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A comparative study on the audio-visual evaluation of the grand Song of the Dong soundscape

Linqing Mao*, Xin Zhang, Jianjun Ma and Yihong Jia

Abstract

Soundscape heritage records the cultural connotations of different ethnic groups, the destruction, and the disappearance of certain heritage makes its preservation urgent. This work aims to explore the influence of audio-visual different sensory stimuli on the subjective cognition, perceptual dimension and value evaluation of the Grand Song of the Dong soundscape heritage. We have conducted an audio-visual interaction experiment, using 2D video and high-fidelity audio systems to show typical visual elements and cultural scenes of the Grand Song of the Dong, and combined them with questionnaires to collect subjective data. The results show that the visual stimuli have no effect on the subjective evaluation of the Grand Song of the Dong soundscape, and that the different social characteristics of the participants are the main reason for the variations. The influence of audio-visual interaction on the perception of the of the Grand Song of the Dong soundscape is greater, with an enhanced perceptual dimension than the single auditory sensory, i.e., the scale dimension, indicating that visual stimuli can enhance the sensing of spatial limitation. The introduction of the visual element results in higher scores for each heritage value than the auditory element alone, indicating a positive impact on the value evaluation. The results of these studies provide a theoretical basis for the living transmission and holistic conservation of the Grand Song of the Dong and their scenes.

Keywords Intangible cultural heritage, Soundscape, Grand Song of the Dong, Soundscape conservation, The Dong nationality, Audio-visual interaction

Introduction

Soundscape as a multidisciplinary research field is gradually becoming a hot spot for research [1]. The International Organization for Standardization officially defined a soundscape as “a sound environment that people perceive, experience or understand in context” [2]. Owing to the rich elements and characteristics of soundscape, the key factors of soundscape can be determined through subjective investigation to understand the requirements and satisfaction of different groups for soundscapes [3–6]

to put forward corresponding soundscape design strategies [7]. For example, in urban soundscape studies, surveys reveal that people appreciate and choose natural and biological sounds [8–10] since the introduction of these sound elements is helpful for urban traffic noise mitigation [11] and can provide a comfortable living environment for residents. Furthermore, the research on soundscapes also involves the cultural meaning, people’s perceptual understanding, the social value, and function, of sound [12], and when the sound has a certain social value, it is considered to have a cultural heritage value [13]. The study of the sound in an environment from the perspective of the humanities, and protecting, preserving, and recording the sound heritage with rich historical and regional cultural connotations, is another important category of the soundscape research, i.e., soundscape

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heritage preservation. However, unlike archaeoacoustics, which explores the cultural significance of sound through instrumental means such as experimental testing [14], the most important aspect of the soundscape heritage protection is the preservation of the environment and life forms that produce and transmit these sounds [15], thus encompassing the heritage proper—the sounds, the heritage transmission space—the cultural environment, and the heritage bearers. They are transmitted through generations and are constantly recreated in the interaction of communities and group environments with nature and history, thus providing a continuous sense of identity for the masses and enhancing respect for cultural diversity and human creativity [16]. Therefore, the soundscape heritage undoubtedly contributes to maintaining the whole cultural heritage as a living entity, rather than only collecting “intangible works of art” [17].

In 1989, the United Nations Educational Scientific and Cultural Organization (UNESCO) put forward the proposal for the protection of folk oral inheritance, which marked the turn of attention to the sound culture that records people’s life and historical memory and the unique survival symbols of multiple ethnic groups and is related to the existence of different spirits of human culture. In 1998, UNESCO proposed the Oral Intangible Cultural Heritage of Humanity, including various social practices, the expression of ideas, forms of expression, knowledge, skills and relevant tools, objects, handicrafts and cultural sites [18], and the “Regulations on representative works of human oral and intangible heritage,” was announced, which aim to reward excellent representative works of oral and intangible heritage. As of 2009, 115 items have been determined in four batches, including 86 items related to sound. In 2003, UNESCO promulgated the Convention on the Protection of Intangible Cultural Heritage. Hitherto, 33 intangible cultural heritage projects have been selected in China, including the 17 ones that are related to sound, encompassing Kunqu opera, the Beijing opera, Tibetan opera, The Grand Song of the Dong, etc. Therefore, several intangible cultural heritage related to sound have been preserved, and most have been maintained in their original cultural environment, becoming precious soundscape heritage, examples include the Portugal’s “manufacture of cowbells” tradition and Belgium’s “carillon culture” [19]. However, concomitantly, certain little-known sound heritage is being or has already been destroyed. Finding the methods to protect, preserve, and restore it is an urgent problem to be solved in the research on soundscape heritage. Owing to the rapid development of modern science and technology, certain disappeared historical heritage can be partially restored by employing modern technology. As an example, Suárez et al. have employed the modern techniques

to restore the acoustic features of the Santiago de Compostela Church [20]. Certain unnoticed cultural heritage can also be publicized, protected, and inherited along with the communication effect of digital media [21, 22], and an “Internet +” model can be built [23] for vitalizing cultural heritage to comply with the development of the society.

