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Artificial intelligence language processing issues: language and communication-based perspectives

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ABSTRACT

Despite remarkable advancements in natural language processing (NLP), artificial intelligence (AI) models struggle to replicate the intricacies of human communication. The article identifies four critical dimensions of these challenges: linguistic nuance, contextual communication, linguistic diversity, and ethical implications. Employing a qualitative methodology, the study integrates insights from an extensive literature review, case studies of prominent AI systems (e.g., chat generative pre-trained transformer 4 (ChatGPT-4), Google Translate, and Siri), and expert interviews. Findings reveal that AI systems often misinterpret ambiguity, idiomatic expressions, and emotional undertones due to a lack of semantic understanding. Additionally, limited contextual awareness and underrepresentation of low-resource languages hinder the inclusivity and effectiveness of these technologies. Ethical concerns, including bias and the potential misuse of AI-generated content, further complicate their deployment in real-world applications. The discussion emphasizes the need for interdisciplinary approaches to address these challenges, combining technological innovation with linguistic and cultural insights. Recommendations include expanding training datasets to include diverse languages, integrating multimodal capabilities to improve contextual understanding, and implementing transparent, ethically guided practices. By addressing these limitations, AI systems can move closer to replicating human-like communication while fostering inclusivity and ethical accountability. This study underscores the critical role of collaborative and holistic strategies in advancing AI language processing technologies.

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1. INTRODUCTION

In recent years, artificial intelligence (AI) has made significant strides in revolutionizing numerous fields, with one of the most transformative advancements being in language processing. AI-driven systems have become adept at understanding, interpreting, and generating human language, enabling applications ranging from chatbots to advanced translation tools and content creation. However, AI language processing remains a highly complex and fraught endeavor despite the breakthroughs. The challenges inherent in making machines understand and communicate effectively in natural language remain significant. These challenges are not only technical but also profoundly rooted in human language and communication itself. The fundamental issue in AI language processing lies in the disparity between human language and machine

understanding [1]–[3]. Human language is inherently rich, ambiguous, and nuanced, making it challenging for machines to accurately grasp meaning in all its contexts. Words and phrases often carry multiple interpretations depending on their use, cultural context, and the subtleties of tone or emotion. For AI systems to truly excel at language processing, they must navigate these intricacies in a way that reflects the complexity of human communication. Nevertheless, despite significant advancements, AI still struggles to capture the full depth of human language, particularly in understanding figurative speech, irony, sarcasm, and emotional undertones [4]–[6]. While vital for nuanced communication, these elements are often elusive for AI models, which typically rely on statistical patterns and algorithms to interpret language.

Moreover, communication goes beyond the mere transfer of words [7]; it encompasses non-verbal cues, context, and shared experiences. Human communication is profoundly contextual and influenced by social, cultural, and individual factors. It involves more than exchanging information-building relationships, expressing emotions, and navigating complex social dynamics. For AI to mimic these aspects of communication, it must integrate a deeper understanding of human psychology and social interaction, which presents a significant hurdle. Many AI systems, even the most advanced ones, cannot recognize and respond to the subtleties of human intent and emotion, leading to misunderstandings or robotic interactions that feel unnatural to users.

Another issue in AI language processing stems from the challenge of linguistic diversity [8]. Thousands of languages are spoken worldwide, each with structure, idioms, and cultural references. While AI has made significant progress in supporting major languages, it struggles with less commonly spoken languages and dialects, often leading to inaccurate translations or poor performance. This linguistic diversity issue further complicates the development of AI systems that are genuinely universally applicable. The reliance on large datasets in training models means that if a language or dialect is underrepresented in the data, the AI's ability to process it effectively diminishes, creating gaps in understanding and communication.

From a language perspective, there are additional barriers related to syntax and semantics [9]. The relationship between words and their meanings is not always straightforward, and the same word can have multiple meanings depending on its context. For instance, homonyms, polysemy, and context-dependent word meanings pose significant challenges for AI. A word like 'bark' can mean the outer covering of a tree or the sound a dog makes, and an AI must rely on the surrounding context to infer which meaning is intended. This becomes even more complex in more convoluted structures, such as metaphors or idiomatic expressions, where AI's direct translation or interpretation can lead to a failure in understanding.

