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A Residential Space Intervention Study on Cultural Identity of Cross-border Chinese Adolescents--An Assessment of the Emotional Arousal Efficacy of Ancestral House VR Scenes Based on Eye Tracking

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Abstract Chinese-American adolescents' cultural identity problems have become increasingly prominent in the context of globalization, and traditional intervention methods have limited effects. In this study, we used eye-tracking technology combined with electroencephalography EEG measurements to construct an emotional arousal experiment in the ancestral house VR scene, and recruited 20 Chinese adolescent subjects for a cultural identity intervention study. Through the ETG 2wTM eye-tracker of SMI (Germany) and the GES 400 EEG system of EGI (USA), the physiological data of the subjects in different emotional scenes were collected, and the subjective emotional responses were assessed by using the SAM scale. The results showed that the subjects' pupil diameter during positive VR scene interaction was 4.362, which was significantly larger than that of neutral emotion, 4.049; the affective valence of positive emotional behaviors reached 7.163, and arousal was 7.162, both of which were significantly higher than that of the neutral condition; the Chinese adolescent ethnic identity was 5.52, and 66% of the subjects wished to maintain their perceived Chinese ethnicity; and the dimensions of ethnic achievement identity and learning motivation were significantly correlated at the 0.01 level. The study shows that the ancestral house VR scene can effectively stimulate the emotional resonance of Chinese adolescents, provide a technological path for cultural identity intervention, and is of great significance in promoting the overseas transmission of Chinese culture.

Index Terms Chinese adolescents, cultural identity, eye-tracking, ancestral home VR scene, emotional arousal, intervention study

I. Introduction

Ethnic Chinese are an important window for the dissemination of Chinese language and culture overseas, and play an important role in enhancing China's national image and promoting humanistic exchanges between China and foreign countries [1]. In recent years, ethnic Chinese youth have gradually become an emerging force in overseas Chinese communities. However, unlike their grandparents and fathers, most of them have not received systematic cultivation of Chinese culture, lack basic perception and understanding of their ancestral homeland, and their homeland complex is much thinner than that of their fathers and grandparents, so the issue of cultural identity of Chinese adolescents has begun to receive great attention from scholars [2], [3].

Cultural identity is a person's acceptance and recognition of the common values and behaviors of the group to which he or she belongs, and spatial concept plays an important role in this process. Spatial concept is the way people perceive, understand and organize space, and different spatial concepts reflect the lifestyles, values and cultural identities of different groups [4], [5]. Among them, the development of virtual space has an important impact on cultural identity. With the popularization of the Internet, people begin to socialize, express their views and find identity in virtual space, and the formation and development of virtual space enables people from different geographical and cultural backgrounds to communicate and interact [6], [7]. For example, some social platforms and forums provide a space for specific groups of people to express their views and find similar people, or to build a virtual space for living and reminiscing about the past. Through the virtual space, people can find people with similar cultural identities as their own, and deepen their identity and sense of belonging to the culture they belong to [8]-[10].

Ancestral houses are regarded as symbols of family lineage in traditional Chinese culture, and they are important carriers of family culture and family memories, which witness the development and changes of the family, and record

family stories and family mottos that have been passed down from generation to generation [11], [12]. Many important cultural relics and family treasures are preserved in the ancestral house, and these heirlooms represent the glory and tradition of the family. For Chinese youth, the spatial memory value of the ancestral house is an effective path for the enhancement of their cultural identity [13].