Being an important branch of Baiyue (“Baiyue” refers to the general name of the tribes in the southern coastal area in the ancient books of the pre-Qin Dynasty) in ancient China, the Dong nationality as shown in Fig. 1, is mainly distributed across Guizhou, Hunan, Hubei, Guangxi, and other places. Owing to the absence of a national language, the Dong culture is preserved and transmitted down the generations through the oral teaching that inspires a true inner understanding. “The Han nationality has words to pass on books, and the Dong nationality has no words to pass on songs” [24]. This implies that Dong people use singing and other artistic performance forms as tools for their cultural and historical records, which is the most direct embodiment of the value of the Dong people’s sound heritage. Therefore, the Dong nationality has brought forth many valuable voices, such as Pipa songs, Lusheng music, The Grand Song of the Dong, etc., and it undertakes the functions of the intergenerational inheritance, ideological education, belief expression, signal transmission, normative constraints, and atmosphere construction in the Dong culture. Furthermore, the spatial layout structure of a Dong village follows the principle of “seeing the drum tower and hearing the drum sound”. Figure 2 shows the drum tower in a Dong-inhabited area, hence the sound heritage is closely connected with the village structure, which is the basis for preserving the vitality of the traditional village as shown in Fig. 3. As the essence of the Dong nationality’s sound art and an important symbol of the Dong nationality’s spiritual culture, the Grand Song



Fig. 1 The Dong nationality



Fig. 2 The Dong nationality and Drum Tower

of the Dong has been preserved and passed down to the present because of its unique multi-voice, no-command, and no-accompaniment performance form [25]. It has been selected for adoption into the national intangible cultural heritage list in 2006 [26] and was included in the human oral and intangible cultural heritage list by UNESCO in 2009 [27]. Hence, the Grand Song of the Dong is a valuable cultural heritage for both China and the world.

Owing to the distinctive national style and unique cultural connotation of the Grand Song of the Dong [28], we should protect it not only by preserving the sound heritage samples [29] but also by carrying out the living transmission and development of the song itself and its cultural sites as a whole [30, 31]. However, owing to the change of the economic environment, the traditional patterns of Dong culture has gradually disappeared, and the original closed cultural environment of Dong nationality has been damaged to a certain extent so that the integrity of the Grand Song of the Dong has been threatened [32]. This necessitates urgent research from the perspective of soundscape heritage, which implies that besides protecting the heritage value of the Grand Song of the Dong, we should not ignore the importance of its inheritance environment, and should protect the three elements of “sound heritage”, “heritage inheritor”, and “heritage inheritance environment”, as a whole.

Recently, owing to the tremendous attention focused on the cultural environment in the traditional areas, multiple researchers have carried out a series of relevant studies on the cultural sites of “oral and intangible cultural heritage” from the perspective of sound and cultural heritage. For example, Escobar et al. have systematically investigated the acoustic environment of the ancient town of Caceres in Spain through sociological research and analyzed the noise distribution of the ancient town [33]. Yilmazer has employed a grounded theory approach to show the relationship among the soundscape elements, spatial functions, and places in mosques [34]. Elicio et al. have analyzed the St. Nicholas Orthodox Church in Bari to explore the relationship between its acoustic characteristics and its architecture and found that the two are



Fig. 3 Hierarchical analysis of Dong villages

closely related [35]. In the study of China's cultural heritage, the selection and standards of the soundscape heritage have been proposed [36]. It is recommended to pay attention to the principles of adjusting measures to local conditions in the design and application in the study of soundscape in certain ancient towns in China [37], to protect the regional sound [38]. Therefore, the oral culture or intangible cultural heritage has also been actively protected and perpetuated through the protection and planning of the soundscape in these ancient towns or historical scenes, from the dimensions of human, sound, and environment. Furthermore, the protection also provides a new means for the protection of villages. However, in previous studies, the engagement of historical sites has been mostly based on visuals, with less consideration of the acoustic environment itself [39, 40]. Therefore, people have less interaction with the historical soundscape. Studies have shown that multisensory stimulation can improve the understanding of soundscapes [41], the restorative effect is also more significant than that of single-sensory stimuli [42], where visual perception is most closely linked to auditory perception [43], and therefore combining the two can significantly improve the people's subjective evaluation of a soundscape [44]. A soundscape that incorporates the audio-visual interaction will be more enjoyable than a sound-only environment [45], and the introduction of good visual elements has significantly improved the overall evaluation of the environment [46]. For example, in urban planning, audio-visual prioritization factors can help improve the quality of residential soundscapes [46, 47]. When designing interior environments, visual environments can be developed to create pleasing interior soundscapes based on the needs of users [48].

Before this study was conducted, researchers have analyzed the natural and cultural characteristics of the soundscape of the traditional settlements in eastern Guizhou from the perspective of sound ecology [49], and obtained the sound field characteristics of sound sources and the space in which they are located at different levels of soundscape elements [50]. These previous studies provide a technical support for the development

of this research. The purpose of this paper is to explore the influence of the subjective perception, perceptual dimension and value assessment of the soundscape of the Grand Song of the Dong by the social crowd under different sensory stimuli of audio-visual interaction experiment using the social survey method. On this basis, it is proposed to consider the Dong song and the cultural place where it is located, etc. as a whole living soundscape heritage [25] for providing relevant strategies for the subsequent inheritance and protection.