Furthermore, while language models such as generative pre-trained transformer (GPT)-3 and GPT-4 have made impressive strides, their reliance on large amounts of text data for training has exposed a fundamental limitation [10]. These models can process vast amounts of information but are still limited in their understanding of how language works in the real world. They often generate grammatically correct sentences but may fail to engage in coherent, contextually appropriate conversation. This is due to a lack of proper comprehension, as AI models do not 'understand' language like humans do. Instead, they predict the most likely next word or phrase based on the input provided, which can lead to responses that seem out of place or disconnected from the user's intent.

Another critical consideration is the ethical and social implications of AI language processing. As AI continues to shape how humans interact with technology, concerns regarding bias and fairness have surfaced. Many AI systems inherit biases from the data they are trained on, leading to skewed or discriminatory outcomes in areas such as hiring, law enforcement, and customer service. Additionally, the potential for AI to be used in manipulating language for disinformation, propaganda, or other malicious purposes is a significant risk. As AI systems become more proficient at generating convincing text, distinguishing between genuine communication and AI-generated content will become increasingly challenging, creating new societal dilemmas that must be addressed.

This article explores these issues from a language and communication-based perspective, examining how AI language processing works, its challenges, and its implications for technology and society. By probing into the complexities of human language, the limitations of current AI models, and the broader social impacts of these technologies, it aims to provide a comprehensive understanding of the current state and future directions of AI language processing. This exploration considers the gap between machine-generated language and the richness of human communication and how AI might be improved to bridge this divide.

2. LITERATURE REVIEW

AI language processing has evolved rapidly, driven by advances in natural language processing (NLP) and machine learning (ML). Researchers and practitioners have sought to develop systems that can process, understand, and generate human language with increasing sophistication. However, the literature reveals significant unresolved challenges stemming from the inherent complexities of language and

communication. This review examines foundational theories, key advancements, and persistent challenges, with a focus on nuances of language, communication dynamics, and socio-ethical concerns. The development of AI systems capable of handling language draws heavily from linguistic theories. Chomsky's theory of generative grammar emphasizes the rule-based structures underlying human language, forming the foundation for early computational approaches to NLP. These systems, however, struggled with ambiguity and the richness of natural language [11]. Later, the emergence of statistical methods and probabilistic models, such as hidden Markov models (HMMs) and conditional random fields (CRFs), marked a shift toward data-driven approaches, enabling machines to process text based on patterns rather than explicit rules. Deep learning models like recurrent neural networks (RNNs) and transformers have since revolutionized the field. Nadeem [12] introduced the transformer architecture, the backbone of GPT-3 and bidirectional encoder representations from transformers (BERT) models, enabling parallelized processing and contextual understanding of language sequences. While these systems exhibit remarkable fluency, their reliance on large-scale training datasets has raised concerns about their ability to grasp deeper semantic and contextual meanings [13]. A recurring theme in the literature is AI's struggle with language nuances. Human language is inherently polysemous, with words and phrases often carrying multiple meanings. Studies highlight that AI models can identify statistical relationships between words but lack proper semantic understanding. For example, idiomatic expressions like 'kick the bucket' pose significant challenges, as models tend to interpret them literally unless explicitly trained on similar data [14]. Irony, sarcasm, and humor are other areas where AI performance falls short. These forms of communication often rely on tone, cultural knowledge, and shared context, which are difficult to encode in computational models. Amam *et al.* [15] underscores the need to integrate affective computing and multimodal data to capture such nuances better. However, progress remains limited, with AI often producing responses that appear robotic or contextually inappropriate. Human communication extends beyond language, involving non-verbal cues, shared experiences, and cultural contexts. Pragmatics, a subfield of linguistics, explores how meaning is derived not just from words but also from context. Sperber and Wilson's [16] relevance theory emphasizes the role of inference in communication, an aspect that AI systems currently struggle to replicate.AI language processing models often fail to adapt to social and cultural variations, leading to miscommunication or bias. For example, Hutson and Ceballos [17] shows how biases in training data lead to outputs that reinforce stereotypes or exclude minority voices. Addressing this issue requires more diverse datasets and models capable of dynamic adaptation to different cultural and social norms.