In the contemporary society where economic globalization and cultural pluralism are intertwined and developing, the construction of cultural identity of overseas ethnic Chinese groups is facing unprecedented challenges. As a key group of cultural heritage, the complexity of Chinese youth's identity is not only reflected in the choice of cultural belonging at the individual psychological level, but also in the dynamic balance between social integration and cultural maintenance. As a concentrated manifestation of individual's sense of belonging and psychological commitment to a specific cultural group, cultural identity profoundly influences the formation of values, the choice of behavioral patterns, and the future development trajectory of ethnic Chinese adolescents. Traditional research on cultural identity relies on subjective measures such as questionnaires and interviews, and lacks a deep exploration of the mechanism of emotional arousal. As an important driving force in the formation of cultural identity, the physiological mechanisms and psychological processes of emotion need to be revealed by more precise measurement techniques. The rapid development of virtual reality technology provides a new experimental paradigm for cultural identity research, which is able to accurately measure individual's emotional response and cognitive process under the condition of controlling variables by constructing immersive cultural scenes. As an important spatial carrier of Chinese cultural memory, the ancestral house carries deep historical and cultural connotations and emotional support, and has unique cultural symbolic significance and potential for emotional awakening.

Based on the theory of emotional cognition and cultural identity, this study adopts eye-tracking technology combined with the multimodal physiological signal acquisition method of electroencephalography (EEG) to construct an experimental paradigm of emotional arousal in the VR scene of the ancestral house. By comparing and analyzing the pupillary responses, EEG activities and subjective emotional evaluations of Chinese adolescents under different emotion-evoking conditions, the mechanism of emotional arousal of cultural identity by the ancestral house VR scene was revealed. The study adopts a mixed research design combining experimental and survey methods. 20 Chinese adolescents were used as subjects, and objective physiological data were collected by using the German SMI eye-tracking device and the American EGI EEG system, combined with the SAM scale to obtain subjective emotional evaluations, and an assessment system of emotional arousal efficacy was constructed, which provides a scientific basis for the development of intervention strategies for the cultural identity of Chinese adolescents.

II. Research on the cultural identity of cross-border Chinese youth

II. A. Cultural identity studies

II. A. 1) The concept of cultural identity

Cultural identity refers to a person's sense of belonging to a culture that has an important impact on them. This article defines cultural identity as "the confirmation of a shared culture among people or between individuals within a group." The use of the same cultural symbols, the following of common cultural concepts, and the adherence to common thinking patterns and behavioral norms are the basis of cultural identity. "Cultural identity refers to the individual's sense of belonging and inner commitment to the culture and cultural group to which he belongs," "Traditional cultural identity usually comes from kinship and geographical affinity, ancestral place identity, dialect identity, religious belief identity, life customs identity, cultural value identity, etc." "Cultural identity is the sense of identity and belonging that a person is influenced by a culture in the process of development.

"The first category is the Chinese cultural norms that the Chinese consider to be binding on them as Chinese, including the study of the Chinese language, the maintenance of family relationships (especially through the observance of norms regarding childbirth, marriage, and funeral), and support for clan regions and other similar organizations that strengthen the unity of Chinese society." The second category is "those modern cultural norms that the Chinese find useful and necessary to accept, including educational standards and occupational structures outside of Chinese society, as well as non-Chinese language skills, and even religious meals and all kinds of social practices that reflect the complexities of diverse societies."

Some of the traditional Chinese cultural customs are still binding on the new generation of young people. Therefore, we believe that cultural identity is people's psychological belonging after experiencing different cultures, "it affects the social identity and self-identity of individuals, and guides people to love and be faithful to culture, so as to preserve and promote culture, and finally incorporate it into the deep psychological structure of personal values." "A high degree of cultural identity indicates an emotion that tends to be accepting, and a low degree of cultural identity indicates an emotion that tends not to accept." In this study, cultural identity refers to the identification

of Chinese adolescents with Chinese culture, as well as their sense of identity with traditional Chinese thoughts, concepts, and customs [14].

II. A. 2) Links between language attitudes and cultural identity

"Language is the carrier of culture, culture is the soil on which language depends, and language cannot exist independently from culture." There is an inextricable and close link between linguistic attitudes and cultural identity. Language attitudes are the cornerstone of culture, and culture is a visual application of language development. "There is a natural relationship between the language spoken by members of a social group and the cultural-identity of the group." "Every speech act, whether spoken or written, indicates the position of the speaker or author in the social structure of a given culture. Through code switching, the decoded speaker indicates his or her own cultural identity. Therefore, language attitudes and recognition of Chinese culture play an important role in the learning of Chinese language and Chinese culture.

