the voiceprint may be regarded as the code that solves the puzzle of numerous crimes, particularly in advanced societies. But the question that arises is: which is more intelligent — human intelligence or artificial intelligence? Does the human mind fall into the trap of its own inventions, paying the price of its intelligence and its rebellion against human nature?

### **2.3 The Impact of Artificial Intelligence on the Falsification of Vocal and Linguistic Identity**

#### **Generative Artificial Intelligence**

Generative artificial intelligence refers to systems and devices that simulate human intelligence in order to perform tasks, and which possess the capacity to improve their own performance based on the information they gather; artificial intelligence manifests itself in numerous different forms.<sup>15</sup>

Generative AI (Gen AI) is a revolutionary and innovative technology, and forms part of the broader field of artificial intelligence; it is used to create new things without the need to process

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<sup>12</sup>Ahmad Mukhtar Omar, I, *Language and Society*, Dar al-Kutub, Egypt, 1st ed., 1422 AH/2002 CE, pp. 168–169.

<sup>13</sup>See: Ahmad Mukhtar Omar, op. cit., p. 171.

<sup>14</sup>See: Adel al-Sheikh Abdallah Ahmad, *Introduction to Forensic Linguistics*, Lejak CV, 2021, p. 33.

<sup>15</sup>Amira Nasser al-Qahtani, "Saudi Female University Students' Perceptions toward the Use of Generative AI Applications (ChatGPT) in Higher Education," *Educational Journal*, vol. 1, no. 131, March 2025, p. 9.

and analyze previously available data. Whereas traditional artificial intelligence deals with tasks such as classification, prediction, and clustering, generative artificial intelligence focuses on producing new content, such as images, music, and linguistic texts, and on creating innovative virtual worlds.<sup>16</sup> This is material that may differ from what humans themselves produce. This technology relies on deep and advanced architectures such as Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs), which enable it to produce unique outputs based on prior training data, through which it can generate new, realistic data resembling the original data. Generative artificial intelligence has revolutionized numerous fields, including art, education, and text generation, owing to its capacity to understand complex linguistic and contextual patterns using deep learning and unsupervised learning techniques.<sup>17</sup>

Generative artificial intelligence is the technology of deploying artificial intelligence to create new and innovative content, its mechanisms resting on Generative Adversarial Networks, which consist of two networks: one generative, the other discriminative. The generative network works to create data, while the discriminative network works to determine how closely this data resembles real data.<sup>18</sup> It is employed in a range of applications and use cases in which the user interacts with a generative machine to obtain a response from text entered into a natural conversational interface; a language model can generate text, images, video clips, and the full range of representational symbols of human thought, with generative artificial intelligence being trained using data collected from web pages, social media conversations, and other online media.<sup>19</sup> Among the most prominent examples of generative artificial intelligence are intelligent conversational applications and deepfake technologies, which are used to regenerate people's faces in video clips, allowing speech, audio segments, and movements to be recreated naturally.<sup>20</sup> Generative AI models understand emotions and vocal tone by analyzing acoustic frequencies and contextually classifying words using deep-learning algorithms, doing so by grasping word meanings and detecting vocabulary indicative of emotion (happy, angry, afraid, upset, etc.), and by understanding context through sentence-structure analysis, as well as by analyzing vocal tone — such as a rise in frequency during anger, or a drop during comfort or fear — thereby merging spoken words with the physical characteristics of the voice simultaneously, which gives these models a high capacity to predict the speaker's emotional and affective state

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<sup>16</sup>Abinaya M. Vadivu, "Future Directions and Open Problems in Generative AI," chapter 10 in *Generative AI and LLMs*, Boston, 2024, p. 139.

<sup>17</sup>Ashwini A. Manoj, Prabhakar S., Seifedine Kadry, *Exploring the Applications of Generative AI*, Berlin, 2024, pp. 154–155.

<sup>18</sup>Goodfellow I., Pouget-Abadie J., Mirza M., Xu B., Warde-Farley D., Ozair S., et al., "Generative Adversarial Nets," 2014, p. 27.

<sup>19</sup>Mohamed Ismail, *Guidance for Generative AI in Education and Research*, UNESCO, France, 2024, p. 8.