Another critical challenge in the literature is the underrepresentation of many languages and dialects in AI systems. English and other widely spoken languages dominate NLP research, leaving low-resource languages underrepresented. Budnarowski *et al.* [18] highlights the disparities in AI performance across languages, emphasizing the need for equitable inclusion in dataset curation and model development. Initiatives like transfer learning and multilingual models, such as multilingual bidirectional encoder representations from transformers (mBERT) and cross-lingual language model-robustly optimized BERT pretraining approach (XLM-R), aim to address this gap, but they still fall short of effectively serving lesser-known languages [19]. The literature also explores the ethical and societal concerns surrounding AI language processing. Tan and Chong [20] cautions against the 'parrot-like' nature of large language models, which generate outputs without understanding and risk perpetuating misinformation. Concerns about bias, fairness, and manipulation have grown as AI becomes increasingly integrated into hiring, customer service, and law enforcement decision-making. Disinformation and the misuse of AI to generate persuasive but false content are other pressing issues. Researchers such as [21] have demonstrated how models like generating articles by digesting open-domain news events and reports (GROVER) can create compelling fake news articles, raising questions about accountability and regulation. These risks necessitate a multidisciplinary approach to ensure AI technologies align with ethical standards and societal values.

While significant advancements have been made in AI language processing, the literature reveals persistent gaps in capturing linguistic nuance, understanding contextual communication, and addressing linguistic diversity. Moreover, the ethical dimensions of AI language use require urgent attention. Future research should prioritize developing models that integrate multimodal data, incorporate a broader range of languages, and address socio-ethical concerns through transparency and accountability frameworks. By addressing these gaps, AI can move closer to achieving a more human-like understanding and generation of language. This review provides a foundation for the article's exploration of AI language processing issues, emphasizing the interplay between linguistic complexity, communication dynamics, and the societal impact of these technologies.

3. METHOD

This study employs a qualitative, interdisciplinary approach to analyze challenges in AI language processing from a linguistic and communication perspective. The methodology comprises three key

components: literature analysis, case study evaluation, and expert interviews. By integrating insights from linguistics, communication theory, and computer science, this study seeks to provide a comprehensive understanding of the multifaceted challenges AI systems face in processing human language.

3.1. Literature analysis

The first step involved an extensive review of scholarly works, technical reports, and case studies related to AI language processing. Peer-reviewed articles from leading linguistics, computational linguistics, and AI journals were prioritized. Key areas of focus included:

- Theoretical underpinnings of language models, including syntax, semantics, and pragmatics [22], [23].
- Advances in NLP technologies, such as neural networks and transformer-based models.
- Challenges in handling linguistic diversity, nuance, and context.
- Ethical implications of AI-driven communication tools.

Sources were selected from academic databases such as PubMed, IEEE Xplore, and Google Scholar using keywords such as "AI language processing," "communication challenges in AI," and "linguistic bias in NLP." This phase aimed to establish a theoretical framework for analyzing the limitations of current AI systems and identifying gaps in existing research.

3.2. Case study evaluation

The study analyzed practical examples of AI language processing systems to contextualize theoretical insights. These case studies were selected for their prominence and relevance to the discussed challenges. Examples included:

- Language generation models: systems like OpenAI's GPT series and Google's BERT highlight achievements and limitations in handling nuanced language.
- Machine translation tools: applications such as Google Translate and DeepL showcase issues in cross-linguistic processing, especially for low-resource languages.
- Conversational agents: chatbots like Amazon Alexa and Apple Siri provide real-world examples of how AI handles context, intent, and conversational flow.

Each case study was analyzed for performance metrics, user interaction feedback, and documented limitations. Particular attention was given to instances in which these systems failed to capture language nuance, misinterpreted cultural or social context, or exhibited bias. This evaluation aimed to link theoretical gaps with real-world consequences.

3.3. Expert interviews

The study included semi-structured interviews with experts from diverse fields, including computational linguistics, AI development, and communication studies. Participants were selected based on their academic contributions and professional experience in AI language processing. The 15 interviewees are from 11 countries (Kuwait, Jordan, Malaysia, Australia, New Zealand, the US, Canada, the UK, Spain, Macedonia, and Russia) and work as university assistants'/associate professors or full professors. The interviews aimed to gather qualitative insights on:

- Perceived strengths and limitations of current AI systems.
- Future directions for improving language and communication understanding in AI.
- Ethical concerns and strategies for mitigating bias and misuse.

Interview questions were designed to address the intersections of technology, linguistics, and societal impact. Responses were transcribed and analyzed thematically to extract common patterns and unique perspectives.