II. B. Research methods and tools

This study is mainly quantitative research, supplemented by qualitative research. The Chinese Learners' Motivation Questionnaire, the self-developed Chinese Culture Mastery Questionnaire and the Multi-group Ethnic Identity Scale were mainly used. The questionnaire consists of four parts: personal information and Chinese language status, learning motivation, ethnic identity, and understanding of Chinese culture. The questionnaire is a "Likert 7 scale", which is bilingual in English and Chinese, and is published through the Internet. A total of 50 valid questionnaires were collected after excluding non-Chinese and mixed-race children. Among the questionnaire providers, 20 were males and 30 were females, and the age was concentrated in the ages of 22-27.

II. C. Analysis of the Cultural Identity of Chinese Youths

Identification with Chinese culture provides Chinese adolescents with endogenous motivation for Chinese language learning, while identification with the Chinese ethnic group directly affects Chinese adolescents' attitudes toward Chinese culture. The identification questionnaire was divided into two parts: ethnic identity and otherness orientation. Ethnic identity includes attitudes toward belonging to the ethnic group, attitudes toward the culture and achievements of the ethnic group, and behavioral practices of participating in ethnic group activities. Other-ethnic orientation, i.e., attitudes toward interacting with other ethnic groups. The survey results are shown in Figure 1. From the figure, it can be seen that Chinese adolescents are clearer about their Chinese identity and have a strong identification with and reliance on the Chinese ethnic group in general (5.52), but they are also active in interacting with other ethnic groups (5.40), and they have more positive attitudes towards Chinese culture and Chinese achievements (4.96), although they are less active in learning and exploring Chinese culture and knowledge (4.45).

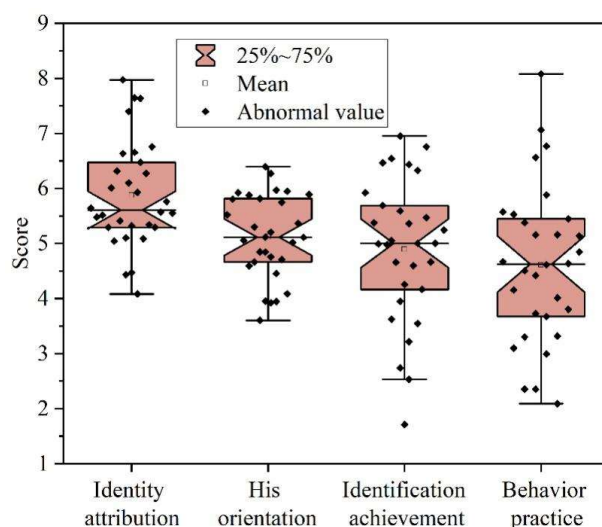


Figure 1: Ethnic identity

We also conducted a survey on how Chinese adolescents want others to perceive them, and the results are shown in Table 1. As can be seen from the table, the majority of Chinese adolescents (66%) want others to notice their Chinese identity and also recognize that they belong to other identities; less than 4% of Chinese want others to see them as foreigners, and none want others to see them only as Chinese.

Table 1: Chinese youth identity survey

Identity	N	Percentage/%
Chinese	0	0
Locals	15	30.00%
Chinese and local	33	66.00%
Other	2	4.00%
Summarize	50	100%

We analyzed the correlation between Chinese adolescents' ethnic group identification and learning motivation, and the results are shown in Table 2. As can be seen from the table, Chinese adolescents' identification with the achievements of the Chinese ethnic group was significantly correlated with all dimensions of motivation at the 0.01 level, and external motivation for practices such as learning and exploring Chinese culture with a high degree of autonomy was significantly correlated with external motivation at the 0.01 level, but did not present a significant correlation with internal motivation. Identity and sense of belonging to the Chinese ethnic group were significantly correlated with all motivational dimensions except external regulation and integrative regulation, which were not significantly correlated with external motivation. Overall, Chinese adolescents showed significant correlations with Chinese language learning motivation in all dimensions of ethnic identity. ** indicates that the correlation is significant at the 0.01 level (two-tailed); * indicates that the correlation is significant at the 0.05 level (two-tailed).