Materials and methods

Visual stimulus materials

In this study, the video of the Grand Song of the Dong performance has been used as the visual stimulus material. The performance form of the traditional Grand Song of the Dong has been divided into four singing forms: male, female, child and mixed male and female. Further, the performance venue is the drum tower, which is the symbol and emblem of the Dong people and an important part of the cultural life of the Dong nationality [51]. Thus, the three typical performance forms of the Grand Song of the Dong have been selected as the research objects of this audio-visual interaction, which are the performance videos of the male, female, and children's songs with the drum tower as the background, and the singers are wearing typical Dong ethnic costumes as shown in Fig. 4. Considering the cultural background and environment of the Grand Song of the Dong, elements such as drums and costumes in the video have been selected as typical visual elements and the proportions varied in each performance scene to satisfy the criteria for generating visual stimuli [52]. Each video plays for 40 s, with sound appearing continuously after the video starts and the sound pressure level remaining consistent for each video.

Experimental design

The audio-visual interaction experiments in this study have been conducted by means of 2D video and were carried out in conjunction with a social survey, and the applicability and role of this method in the research



a. Male Grand Song.

b. Female Grand Song.

c. Children's Grand Song.

Fig. 4 Visual stimulus materials

on soundscapes have been verified [3]. Quantitative analysis is the primary analysis method of this experimental data analysis, which has been used by several previous researchers to investigate soundscapes [3,4,53]. The investigated population has been randomly divided into two groups, A and B, for comparative study. The respondents in group A completed the questionnaire after watching three videos, while those in group B only listened to the three audio clips before completing the questionnaire. Before the official distribution of the questionnaires, 15 pre-questionnaires/groups have been distributed and filled out, and the questionnaire structure was optimized and adjusted accordingly. The online survey began in January 2020 and ended in June 2020.

Questionnaire design

The questionnaires of both the groups, A and B, consist of four parts. The first part is the overall perception and sound preference evaluation, which is the overall impression scoring and sound preference evaluation of the Grand Song of the Dong. It includes seven evaluation indexes: understanding (degree of understanding of the Grand Song of the Dong), urgency (degree of urgency to protect the Grand Song of the Dong), importance (degree of importance of protecting the Grand Song of the Dong), preference (degree of preference for the Grand Song of the Dong), comfort (degree of comfort after enjoying the Grand Song of the Dong), pleasure (degree of pleasure after enjoying the Grand Song of the Dong), and stimulation (the degree of stimulation after appreciating the Grand Song of the Dong). The second part is the semantic segmentation evaluation of the sound perception and its dimensions of the Grand Song of the Dong, consisting of a semantic scale of 32 common adjective pairs in Table 1, including low pitch—high pitch, easy—depressed, modern—traditional, etc., divided into five consecutive grades, and the scores are -2, -1, 0, 1, 2, in turn. The third part is the investigation of the heritage value evaluation of the Grand Song of the Dong. The fourth part is the basic information of the investigated population, including nationality, gender, age, and family location.

Participant

The survey population has been mainly divided into two categories, viz., (1) Han nationality, whose answers reflect the intuitive feelings about the Grand Song of the Dong, and (2) the ethnic minorities, whose answers reflect the cultural perception of the Grand Song of the Dong heritage. The questionnaire has been mainly completed through a network platform named Questionnaire Star. A total of 291 questionnaires have been collected from group A and 246 questionnaires from group B. After filtering the questionnaires according to "how many audio

clips were heard from the above video/audio", 270 questionnaires were valid for group A and 227 for group B.

The social characteristics are vital for soundscape evaluation. As shown in Table 2, respondents are 50% male and 50% female in group A, and in group B, 51.5% are male and 48.5% were female, basically meeting the ratio of 1:1. Only 1.9% of the group A had the experience of living in a Dong settlement and 1.8% of the group B. Figure 5 shows the age distribution of respondents in both groups, both male and female. The age stage of respondents is predominantly young, mainly concentrated in 24 years old and below. The education of the interviewees is shown in Fig. 6. It is seen that interviewees generally have a high level of education, with all having a bachelor's degree or above.

Statistical analysis

The questionnaire results have been imported into the numerical analysis software SPSS26 for statistical analysis. To analyze the relationship between the subjective perceptions of the soundscape of the Grand Song of the Dong and the background of the crowd, analysis of variance (ANOVA) and Spearman correlation coefficient have been employed. For factor analysis of semantic scales, the principal component method has been employed to extract the common factors, and the maximum variance method was used for the factor rotation method.