4. DATA ANALYSIS

The data analysis for this study was carried out in three phases: synthesizing findings from the literature review, evaluating insights from case studies, and thematically analyzing expert interviews. These data sources provided a multifaceted understanding of AI systems' challenges in language processing, particularly from linguistic and communication-based perspectives. Given the study's focus on ethical challenges in AI language processing, careful attention was paid to the ethical handling of data and expert opinions. Interview participants were informed of the study's purpose and provided consent for their responses to be included. Additionally, all case study evaluations relied on publicly available data to ensure transparency and compliance with intellectual property rights. This methodology combines theoretical insights, practical evaluations, and expert opinions to explore AI language processing issues holistically. It highlights both current limitations and pathways for improvement.

4.1. Synthesis of literature findings

The literature review revealed recurring challenges in AI language processing, which were organized into four primary dimensions for analysis (see Table 1). Table 1 synthesizes the core challenges in AI language processing as identified in the literature and organizes them into four interrelated dimensions: linguistic nuance, contextual communication, linguistic diversity, and ethical implications. Table 1 shows that AI systems consistently struggle with linguistic nuance because human language is inherently ambiguous and figurative, relying on idioms, irony, and sarcasm that require semantic and pragmatic inference rather than surface-level pattern recognition. It further highlights limitations in contextual communication, where AI models demonstrate strong syntactic competence but weak pragmatic awareness, often misinterpreting user intent when contextual cues are implicit or incomplete. Table 1 also underscores linguistic diversity as a structural challenge, showing how the dominance of high-resource languages in training data marginalizes low-resource languages and dialects, thereby reducing accuracy and inclusivity. Finally, the ethical dimension captures concerns about bias and discrimination embedded in training datasets, which can lead to socially harmful outputs in real-world applications. Taken together, Table 1 provides a concise conceptual framework that explains why current AI language systems, despite their technical sophistication, fall short of human-like communication and why addressing these challenges requires simultaneous linguistic, technological, and ethical interventions.

Table 1. AI language processing challenges-Literature-based findings

Challenges	Literature-based findings
Linguistic nuance	Ambiguity, idiomatic expressions, and figurative language characterize human language. The review found that AI models struggle to interpret these aspects accurately (i.e., [24]–[28]. For instance, idioms like 'spill the beans' often lead to literal interpretations by AI systems unless explicitly trained on idiomatic datasets. Similarly, sarcasm and irony, which depend on tone and context, remain largely inaccessible to most AI models [29], [30].
Contextual communication	The literature underscored that AI models excel at syntactic analysis but struggle with pragmatics- how meaning is derived from context [31]–[35]. Research has shown that AI models often misinterpret user intent when sufficient contextual cues are unavailable, leading to irrelevant or robotic responses [16]. This gap in contextual understanding is especially pronounced in conversational agents like chatbots.
Linguistic diversity	Underrepresentation of less commonly spoken languages and dialects in training datasets has emerged as a critical issue. Studies highlighted how this disparity leads to errors in translation, sentiment analysis, and conversational accuracy for these languages [18], [19]. Models trained on predominantly English datasets often fail to generalize effectively to other linguistic contexts [36]–[40].
Ethical implications	AI's susceptibility to bias, stemming from biased training data, poses significant ethical concerns. The literature identified examples where biased outputs reinforced stereotypes or produced discriminatory results, particularly in applications like hiring or customer service chatbots [41]–[44].

4.2. Case study evaluation

Each case study was analyzed based on performance metrics, user interaction feedback, and documented limitations. The findings were categorized under the four dimensions identified earlier (see Table 2). Table 2 presents a comparative overview of key AI language processing platforms and illustrates how theoretical challenges identified in the literature materialize in real-world applications. Table 2demonstrates that language generation models such as GPT-3 and BERT achieve high levels of surface fluency and grammatical accuracy, yet frequently lack grounded semantic understanding, resulting in outputs that may appear coherent but are factually incorrect or conceptually inconsistent. In the case of machine translation tools such as Google Translate and DeepL, the findings show strong performance in high-resource languages. At the same time, significant limitations persist for low-resource languages, particularly in handling culturally embedded expressions and idiomatic meanings. Similarly, conversational agents such as Alexa and Siri perform efficiently when responding to explicit, straightforward commands but struggle with ambiguous, context-dependent, or personalized requests, revealing weaknesses in pragmatic and contextual interpretation. Overall, Table 2 empirically reinforces the earlier literature-based challenges by showing that deficiencies in nuance, context handling, and linguistic diversity are not merely theoretical concerns but have tangible consequences for user interaction and communication effectiveness across widely deployed AI systems. The case studies corroborated the literature findings, particularly regarding the limitations in handling nuance, context, and diversity. They also illustrated how these limitations manifest in real-world applications, leading to user frustration or miscommunication.

