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Research Article

Gender and Age Effects of Artificial Intelligence Narrator on Cultural Belonging and Comprehensibility in Heritage Museums

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Abstract

Heritage museums balance a dual mission: preserving culture and providing educational experiences. As institutions adopt AI-generated audio guides, narrator acoustic features—such as gender and age—significantly impact visitor experiences. This study examines how AI narrator gender and age influence Korean-English bilingual youths' (ages 15–24) perceptions across two domains: the cultural function (belonging and empathy) and the educational function (comprehensibility and professionalism). Utilizing a between-subjects design, 71 participants were randomly assigned to one of four AI voice conditions (young/old, female/male) to evaluate audio guides for two heritage sites (Korea's Geunjeongjeon and France's Hall of Mirrors). A two-way ANOVA revealed older voices yielded significantly higher scores across both functions. For the educational function, male voices independently scored higher than females. For the cultural function, a significant interaction emerged, with older male voices scoring highest. These findings demonstrate that AI voices are not merely neutral information-delivery tools, but active social cues that shape cultural resonance and credibility. Older voices were associated with higher perceived educational and cultural function ratings, while older male voices received the highest cultural-function rating. Consequently, the study suggests that museums must move beyond default voice settings and strategically align AI personas with specific communicative goals.

Keywords: User Experience, Cultural Belonging, Heritage Museums, Artificial Intelligence Voices, Comprehensibility.

1. Introduction

With visitor experience centered to view objects passively than holistically, museums have historically functioned as authoritative and top-down institutions (Hooper-Greenhill, 2000). However, this paradigm has shifted. The International Council of Museums recently changed its definition of museums as institutions that simultaneously exhibit heritage while "offering varied experiences for education, enjoyment, reflection and knowledge sharing" (International Council of Museums United States, 2022). With this renewed definition, two functions can be underlined. First, to preserve and transmit cultural identity (Wróblewska, 2019; Ma *et al.,* 2025); Second, to serve as inclusive educational centers for all visitors (Hooper-Greenhill, 2007). In order to achieve these missions, museums have increasingly adopted interactive and visitor-centered strategies (Daley, 2020; Apan and Özdemir, 2024).

One prominent strategy is the use of audio tours. While major cultural institutions (e.g., the Louvre, the British Museum) (Musée du Louvre, n.d.; British Museum, n.d.) continually expand their digital voice offerings, the specific vocal features of narrators remain largely unexamined. With the COVID-19 pandemic, the adoption of Artificial Intelligence (AI) to optimize visitor experience grew as more museums sought digitalization (Giannini and Bowen, 2022). Advancements in text-to-speech (TTS) technology enabled museums to produce high-quality narrations with customizable acoustic features, such as gender and age (Xia and Haas, 2024). However, this shift toward AI-generated voices often occurs without considering how some voice features may influence visitors. While studies of AI voices are well-examined in commercial and customer service contexts

(Cuciniello *et al.,* 2022; Pias *et al.,* 2024; Sun *et al.,* 2025), there is a lack of research within cultural heritage settings.

1.1. Social Identity and Belonging in Museums

Baumeister and Leary highlight that forming and maintaining meaningful social attachments is a fundamental human drive (Baumeister and Leary, 1995). Social Identity Theory extends this by explaining how a core part of individuals' self-concept comes from group-membership, unconsciously preferring their in-group for their self-esteem (Tajfel and Turner, 1979). In a museum context, visitors who perceive cultural content as belonging to their in-group experience highly self-relevant encounters. On the other hand, when museum representations don't match with a visitor's identity, the individual often experiences psychological withdrawal, making them resist the cultural narrative (Newman and McLean, 2006).

1.2. Bilingualism and Cultural Processing

Bilingual individuals, capable of alternating between two or more languages (Mackey, 1962; Weinreich, 1968), are an understudied audience in museum communication. Grounded in Grosjean's holistic view, bilinguals process their dual identities compositely rather than additively (Grosjean, 2010); their response to cultural content is shaped by both linguistic identities simultaneously. This configuration suggests bilinguals distinct advantages in social-cognitive processing, particularly in intergroup perception, which relates to how visitors determine whether museum content belongs to their cultural in-group (Xia and Haas, 2024). Furthermore, bilinguals go through a modulating emotional sensitivity based on the language they process, which can indicate measurable differences in cultural resonance (Ji, 2023). Consequently, bilingual audiences introduce unique experiential dynamics, necessitating targeted research that approaches them as a specialized demographic within museum studies.