Results

The results can be divided into three parts. The first part is the overall evaluation and sound preference analysis of the Grand Song of the Dong, establishing the correlation with the background of the surveyed population and determining the impact of visual perception on the evaluation results. The second part is a survey of the perceptual dimensions of the Grand Song of the Dong, and several dimensions of perception are identified through semantic differentials to compare the differences of perceptual dimensions under different audio-visual stimuli. The third part is the cognitive investigation and comparison of the six kinds of values of the Grand Song of the Dong.

Subjective evaluation and difference analysis of the soundscape

Soundscape subjective evaluation

The 5-scale evaluation method has been adopted to evaluate the soundscape cognitive of the Grand Song of the Dong. This implies that the subjective evaluation attitude is more positive for a larger value. The overall attitudes of respondents' seven subjective perceptions on the conservation of the soundscape of the Grand song of the Dong

Table 1 Semantic Evaluation Scale

	Very	Little	Neutral	Little	Very	
Stimulating	-2	-1	0	1	2	Mild
Slow	-2	-1	0	1	2	Fast
Various	-2	-1	0	1	2	Single
Smooth	-2	-1	0	1	2	Rough
Common	-2	-1	0	1	2	Rare
Unstable	-2	-1	0	1	2	Stable
Boring	-2	-1	0	1	2	Interesting
Sad	-2	-1	0	1	2	Happy
Relaxed	-2	-1	0	1	2	Tense
Abrupt	-2	-1	0	1	2	Harmonious
Heavy	-2	-1	0	1	2	Light
Quiet	-2	-1	0	1	2	Noisy
Uncomfortable	-2	-1	0	1	2	Comfortable
Pure	-2	-1	0	1	2	Complex
Dislike	-2	-1	0	1	2	Like
Energetic	-2	-1	0	1	2	Oppressive
Omnidirectional	-2	-1	0	1	2	Unidirectional
No memory	-2	-1	0	1	2	A sense of memory
Unimaginable	-2	-1	0	1	2	Imaginable
Uncultured	-2	-1	0	1	2	Cultured
No sense of belonging	-2	-1	0	1	2	A sense of belonging
Marked	-2	-1	0	1	2	Unmarked
Low tone	-2	-1	0	1	2	High tone
Ordinary	-2	-1	0	1	2	Sacred
Disdain	-2	-1	0	1	2	Awe
Calm	-2	-1	0	1	2	Irritable
Easy	-2	-1	0	1	2	Depressed
Rigid	-2	-1	0	1	2	Vivid
Plain	-2	-1	0	1	2	Wonderful
Modern	-2	-1	0	1	2	Traditional
Excited	-2	-1	0	1	2	Disconsolate
Resounding	-2	-1	0	1	2	Lowering

Table 2 Distribution of respondents' gender, nationality, and whether they had lived experience in Dong-inhabited areas

	Gender		Nationality		Previous living experience in Dong inhabited areas	
	Male	Female	Han nationality	Minority nationality	Yes	No
Number of people	135/117	135/110	225/190	45/37	5/4	265/223
Proportion	50%/51.5%	50%/48.5%	83.3%/83.7%	16.7%/16.3%	1.9%/1.8%	98.1%/98.2%

The results section of the table; the proportion and number of people on the top are the results of group A and the proportion and number of people on the bottom are the results of group B

have been obtained through statistical frequency analysis. The scores for understanding are significantly lower than other six subjective evaluations ($P < 0.01$), based on Paired Samples T-tests, indicating that although people may not know much about the Grand song of the Dong,

they still have positive perceptions of the other six subjective evaluations. Figure 7 shows both groups have a low level of knowledge related to the Grand song of the Dong. In group A, the average score is 2.06 for the degree of understanding, and in group B the value is 2.05. The