Table 2: Ethnic identity is related to learning motivation

Identity		External regulation	Internal adjustment	Identity regulation	Integrated regulation	knowledge	achievement	stimulate	inmotivation
Identification achievement	Pearson	0.475**	0.601**	0.589**	0.587**	0.478**	0.425**	0.653**	0.026
	Sig.	0.002	0.001	0.001	0.001	0.001	0.003	0.001	0.874
Behavior practice	Pearson	0.274	0.400**	0.495**	0.378**	0.152	0.040	0.263	0.039
	Sig.	0.056	0.004	0.001	0.007	0.287	0.785	0.062	0.801
Identity attribution	Pearson	0.147	0.345*	0.378**	0.258	0.389**	0.412*	0.521**	-0.142
	Sig.	0.311	0.015	0.009	0.069	0.007	0.016	0.001	0.325
His orientation	Pearson	-0.118	0.063	0.142	-0.098	0.078	0.154	0.085	-0.215
	Sig.	0.415	0.703	0.322	0.495	0.587	0.278	0.569	0.125

To summarize, Chinese adolescents have a very clear perception of Chinese identity, a high sense of identification and belonging to the Chinese community, a strong sense of pride in their Chinese background and culture, and a clearer understanding of the significance of Chinese identity to them. The sense of belonging to the Chinese community and the identification with the Chinese culture provide an intrinsic and inexhaustible motivation for the learning and transmission of Chinese language and culture. They do not want to be excluded from Indonesian society while maintaining their Chinese ethnic identity, which affects their initiative to learn and explore Chinese culture.

II. D. Intervention Strategies for Chinese Youth Cultural Identity

II. D. 1) Promoting the localization of Chinese language education in foreign countries

The localization of Chinese language education is a sign of the high degree of development of Chinese language in foreign countries. The localization of international Chinese language education is equivalent to the localization of education support, i.e., the use of local language, culture, teachers and other resources to carry out language teaching, mainly including the localization of teaching concepts, teaching contents and teaching services. In order to realize the high-quality development of Chinese education in foreign countries, it is necessary to promote the localization of Chinese education in foreign countries.

Chinese language has a long history in foreign societies, but it has not been formally incorporated into the education system for a long time. Compared with other foreign language education in foreign societies, Chinese education is still in the primary stage of insufficient localization. In analyzing the localization of Chinese education in foreign countries, it is suggested that in the initial stage of introducing a foreign language into any country, it is necessary to rely to a large extent on the resources of the mother country of the foreign language, especially the teaching framework system and the basic teaching resources such as teachers and teaching materials, which is a general law of foreign language teaching. Therefore, the government should give full play to China's resource

advantages as a native Chinese-speaking country, and give foreign countries the strongest support in terms of basic teaching resources, so as to promote the localization of Chinese education in foreign countries.

II. D. 2) Enhancement of the national image and consolidation of the identity of young people of Chinese descent

International Chinese language education is a window for the dissemination of Chinese culture overseas and an important channel for shaping and presenting national image. At the same time, the enhancement of the national image is also an important help to promote the spread and development of Chinese language in other countries. For foreign Chinese communities, the enhancement of China's national image can strengthen their ethnic and cultural identity, and promote their language attitude to become more and more positive. Therefore, efforts should be made to enhance China's national image and consolidate the identity of ethnic Chinese abroad.

The ways to enhance the national image cover all levels of politics, economy and culture, but in view of the cultural attributes of language teaching and the high degree of recognition of Chinese culture by foreign Chinese communities, it is practicable to enhance the national image at the cultural level with the starting point of enhancing the retention of the Chinese language by foreign Chinese communities. Cultural activities are an important means of presenting Chinese culture, which can strengthen the exchanges between Chinese and British people at the cultural level, enhance the popularity of Chinese culture in foreign countries, consolidate the Chinese identity and improve the national image of China at the same time. Cultural activities can be categorized into official level and private level according to the different implementation subjects, and the author believes that in the highly sensitive political environment of the world today, it is more prudent to carry out private cultural activities.