1.3. Psychological Impacts of Acoustic Cues in AI Voices

As a voice doesn't have an acoustically neutral form, vocal features function as crucial indicators that shape listeners' perceptions of a speaker's warmth, competence, trustworthiness, and authority (Schirmer *et al.,* 2020; Shiramizu *et al.,* 2022). Regarding gender, female AI voices are consistently perceived as more human-like, with greater warmth and emotional sensitivity than male voices (Eyssel and Hegel, 2012; Stroessner and Benitez, 2019). Sun et al. found that female AI voice assistants in healthcare were perceived with greater warmth and competence than male counterparts (Sun *et al.,* 2025), which aligns with the societal default of feminine voice assistants like Siri and Alexa (Dave and Kushwah, 2025).

Age, though comparatively less studied in AI literature, also carries significant weight. Schirmer et al. found that younger-sounding human voices were rated as warmer and more trustworthy than older ones (Schirmer *et al.,* 2020). The Computers Are Social Actors (CASA) paradigm suggests that listeners apply the same social expectations to synthetic voices as to human ones (Nass and Moon, 2000). This implies that these age-based patterns can extend to TTS narration. Along with this, research on synthetic voice preferences has shown that listeners have a tendency to favor voices that are slightly younger than their own age. This suggests that perceived age similarity can play a meaningful role in evaluating AI-generated narration (Cuciniello *et al.,* 2022). When examined interactively, specific combinations, such as younger female voices, have been shown to significantly influence user behavior (Pias *et al.,* 2024).

1.4. Current Study and Research Gap

While the importance of fostering cultural belonging as well as serving educational function within museum settings is increasingly recognized, how the acoustic features of AI narrators impact these experiences remains largely underexplored. Furthermore, a general lack of focus on the audience's linguistic and cultural backgrounds calls for a targeted examination of how content delivery via audio guides shapes the user experience.

This study addresses these gaps by investigating how variations in the gender and age of AI narrators affect Korean-English bilingual youth visitors' (ages 15–24) perceptions across two core domains: the cultural function (e.g., sense of belonging and empathy) and the educational function (e.g., perceived comprehensibility and institutional professionalism). By surveying 71 participants, this study not only identifies which vocal combinations produce the strongest effects on each dimension but also examines whether certain combinations systematically elevate both the cultural and educational functions of museum communication. Ultimately, the findings provide an empirically grounded framework for AI voice design for museums, proposing actionable strategies to successfully provoke a sense of cultural inclusion and effectively educate the public.

2. Methods

2.1. Participants

A total of 83 bilingual (Korean and English) youth participants (ages 15–24) were recruited. This demographic represents an increasingly prioritized yet underrepresented audience in museum communication research (Daley, 2020). After the data collection, 12 participants were excluded for exceeding reasonable completion times (eight for excessive total survey time and four for remaining on the audio page for triple the duration of the clips). The final sample consisted of 71 participants. Of the initial pool, 40 identified as male, 42 as female, and one as non-binary, with a mean age of 18.91 years (SD = 3.07).

2.2. Stimulus

Auditory stimuli were generated using ElevenLabs, manipulating two between-subject factors: Voice Gender (Male, Female) and Voice Age (Young, Old). Speaking rate and audio quality were kept constant to isolate the variables of interest. Participants were randomly assigned to one of four voice conditions: Young Female (n = 17), Old Female (n = 17), Young Male (n = 19), or Old Male (n = 18).

Two architectural sites with equivalent heritage significance but distinct cultural backgrounds were selected: Geunjeongjeon (Korea) and the Hall of Mirrors (France). Utilizing both Asian and Western sites controlled for participants' prior familiarity and allowed the study to examine whether voice feature effects differed across culturally dissimilar content. Narration scripts were adapted from official sources (Korea Heritage Service and Chateau de Versailles) (Korea Heritage Service, n.d.; Château de Versailles, n.d.), standardized for parallel content (e.g., accessibility of content, fidelity to source material, and adequate information), and trimmed to an average of 118 words (approximately 54 seconds).

2.3. Procedure

The experiment was conducted entirely online via the Qualtrics survey platform. First, participants were presented with an informed consent form detailing the study's purpose, anonymity, and voluntary nature. Minors under 18 were required to obtain parental consent. Those who consented completed an eligibility screening to confirm they were within the UN-defined youth age range (15–24) (United Nations, n.d.) and possessed Korean-English bilingual fluency.