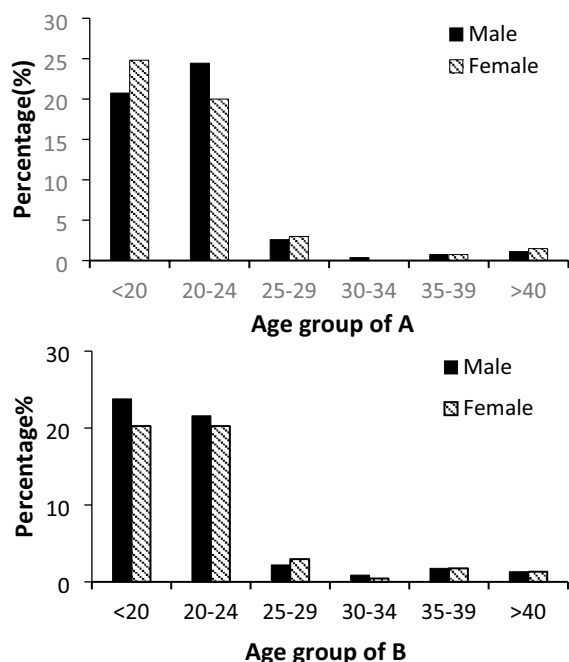


Fig. 5 Age distribution in group A and B

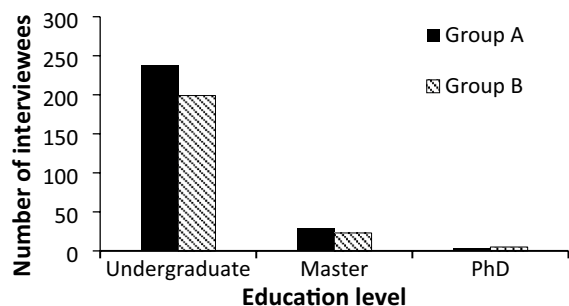


Fig. 6 Education profile of the interviewees in group A and B

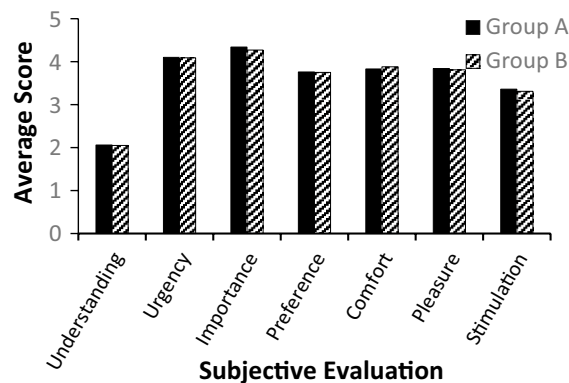


Fig. 7 The subjective evaluation values of the two groups A and B

degree of urgency and importance of conservation are rated higher in both groups, with the average score of 4.1 and 4.34 in group A and 4.09 and 4.27 in group B, respectively.

According to the correlation analysis, it is found that the degree of understanding, urgency, and importance in group A are all correlated with the other six subjective perceptions. Further in group B, except for there being no correlation between importance and understanding, pleasure and understanding, the others are all positively correlated, as shown in Table 3. This shows that,

generally, there is a strong correlation between the seven subjective perceptions of the Grand Song of the Dong soundscape.

Analysis of the difference in subjective evaluation

Variance analysis has been used to test the difference between the questionnaire data of groups A and B. The results in Table 4 show that in group A, the willingness to pay has a significant impact on urgency, importance, preference, comfort, pleasure, and stimulation, whereas nationality has a significant impact only on stimulation. Age has a significant impact on understanding and comfort, and personal monthly expenditure has a significant impact on understanding. In group B, willingness to pay has a significant impact on the degree of understanding, importance, preference, comfort, pleasure, and stimulation, while nationality has a significant impact on the degree of urgency and importance. Gender only has a significant impact on stimulation, and previous living experience in Dong inhabited areas has a significant impact on the degree of understanding of its cultural heritage. An example is shown in Table 5, willingness to pay has significantly impact in both groups A and B on preference ($p < 0.01$). The comparison reveals that participants in both groups who are willing to pay to enjoy the Grand Song of the Dong are more likely to have a preference of them. It can be seen that there are differences in people's subjective evaluation of the soundscape of the Grand Song of the Dong based on different social characteristics, whether under audio-visual dual-sensory stimulation or under single-sensory stimulation.

Analysis and comparison of the perceptual dimensions of a soundscape

Perceptual dimension analysis

Factor analysis has been employed to screen and summarize the main factors. In this study, this method is employed to analyze the semantic scale to obtain the perception dimension of the Grand Song of the Dong soundscape. The Cronbach's alpha of the group A is 0.851, and in group B is 0.893, indicating that the internal consistency of the two questionnaires is good. Furthermore,

Table 3 Correlation between seven subjective perceptions in group A/B

	Understanding	Urgency	Importance	Preference	Comfort	Pleasure	Stimulation
Understanding	1						
Urgency	0.145 ^b /0.155 ^b	1					
Importance	0.189 ^a /0.092	0.659 ^a /0.753 ^a	1				
Preference	0.303 ^a /0.252 ^a	0.441 ^a /0.417 ^a	0.462 ^a /0.510 ^a	1			
Comfort	0.191 ^a /0.178	0.475 ^a /0.467 ^a	0.468 ^a /0.546 ^a	0.690 ^a /0.678 ^a	1		
Pleasure	0.202 ^a /0.119	0.419 ^a /0.421 ^a	0.420 ^a /0.483 ^a	0.696 ^a /0.570 ^a	0.769 ^a /0.765 ^a	1	
Stimulation	0.149 ^b /0.210 ^a	0.256 ^a /0.337 ^a	0.244 ^a /0.307 ^a	0.425 ^a /0.352 ^a	0.353 ^a /0.355 ^a	0.453 ^a /0.451 ^a	1

^a The significance level is 0.01

^b The significance level is 0.05

Note: The left proportion in the table is the result of group A, and the right proportion is the result of group B

Table 4 Variance analysis of seven subjective evaluation of soundscape in group A/B based on changes in different social characteristics