<sup>20</sup>See: Mohamed Ismail, op. cit.

with an accuracy approaching that of humans. This process relies on two principal tracks: text analysis and audio-signal analysis.<sup>21</sup>

The matter has grown more difficult with the tremendous advance of artificial intelligence and the spread of its applications and uses, particularly in the field of voice identification and verification, which calls for careful and focused attention in order to avoid forgery, fraud, cybercrime, scams, and the appropriation of others' funds — with particular reference to religious and national identity. The darker side of artificial intelligence has, with striking simplicity and ease, made it possible to alter sentences through reordering, deletion, and addition with exceptional skill, along with manipulation, deception, and montage operations, among others.<sup>22</sup> To cite but one example among many, the religious domain has been noticeably affected by artificial intelligence, with videos appearing of preachers and unofficial influencers acting as programmed alternative authorities, speaking on jurisprudence and religious matters, analyzing and interpreting social-religious issues that bear no relation to what is stated in the Qur'an and the Sunna.<sup>23</sup> Those knowledgeable in these matters note that such videos carry mistaken ideas concealed behind the face of a preacher or a professor of religious law, seeking to gain credibility through vocal and linguistic forgery, and contributing to the spread of harmful cultures led by artificial intelligence, with the Muslim — regardless of age or geographic affiliation — as the victim. The same holds true for the media, where artificial intelligence affects vocal identity by standardizing voices across broadcasting platforms, using familiar vocal tones to capture rapid attention while marginalizing local voices, and by disseminating machine-generated voices in podcasts and media that depart from ordinary human identity features, thereby undermining linguistic stability, enabling impersonation, and misleading public opinion.<sup>24</sup>

Delving further into the matter, we find that linguistic and vocal forgery particularly affects the Arabic language. Dr. Belkhiati Lounis has published an article in which he states: "Artificial intelligence poses a genuine challenge to the identity of research and to cultural and scientific awareness within the humanities across their various disciplines, as it affects the researcher's critical and creative thinking skills and may even eliminate their role altogether. This has given rise to what is called 'digital language,' characterized by lexical, structural, and pragmatic features that differ in many respects from traditional standard language, and that is replete with

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<sup>21</sup>Victoria Chen, *The Language of Memes: Semiotics and Pragmatics in Digital Culture*, Journal of New Media Studies, 2015, p. 117.

<sup>22</sup>Mohamed Hattahet, "The Voiceprint: Field of Application," Journal of Phonetics, vol. 21, no. 2, Jumada al-Akhira 1447 AH/December 2025, p. 129.

<sup>23</sup>Taher Mohamed Mohamed Amine, "Arab Platforms Resistant to Algorithms and Their Role in Confronting Algorithmic and Identity Hacking: A Case Study of Al Jazeera Channel's Website," Journal of Digital Media Research, Faculty of Media and Communication, Suez University, no. 11, April–June 2026, p. 1131.

<sup>24</sup>Lamis al-Wazzan, "The Impact of AI Voice in Podcast Programs and University Youth Attitudes Toward Them (Within the Framework of Diffusion of Innovation Theory and Complexity Theory as an Intellectual Approach)," Arab Journal of Digital Communication and Media Research, vol. 2, no. 8, July–December 2025, p. 184.

cognitive, grammatical, and morphological errors, with no identifiable source to which it may be traced.”<sup>25</sup>

As for the criminal domain, artificial intelligence has opened a dangerous door to the falsification and precise cloning of human voices, threatening the credibility of forensic evidence and security systems. This may be summarized as follows:

**Voice Cloning:** Generative AI models can, through extremely short voice samples, analyze the unique characteristics of any individual and convert any written text into spoken speech that appears entirely identical to their real voice, complete with emotional dimensions and natural breathing patterns.<sup>26</sup>

**Facilitating Fraud:** Audio deepfake techniques have been used to simulate the voices of relatives, company executives, or political figures<sup>27</sup>, in order to carry out financial scams and security breaches.

**Undermining the Reliability of Forensic Evidence:** It has become difficult for security systems and courts to rely on voice alone in audio recordings as decisive proof of guilt or innocence without subjecting it to a technological examination capable of detecting digital manipulation.<sup>28</sup>

### **3. Methods Used to Detect AI-Based Forgery**

Detecting AI-generated voice is a complex technical challenge, since the very purpose of voice cloning is to produce speech indistinguishable from a human voice. Traditional methods, such as simple voice recognition matched against voiceprints, are often insufficient, since the cloned voice will match the target’s voiceprint; what is required instead is “liveness detection” for the voice<sup>29</sup>, that is, verifying that the voice originates from a living, present human being rather than from a recording or an AI-generated clone.