Eligible participants were randomly assigned to one of the four between-subject voice conditions. During the main task, participants were presented with a photograph of the architectural site alongside the assigned auditory stimulus. To ensure full exposure, a forced-timing mechanism was implemented, preventing participants from proceeding to the next page until the audio clip finished playing. After listening, they evaluated the narrator's voice using a standardized questionnaire. To prevent order bias, the presentation sequence of the two heritage sites, as well as the order of the survey items within each site, were randomized for every participant.

Participants evaluated their experience across eight statements on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree). The items were adapted from established psychological and museum scales, including the Multigroup Ethnic Identity Measure (MEIM) (Phinney, 1992), Cultural Context Belonging Scale (CCBS) (Price and Applebaum, 2022), and Museum Experience Scale (MES) (Othman *et al.,* 2011), reworded to capture immediate responses to the voice stimuli. The items were divided into two core constructs (Table 1):

Table 1. Rating-scale items for cultural (Q1-Q4) and educational functions (Q5-Q8).

Construct	Q	Item
Cultural function	Q1	*The narrator's voice helped me emotionally connect with the historical weight of the space.*
	Q2	*The narrator's delivery helped bridge any cultural distance between me and the space being described.*
	Q3	*Listening to the narrator's voice made me feel welcomed in the museum setting.*
	Q4	*The voice of the audio guide made the cultural artifact sound captivating and engaging.*
Emotional function	Q5	*The narrator's voice kept me focused on the educational facts presented in the guide.*
	Q6	*The narrator's delivery made the complex historical and architectural information easy to comprehend.*
	Q7	*The narrator sounded like a highly credible and authoritative source of historical information.*
	Q8	*The narrator's voice conveyed appropriate dignity and respect for the cultural heritage.*

The survey concluded with a demographic questionnaire collecting data on gender, age, ethnicity, and highest completed education level.

3. Results

3.1. Data Analysis

The mean and standard deviation were calculated across the four voice conditions (female-young, female-old, male-young, male-old). Among the eight rating-scale items, the average of Q1-Q4 indicated the cultural function score, and the average of Q5-Q8 indicated the educational function score (Table 1). Critically, a between-subject Analyses of Variance (ANOVAs) was conducted on the two function scores, cultural, and educational, with two independent variables: gender (male vs. female), and age (old vs. young). All statistical computations were calculated in Python using the statsmodels and pingouin library.

3.2. Preliminary Analysis

A preliminary analysis was conducted to determine whether the specific type of cultural site confounded participants' evaluations. A repeated-measures ANOVA, using stimulus type (Geunjeongjeon vs. Hall of Mirrors) as a within-subjects factor, revealed no significant differences between the two audio stimuli on either the cultural function or educational function scores (*p*s > .405). This pattern remained consistent across all four between-subjects voice conditions (*p*s > .608). These results provided no evidence of a systematic difference in ratings between the two heritage sites. Consequently, this finding ensured that the study could isolate the voice features, enabling further analyses to focus strictly on the main effects of narrator gender and age on user perceptions.

Table 2. Descriptive statistics for cultural and educational function scores by voice condition.

Voice condition	*n*	Cultural function		Educational function	
		M	***SD***	***M***	***SD***
Young female	17	4.02	0.90	4.10	0.94
Old female	17	4.35	1.37	4.93	1.26
Young male	19	3.78	1.46	4.38	1.16
Old male	18	5.52	0.68	5.93	0.28