Table 2. AI language processing platforms- case study findings

AI processing platforms	Case study-based findings
Language generation models (GPT-3 and BERT)	These systems displayed impressive fluency but showed limitations in semantic understanding. GPT-3, for example, was prone to generating plausible but incorrect or nonsensical answers, demonstrating a lack of 'grounded understanding' [13].
Machine translation tools (Google Translate and DeepL)	Machine translation systems performed well for high-resource languages but exhibited substantial errors for low-resource languages. These errors often included mistranslations of culturally specific idioms or phrases, highlighting the challenge of linguistic diversity.
Conversational agents (Alexa and Siri)	These systems performed effectively for direct queries but often failed to interpret nuanced or context-dependent requests. For instance, conversational agents struggled with resolving ambiguous instructions like 'play my favorite song' when context was not explicitly provided.

4.3. Thematic analysis of expert interviews

Expert interviews provided qualitative insights that enriched the findings from the literature and case studies. The thematic analysis identified the following key themes (see Table 3). Table 3 summarizes the thematic insights derived from expert interviews and provides an expert-driven perspective on the current and future limitations of AI language processing systems. Table 3 shows strong consensus among specialists that contemporary AI models, particularly transformer-based architectures, remain fundamentally probabilistic rather than genuinely interpretable, which constrains their ability to engage in complex, human-like communication.

Experts emphasize that limitations in contextual understanding stem from AI's reliance on text-only inputs, leading to calls for multimodal integration that incorporates visual, auditory, and paralinguistic cues to enhance the interpretation of intent, emotion, and sarcasm. Linguistic equity emerges as a critical concern, with interviewees highlighting the systemic marginalization of low-resource languages and advocating collaborative, community-driven data collection to improve representational balance. Finally, Table 3 foregrounds ethical and regulatory challenges, noting expert apprehension about biased outputs, accountability, and the erosion of trust as AI-generated content becomes increasingly indistinguishable from human communication. Collectively, Table 3 reinforces and extends the findings from the literature and case studies by demonstrating that experts widely recognize technical, linguistic, and ethical challenges that must be addressed through interdisciplinary and ethically guided AI development.

The combined findings from the literature review, case studies, and interviews were mapped to the four analysis dimensions. The comparison revealed significant alignment across all sources, particularly regarding AI's limitations in interpreting nuance and context. Additionally, the importance of addressing linguistic diversity and implementing ethical safeguards emerged as consistent themes. The synthesis of these data sources highlighted a key insight: while AI systems demonstrate remarkable technical capabilities, they fall short of replicating the complexity of human communication. Addressing this gap requires integrating advances in computational models with a deeper interdisciplinary understanding of language and communication.

Table 3. Interview insights into AI language processing platforms

Concerns	Input
Current limitations of AI Models	Experts highlighted that transformer-based models have advanced state-of-the-art NLP but remain fundamentally statistical tools. Several interviewees pointed out that these models generate outputs based on probabilistic patterns rather than proper understanding, which limits their ability to handle complex communication tasks.
Context and multimodality	Experts emphasized the need for AI systems to integrate multimodal data, such as visual and auditory cues, to better grasp context. For example, combining text data with facial expressions or voice tone could enhance the system's ability to detect sarcasm or emotion.
Linguistic equity	There was unanimous agreement on prioritizing linguistic diversity in AI training. Experts suggested that initiatives such as crowdsourced datasets and collaborative research with linguistically diverse communities could address the underrepresentation of low-resource languages.
Ethical and regulatory concerns	Experts expressed concerns about the societal impact of biased AI outputs and the growing difficulty in distinguishing between human-generated and AI-generated content. They advocated for transparent AI development practices and the incorporation of ethical oversight in AI systems.