	Understanding	Urgency	Importance	Preference	Comfort	Pleasure	Stimulation
Willingness to pay	0.213/0.004 ^a	0.000 ^a /0.406	0.000 ^a /0.035 ^b	0.000 ^a /0.001 ^a	0.000 ^a /0.002 ^a	0.000 ^a /0.000 ^a	0.037 ^a /0.025 ^a
Nationality	0.263/0.186	0.574/0.020***	0.716/0.011 ^b	0.724/0.976	0.573/0.522	0.179/0.343	0.028 ^b /0.358
Gender	0.114/0.714	0.858/0.218	0.928/0.208	0.752/0.844	0.159/0.654	0.874/0.579	0.102/0.011 ^b
Age	0.026 ^b /0.297	0.601/0.893	0.747/0.997	0.279/0.982	0.031 ^b /0.314	0.901/0.642	0.271/0.657
Previous living experience	0.731/0.000 ^a	0.749/0.794	0.852/0.381	0.200/0.505	0.633/0.291	0.633/0.408	0.903/0.884
Degree of education	0.761/0.882	0.702/0.753	0.341/0.375	0.866/0.530	0.843/0.602	0.796/0.596	0.598/0.378
Personal monthly expenditure	0.035 ^b /0.483	0.255/0.635	0.700/0.956	0.129/0.356	0.214/0.140	0.359/0.154	0.663/0.485

^a The significance level is 0.01

^b The significance level is 0.05

The left proportion in the table is the result of group A, and the right proportion is the result of group B

Table 5 Differences in percentage between “willingness to pay” in evaluating the preference of the Grand Song of the Dong

Group	Willingness to pay	Very dislike	Dislike	Neutral	Like	Very like
A	No	0.55	5.46	38.8	41.53	13.66
	Yes	0	0	13.79	66.67	19.54
B	No	0.63	5.7	34.81	46.84	12.03
	Yes	0	1.45	14.49	65.22	18.84

the KMO coefficient of group A is 0.917, and that of group B is 0.921, indicating that the effectiveness of the factor analysis results is high. According to the correlation coefficient matrix of each index, the principal component analysis with a maximum variance rotation has been employed to extract the orthogonal factors from 32 semantic word pairs, the respective main factors are extracted. From Table 6, we can see the degree of interpretation is increasing with the increase in the number of factors.

In group A, when the number of main factors is five, the cumulative variance contribution rate has reached 65.66%, so five main factors have been determined.

Factor 1 can be summarized as culture, including common-rare, no memory-a sense of memory, unimaginable-imaginable, uncultured-cultured, no sense of belonging-a sense of belonging, marked-unmarked, low tone-high tone, ordinary-sacred, disdain-awe, rigid-vivid, plain-wonderful, and modern-traditional. Factor 2 can be summarized as emotion, including smooth-rough, relaxed-tense, pure-complex, energetic-oppressive, omnidirectional-unidirectional, calm-irritable, easy-depressed, excited-disconsolate, and resounding-lowering. Factor 3 can be summarized as rhythm, including stimulating-mild, slow-fast, unstable-stable, boring-interesting, sad-happy, abrupt-harmonious,

Table 6 Comparison of the main factors of the two groups A and B

Group A	Culture	Emotion	Rhythm	Atmosphere	Scale
Interpretation rate	20.7%	19.2%	16.3%	4.7%	4.5%
Semantic word pairs	Common-rare no memory-a sense of memory unimaginable-imaginable uncultured-cultured no sense of belonging-a sense of belonging marked-unmarked low tone-high tone ordinary-sacred disdain-awe rigid-vivid plain-wonderful modern-traditional	Smooth-rough relaxed-tense pure-complex energetic-oppressive omnidirectional-unidirectional calm-irritable easy-depressed excited-disconsolate resounding-lowering	Stimulating-mild slow-fast unstable-stable boring-interesting sad-happy abrupt-harmonious heavy-light uncomfortable-comfortable dislike-like	Quiet-noisy	Various-single
Semantic word pairs	<u>Unstable-stable</u> <u>boring-interesting</u> <u>sad-happy</u> <u>abrupt-harmonious</u> <u>heavy-light</u> <u>uncomfortable-comfortable</u> <u>dislike-like</u> no memory-a sense of memory unimaginable-imaginable uncultured-cultured no sense of belonging-a sense of belonging marked-unmarked low tone-high tone ordinary-sacred disdain-awe rigid-vivid plain-wonderful modern-traditional	<u>Various-single</u> smooth-rough relaxed-tense pure-complex energetic-oppressive omnidirectional-unidirectional calm-irritable easy-depressed excited-disconsolate resounding-lowering	<u>Slow-fast</u> <u>common-rare</u>	<u>Stimulating-mild</u> quiet-noisy	
Group B	Culture	Emotion	Rhythm	Atmosphere	
Interpretation rate	34.9%	19.8%	6.77%	4.5%	

Among the semantic word pairs included in each dimension of the table, those included in both groups A and B are represented by normal fonts, only those in group A are represented in bold italics, and only those in group B are represented by underlining

heavy-light, uncomfortable-comfortable, and dislike-like. Factor 4 can be summarized as atmosphere, including quiet-noisy. Factor 5 can be summarized as scale, including various-single.