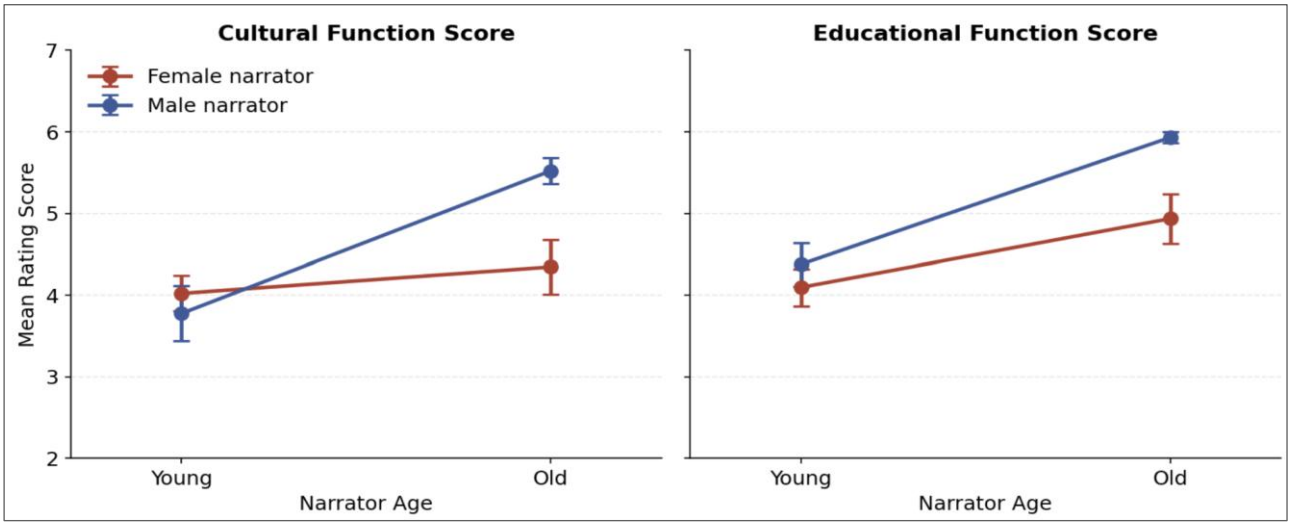


Figure 1. Mean rating scores for cultural and educational functions by voice age and gender.

3.3. Cultural Function Scores (Q1-Q4)

The overall cultural function score was 4.41 (*SD* = 1.32). The cultural function scores across the four conditions were as follows: young female voice (*M* = 4.02, *SD* = 0.90), old female voice (*M* = 4.35, *SD* = 1.37), young male voice (*M* = 3.78, *SD* = 1.46), and old male voice (*M* = 5.52, *SD* = 0.68) (Table 2). A two-way ANOVA revealed a significant main effect of age, $F(1, 67) = 15.08$, $p < .001$, MSE = 20.08, $\eta p2 = .18$, showing higher scores for older voices (*M* = 4.95) than for younger voices (*M* = 3.89) (see Figure 1, left panel). On the other hand, the main effect of gender was not significant, $F(1, 67) = 2.76$, $p = .101$, between male voices (*M* = 4.63) and female voices (*M* = 4.18). Critically, the interaction between age and gender was significant, $F(1, 67) = 6.72$, $p = .012$, MSE = 8.94, $\eta p2 = .09$. Specifically, simple main effects analysis indicated that the effect of age was significant in male voices, $F(1, 67) = 21.13$, $p < .001$, *Mdiff* = 1.74, but was not present in female voices, $F(1, 67) = 0.67$, $p = .417$, *Mdiff* = 0.32.

3.4. Educational Function Scores (Q5-Q8)

The overall educational function score was 4.84 (*SD* = 1.20). The educational function scores across the conditions were: young female voice (*M* = 4.10, *SD* = 0.94), old female voice (*M* = 4.93, *SD* = 1.26), young male voice (*M* = 4.38, *SD* = 1.16), and old male voice (*M* = 5.93, *SD* = 0.28) (Table 2). The main effect of age was significant, $F(1, 67) = 26.77$, $p < .001$, MSE = 26.06, $\eta p2 = .29$, showing higher scores for older voices (*M* = 5.45) than for younger voices (*M* = 4.24) (see Figure 1, right panel). Additionally, the main effect of gender was also significant, $F(1, 67) = 7.30$, $p = .009$, MSE = 7.11, $\eta p2 = .10$, showing higher scores for male voices (*M* = 5.13) than for female voices (*M* = 4.52). Importantly, the interaction between age and gender was not significant, $F(1, 67) = 2.34$, $p = .131$. This indicates that older voices scored higher than younger voices regardless of gender, and male voices scored higher than female voices regardless of age.

4. Discussion

The current study found that older voices earned higher cultural and educational function scores than younger voices, while male voices additionally rated higher on the educational function than female voices. These findings diverge from prior research. Schirmer et al. concluded that younger voices were perceived as more trustworthy in general social evaluations (Schirmer *et al.,* 2020), and Sun et al. found that female AI voice assistants were rated higher in warmth and competence in healthcare settings (Sun *et al.,* 2025). This divergence suggests that the effect of AI voice features on listener perception is not fixed, but rather heavily shaped by the context and the functional usage of the audio. In a cultural heritage museum setting, listeners appear to apply different social expectations than they would in healthcare or general social environments.