5. DISCUSSION

The findings from this study reveal that, despite significant technological advancements, AI language processing systems continue to face persistent challenges in understanding and replicating the intricacies of human language and communication. This discussion explores the implications of these challenges, situates them within the broader societal and technological context, and identifies opportunities for future advancement. The inability of AI systems to fully capture linguistic nuance reflects their reliance on statistical patterns rather than proper semantic understanding. This limitation underscores the distinction between syntactic fluency and meaningful comprehension. For example, while transformer-based models like GPT-4 can generate coherent, contextually relevant text, their inability to discern sarcasm, irony, or humor highlights a critical design gap. This gap has practical consequences. In customer service applications, for instance, an inability to detect emotional undertones may lead to tone-deaf or unsatisfactory responses, reducing user trust. To address this, integrating advancements in affective computing and emotion recognition into NLP models could enable more nuanced interactions. Additionally, future research should focus on developing mechanisms that allow AI to infer implicit meanings, drawing on contextual clues beyond surface-level text.

AI's struggle with contextual communication arises from its dependence on static datasets and limited dynamic adaptability. Human communication often involves inferred meaning based on shared knowledge, which AI systems fail to emulate effectively. For example, conversational agents frequently falter when engaging in multi-turn dialogues, leading to repetitive or irrelevant responses. This limitation is particularly problematic in applications such as virtual assistants and healthcare chatbots, where a precise understanding of user intent and context is essential. Incorporating multimodal data, such as voice intonation, facial expressions, and situational context, into AI systems offers a promising avenue for improvement. Such integration would enhance contextual understanding and bring AI interactions closer to human-like communication [45], [46].

The underrepresentation of low-resource languages and dialects in AI training datasets reflects a broader issue of inequality in technological development. This disparity not only limits the accessibility of AI tools to speakers of minority languages but also perpetuates linguistic and cultural hegemony. For instance, AI-driven translation services often fail to capture the cultural and linguistic richness of lesser-used languages, reducing their utility in diverse global contexts. Addressing these issues requires a concerted effort to expand the scope of linguistic data used in AI training. Collaborative initiatives involving local communities, linguists, and technologists could help curate diverse datasets, ensuring better representation of low-resource languages. Furthermore, leveraging advancements in transfer and zero-shot learning could enable AI models to perform effectively across a broader range of languages, even with limited training data.

The ethical concerns surrounding AI language processing extend beyond technical limitations to encompass broader societal impacts. The findings highlight the risks of biased outputs, misinformation, and a lack of transparency. For instance, AI systems that inadvertently reinforce stereotypes or generate misleading content can profoundly affect hiring, education, and public discourse. Regulatory frameworks that promote fairness, accountability, and transparency in AI development are essential to mitigate these risks. This includes requiring developers to audit and address biases in training data, providing clear documentation of model capabilities and limitations, and implementing mechanisms for user feedback and correction. Ethical AI development should also prioritize inclusivity, ensuring systems serve diverse user needs and contexts.

The findings underscore the need for interdisciplinary collaboration to bridge the gap between human and machine communication. Insights from linguistics, psychology, and sociology can complement technological advancements, enabling the development of AI systems that better align with human communication patterns. For instance, incorporating theories of pragmatics and relevance into model architectures could enhance AI's ability to infer intent and context. Moreover, fostering greater public engagement and education around AI technologies can empower users to understand and navigate their limitations. As AI becomes increasingly integrated into daily life, ensuring that these systems reflect human values and needs is a technological challenge and a societal responsibility.

6. CONCLSUION

Although AI has achieved substantial progress in language processing and enabled powerful applications such as machine translation and conversational agents, this study demonstrates that current AI systems remain limited in their ability to replicate the full complexity of human language and communication. These limitations are most evident in difficulties with linguistic nuance, contextual interpretation, and equitable representation of linguistic diversity, alongside persistent ethical concerns about bias, transparency, and accountability. Addressing these challenges requires a shift toward interdisciplinary AI development that integrates insights from linguistics, communication studies, and cultural analysis with advances in computational modeling, including multimodal and low-resource language approaches. Equally

critical is the establishment of robust ethical and regulatory frameworks that promote fairness, inclusivity, and responsible use. By adopting a holistic and human-centered approach, AI language technologies can move beyond surface-level fluency toward more meaningful, culturally sensitive, and ethically sound communication that genuinely supports and enhances human interaction.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The research related to human use has been complied with all the relevant national regulations and institutional policies in accordance with the tenets of the Helsinki Declaration and has been approved by the authors' institutional review board or equivalent committee.

DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author, [MAA]. The data, which contain information that could compromise the privacy of research participants, are not publicly available due to certain restrictions.

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