In group B, when the number of main factors is four, the cumulative variance contribution rate reached 66.11%, hence four main factors have been determined. Factor 1 can be summarized as culture, including unstable-stable, boring-interesting, sad-happy, abrupt-harmonious, heavy-light, uncomfortable-comfortable, dislike-like, no memory-a sense of memory,

unimaginable-imaginable, uncultured-cultured, no sense of belonging-a sense of belonging, marked-unmarked, low tone-high tone, ordinary-sacred, disdain-awe, rigid-vivid, plain-wonderful, and modern-traditional. Factor 2 can be summarized as emotion, including various-single, smooth-rough, relaxed-tense, pure-complex, energetic-oppressive, omnidirectional-unidirectional, calm-irritable, easy-depressed, excited-disconsolate, and resounding-lowering. Factor 3 can be summarized as rhythm, including slow-fast and common-rare. Factor 4 can be summarized as atmosphere, including stimulating-mild and quiet-noisy.

Dimension comparison

Regarding the average score of the two groups of the respondents' perceptions of the Grand Song of the Dong soundscape obtained from the semantic differential evaluation, the scores of the semantic word pairs in group A are mostly higher than those in group B. Both groups have the highest average scores for the modern-traditional and uncultured-cultured pairs, with 1.11 and 1.09 in group A, 0.9 and 0.95 in group B respectively. The average score for the two semantic word pairs of relaxed-depressed and energetic-oppressive have been the lowest, with scores of -0.29 and -0.26 in group A, -0.24 and -0.2 in group B. This shows the two groups of respondents have a relatively consistent perception of the Grand Song of the Dong, that is, they think the sense of tradition and culture is obvious, but the sense of relaxation and vitality is lacking. Groups A and B have extracted five and four perception dimensions, respectively, indicating that the perception structure of the Grand Song of the Dong soundscape is complex, and that there are more factors that can affect the subjective evaluation.

According to Table 6, group A increased the "scale" dimension relative to group B. Although there are four dimensions of culture, emotion, rhythm, and atmosphere in the two groups, the adjective pairs contained in each dimension are quite different. For example, the "common-rare" pair in the culture dimension of group A belongs to the rhythm dimension in group B. Further, there is a large difference in the average evaluations of each perceived dimension between groups A and B as shown in Fig. 8, indicating that the audio-visual interaction has a significant impact on the evaluation of dimension perception.

Heritage value evaluation

According to the function and meaning of the Grand Song of the Dong in the history and culture of the

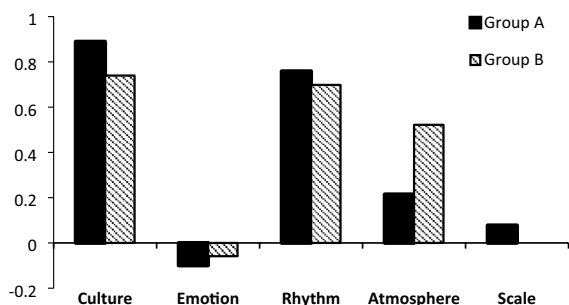


Fig. 8 The mean values of the main perception dimensions in groups A and B

Dong nationality, its value can be summarized into six aspects that are listed in the following:

- (1) Artistic value: the value of sound art as music itself and as oral literature;
- (2) Economic value: the economic benefits produced by the Grand Song of the Dong;
- (3) National identity value: in terms of a distinction from other nationalities and a sense of belonging resulting from the formation of a holistic cognition based on culture, history, and blood;
- (4) Cultural communication value: the most basic value attribute of the wordless nation;
- (5) Educational value: the oral normative value of moral restraint within the clan; and
- (6) Emotional value: the value of creating different cultural situations and emotions.

The score is divided into five grades from high to low. The recognition of importance is higher for a higher score.

Figure 9 shows that group A and B have the highest average score in national identity value at 4.43 and 4.25, respectively, and the lowest in economic value at 3.77 and 3.66, respectively. The order of value average scores of the two groups is the same. From high to low, they are the values of national identity, cultural communication, artistic, educational, emotional, and economic. This indicates that the public has a relatively consistent level of value cognition of the Grand Song of the Dong soundscape heritage. However, all the value average scores of group A have slightly higher than those of group B. Accordingly, the inclusion of visual stimuli have led to a significant increase in the evaluation of heritage values.

Discussion

Through the subjective evaluation of the Grand Song of the Dong, both groups of participants have rated its urgency and importance high, indicating that the general public's awareness of intangible cultural heritage

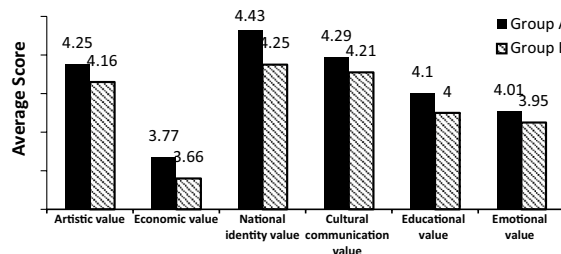


Fig. 9 Evaluation and ranking of the Grand Song of the Dong soundscape heritage

is adequate. However, the low evaluation of the degree of understanding of the Grand Song of the Dong indicates that the cultural promotion of the Grand Song of the Dong is insufficient, thus resulting in the insufficient public attention. Therefore, its cultural dissemination and promotion should be strengthened in the subsequent conservation.