Advanced detection systems employ multiple methods, one principal technique being the analysis of subtle vocal anomalies that are often present in synthetic speech, even if imperceptible to the human ear — these being inconsistencies in intonation, unnatural pauses, or specific spectral patterns that deviate from natural human articulation.<sup>30</sup> Machine-learning models are trained on a massive dataset of real and synthetic voices in order to identify these subtle vocal inconsistencies.

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<sup>25</sup>Belkhiati El-Hadj Lounis, "Digital Transformation and Its Impact on the Structure and Functions of Linguistic Discourse," *Al-Hikma Journal for Philosophical Studies*, University of Tissemsilt, Algeria, vol. 14, no. 2, 2026, p. 336.

<sup>26</sup>Abdelkarim Abdelkader Abdallah Aqilan, "Linguistic Expression in Artificial Intelligence: Arabic as a Model," *Al-Qasimia University Journal of Arabic Language and Literature*, United Arab Emirates, vol. 3, no. 2, Jumada al-Akhira 1446 AH/December 2024, p. 180.

<sup>27</sup>Hassanein al-Muhammadi Bawadi, *Criminal Proof: Fingerprints and Voiceprints*, Munsha'at al-Ma'arif, Alexandria, 2005, p. 970.

<sup>28</sup>See: Mohamed Hattahet, *op. cit.*, p. 130.

<sup>29</sup>See: Iman Mohamed Mohamed Qasim, "The Use of Artificial Intelligence in Speaker Identification in Arabic: An Overview of Future Foundations," *Middle East Research Journal*, vol. 13, no. 115, Faculty of Arts, Alexandria University, September 2025, p. 22.

<sup>30</sup>See: *Ibid.*, p. 24.

Analysis of acoustic frequencies and detection of the minute differences and synthetic sound waves that the human ear cannot perceive.

**Breathing and Biological Signatures:** Experts search for biological evidence of humanness in the voice, such as natural breathing intervals and the virtual lip movement appropriate to the articulation of sounds.<sup>31</sup>

**Detection of Code-Switching:** This involves training modern models to detect forgery in sentences that combine more than one language (Modern Standard Arabic and colloquial dialects, or Arabic and English together) with high accuracy.<sup>32</sup>

Detection of fake news by comparing claims made in texts against large databases and reliable sources for instant fact-checking.

Experts and researchers in algorithmic analysis also rely on detecting machine-generated texts, such as those produced by ChatGPT, by measuring the degree of randomness in a text: human-authored texts tend to be more varied and less predictable compared with machine-generated texts, with greater variation in sentence length and structure, since human writing is characterized by diversity, whereas artificial intelligence tends toward continuous monotony and repetitiveness.<sup>33</sup>

Examining the distinctive characteristics of a particular writer's style, under what is called the "stylistic fingerprint" (preferred words, breathing patterns accompanying word articulation, and emotional state), in order to detect fraudulent digital impersonation.<sup>34</sup>

## **Conclusion**

Artificial intelligence is a scientific technology focused on developing systems capable of simulating human capacities such as learning, thinking, decision-making, and problem-solving. It has passed through several stages in its development, and now encompasses multiple branches such as machine learning, deep learning, and computer vision.

Artificial intelligence has two principal facets: a bright side, used to perform specific and varied tasks such as the systems used in medical diagnosis, autonomous vehicle driving, or facilitating a difficult task in business management; and a darker side, which aims to develop systems capable of simulating human mental capacities using generative and simulation algorithms, thereby creating opportunities for fraud and for vocal and linguistic forgery to spread across numerous domains. This has given artificial intelligence a clear impact on the voiceprint in particular, in two principal areas — the criminal and the educational — and on the criminal cases arising from them.

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<sup>31</sup>See: Ibid., p. 31.

<sup>32</sup>See: Ibid., p. 28.

<sup>33</sup>Mohamed El-Sayed Suleiman Ahmad Ashraf, "Research in the Humanities Between Identity and Precipice in the Age of Artificial Intelligence," vol. 7, no. 1, Al-Baida University Journal, Proceedings of the Fifth Scientific Conference, February 2025, p. 754.

<sup>34</sup>See: Iman Mohamed Qasim, op. cit., p. 32.

On the whole, it may be said that artificial intelligence offers numerous possibilities for advancing scientific progress, but its success is contingent upon addressing the unique vocal, linguistic, and stylistic challenges it poses.

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