The finding that older voices are more effective in both functions can be understood through the activation of context-specific schemas. In a heritage institution, an older voice can trigger associations of experience and accumulated knowledge, as older individuals are often perceived as wiser (Löckenhoff *et al.,* 2009). When the primary purpose of an AI narrator is to deliver historical knowledge, this age-credibility association becomes highly salient. For bilingual youth, this effect may be further reinforced. Bilinguals demonstrate heightened sensitivity to intergroup social cues compared to monolinguals (Xia and Haas, 2024), potentially making them more attuned to age signals. Specifically for Korean-English bilingual youth, an older narrator may activate a culturally familiar schema rooted in Confucian values, which underscore respect and authority for the elderly (Palley, 1992). Because audio guides serve as a unique communicative bridge between the visitor and the artifact, this effect carries significant weight. As Hooper-Greenhill stated, museums actively shape visitors' cultural understanding (Hooper-Greenhill, 2000). Thus, an older narrator naturally aligns with the museum's authoritative identity as a heritage institution, reinforcing the credibility of the content in a way a younger, albeit warmer, voice does not.

The finding that the main effect of gender was significant only for the educational function highlights a critical distinction in how listeners evaluate different museum goals. Cultural identity research frequently distinguishes between two dimensions: affective and cognitive (Pan et al., 2020). The affective dimension encompasses emotional attachment, a sense of belonging, and cultural pride, whereas the cognitive dimension involves evaluative judgments, knowledge, and understanding. This distinction aligns with the current study's framework: the cultural function interacts heavily with the affective dimension, while the educational function engages the cognitive dimension. Because affective responses—such as feeling a sense of belonging—are highly subjective and driven by complex personal experiences, they may be less susceptible to single acoustic features like gender alone. By contrast, the educational function involves a straightforward cognitive judgment of professionalism and comprehensibility, a domain where gender-based voice schemas are more readily activated (Garnham *et al.,* 2026). Furthermore, the interaction effect observed in the cultural function, where the advantage of older voices was present only in male narrators, demonstrates that fostering cultural belonging requires a more complex combination of vocal features rather than a single acoustic cue.

These divergent results demonstrate that the acoustic features of AI narration cannot be uniformly applied to fulfill all museum goals. For institutions prioritizing educational delivery, the findings suggest utilizing older, male voices to maximize perceived comprehensibility and professionalism. For museums prioritizing cultural function, the interaction effect indicates that the specific combination of an older male voice is particularly effective at fostering a sense of belonging. However, these implications must be contextualized within the study's limitations. The current research focused on historical heritage sites (Korean and Western); contemporary or modern art museums, which may actively subvert traditional authoritative frameworks, might find different acoustic features more effective to suit their communicative goals. Additionally, because the sample was restricted to Korean-English bilingual youth, the results may not generalize to bilinguals from other cultural backgrounds. Future research should explore whether these findings replicate across different

bilingual populations and investigate how the interaction between voice features might shift when paired with varying types of heritage content.

5. Conclusion

The present study explored how the gender and age of AI-generated narrations affect bilingual Korean-English youth visitors' sense of cultural belonging and perceived comprehensibility within a cultural heritage museum context. Across both the cultural and educational functions, older voices consistently yielded higher outcomes than younger voices. However, the mechanisms through which gender and age operated differed meaningfully between the two domains. For the educational function, age and gender exerted significant independent main effects, with older and male voices respectively producing higher ratings. In contrast, the cultural function was driven by a main effect of age and a critical interaction effect, where the specific combination of an older male voice proved most effective in fostering belonging. The findings establish that AI voices in museums are not neutral information-delivery tools, but active social cues that dictate institutional credibility and cultural resonance. While older voices effectively project the authoritative expertise required for educational delivery, the specific intersection of older and male vocal features uniquely maximizes a visitor's affective sense of belonging. As heritage institutions increasingly integrate AI technologies into their digital infrastructure, they must move beyond default voice configurations. By intentionally designing AI personas that align with targeted communicative goals, museums can elevate audio guides from mere assistive devices into strategic catalysts for deeper cultural connection and inclusive visitor engagement.

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