According to the comparison of the perceptual dimensions of the Grand Song of the Dong, under the dual-sensory stimulation of audio-visual, people can feel the sense of scale that is missing under the auditory stimulation only, which indicates that the visual factor causes spatial limitation thus making the participants interact with the heritage itself. Therefore, the soundscape heritage protection of the Grand Song of the Dong should follow the characteristics of living and holistic protection, taking into account the connection between the heritage itself and its cultural environment as well as the interaction between the heritage experiencers and the heritage. The research on urban soundscapes has found that of the five main dimensions of urban residents' perception, namely, relaxation, vitality, representativeness, intensity, and richness, relaxation is the most important perception dimension [54]. The research on the perception of the acoustic environment of the historical ancient city has found three main dimensions: comfort, interest, and physical attributes [55]. In contrast, the Grand Song of the Dong soundscape is composed of five or four dimensions, among which the dimensions of culture, emotion, and rhythm are more important, which shows the traditional historical and cultural soundscape is richer in content. Therefore, its cultural, artistic, and emotional value and role can be emphasized in protection.

In heritage value evaluation, the visual characteristics of a site are usually considered more important [56], the consistency of soundscape and visual landscape enhances people's experience and thus influence the perceived evaluation of the soundscape [57, 58]. According to the evaluation of the heritage value of the Grand Song of the Dong, participants in Group A have evaluated the heritage value higher than Group B. This may be because visual elements such as the background of the Grand Song of the Dong performance caused participants to interact with the heritage itself. While watching the video triggering more associations, influences the participants' evaluation of the heritage value.

Conclusion

This research conducts a study on the subjective evaluation, perceptual dimensions, and heritage values of the Grand Song of the Dong through an audio-visual interaction experiment that allows the participants to interact with the soundscape heritage. The differences in the

perception of the Grand Song of the Dong among different groups of people under the influence of audio-visual senses and single auditory senses have been analyzed separately through questionnaires:

- (1) There is no effect of the visual stimuli on the subjective evaluation of the Grand Song of the Dong soundscape, and the different social characteristics of the participants are the main reasons for the differences. There are certain differences in the results of the subjective evaluation of the Grand Song of the Dong between the two groups of respondents under different sensory stimuli. However, the overall attitude tends to be the same, i.e., the general understanding of the Grand Song of the Dong is low, but there is a positive perception of the urgency and importance of conservation. Further analysis has revealed significant variability in the results of the seven subjective evaluations by different social characteristics of the two groups of respondents.
- (2) Audio-visual interactive stimuli have a greater impact on the perception of the Grand Song of the Dong. Factor analysis has been conducted to obtain the perceptual dimensions of the soundscape of the Grand Song of the Dong under different sensory stimuli of audio-visual. The audio-visual interaction group has five dimensions, viz., culture, emotion, rhythm, atmosphere and scale. The single-auditory group has four dimensions, respectively, culture, emotion, rhythm, atmosphere. The content is richer than certain urban soundscapes and the structure is more balanced. The scale has been perceived only in the condition of audio-visual dual-sensory stimulation, indicating that the perception of the Grand Song of the Dong is more intuitive after the introduction of visual elements. The comparison obtained a large difference in semantic structure within the same perceptual dimension between the two groups, confirming the influence of audio-visual interaction on the perception of the Grand Song of the Dong.
- (3) Audio-visual interactive stimuli have positively influenced heritage value evaluation. The evaluation of heritage values has revealed that both groups have the same average score and rank i.e., the highest is ethnic identity value and the lowest is economic value, whereas the scores for each value are higher with audio-visual stimuli than with the single auditory stimuli.

The experiment has been conducted using 2D video and the audio itself has been processed. In the questionnaire, it is stated that "please fill in the questionnaire after

watching the video/audio in a quiet environment” in order to achieve the purpose of not being affected by the outside environment. However, there is still no guarantee that all the participants’ experimental environment will meet the experimental conditions. In this experiment, considering the large scope outside the Dong cultural area, the online questionnaire has been chosen to obtain more data from different areas, though not all areas outside the Dong cultural area have been covered, hence the experimental results may not be applicable to the comparative study of all areas.

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Author contributions

LM: Conceived and designed the experiments, performed the experiments, analyzed and interpreted the data, contributed reagents, materials, analysis tools or data, wrote the paper. XZ: Performed the experiments, analyzed and interpreted the data, contributed reagents, materials, analysis tools or data, wrote the paper. JM: Performed the experiments, analyzed and interpreted the data, contributed reagents, materials, analysis tools or data. YJ: conceived and designed the experiments, analyzed and interpreted the data, contributed reagents, materials, analysis tools or data. All authors read and approved the final manuscript.

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Availability of data and materials

Data will be made available on request.

Declarations

Competing interests

The authors declare that they have no conflict of interest.

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