III. A Study of Emotional Arousal of Cultural Identity among Chinese Youth Based on Eye Tracking

III. A. Subjects

A total of 20 subjects were recruited for this experiment, all of whom were Chinese adolescents in school, including 10 males and 10 females. All subjects were between 20 and 26 years old. All subjects had normal visual acuity or corrected visual acuity, no history of mental illness, were in good mental health before the experiment, and were not familiar with the VR equipment used in the experiment (the ancestral house scene). All subjects were informed in detail about the content of the experiment before the experiment and voluntarily agreed to sign an informed consent form.

III. B. Experimental equipment

(1) **Eye tracking system:**In this experiment, the ETG 2wTM manufactured by SMI Germany was used to collect the subjects' eye movement data, with a sampling rate of 120 Hz, a three-point calibration method, and a visual acuity correction range of $-400^{\circ}\sim 400^{\circ}$.The data collection and data analysis were done by Experimentcenter 3.5 and Be-gaze 3.6 software, respectively [15].VR hardware includes a head-mounted display (HMD), a computer or game console, a motion tracker, a touch grip, and other peripherals. The head-mounted display (HMD) is the most important hardware device, which presents the virtual world to the user through the display and lenses.

(2) EEG Acquisition System: EEG data were collected using the GES 400 EEG system produced by EGI, USA. A 64-conductor high-density network electrode cap was used, with the Cz electrode as the reference, 0.05~70 Hz band-pass filtering, and 1000 Hz sampling. The positions of the high-density network electrodes are shown in Figure

2.

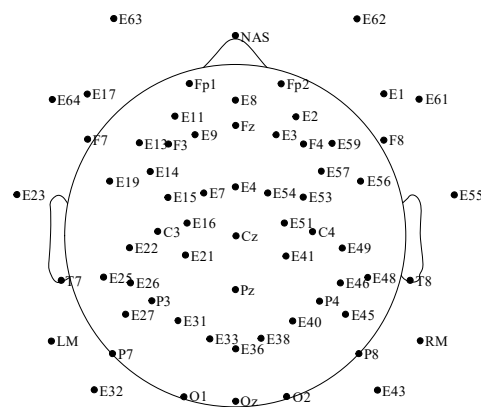


Figure 2: The position of high density network electrode

(3) Subjective emotion evaluation scale: A 9-point SAM scale was used to obtain the subjective evaluation results of user emotion. The SAM scale was divided into three dimensions of valence, arousal and dominance, and each dimension was divided into 9 grades (1 for low valence/arousal/dominance; 5 for medium valence/arousal/dominance; 9 for high valence/arousal/dominance), which were described by cartoon character expressions. Subjects compared the cartoon character's expression with their own emotional state and selected the cartoon character that best described their emotional state in each dimension.

III. C. Data processing

The EEG data were first previewed in NetStation5 with the quiet state as the EEG signal reference, and the larger artifacts were manually removed, and then converted to a .raw format file, which was imported into Matlab2014a and processed using the EEGLAB v13.2.2b toolbox. The main steps included 1) converting the reference to a bilateral mastoid reference, resampling to 300Hz, and low-pass filtering at 50Hz; 2) removing artifacts such as ophthlmoelectric and electromyographic traces by using independent component analysis; 3) segmenting the EEG data, and extracting the EEG data of the interaction process of the VR scene of each ancestral house for each subject; 4) calculating the power spectral density by using the Pwelch method (512 points) Hanning window with 50% overlap), calculate the absolute power value of each rhythm wave by the frequency bands of delta (1~4Hz), theta (4~8Hz), alpha (8~13Hz), beta (13~30Hz), and gamma (30~45Hz), and then calculate the relative power of

the five rhythm waves, which is given by the following formula: absolute power $PS_x \sum_{w1}^{w2} p(w) * d$.

where: $x = \delta, \theta, \alpha, \beta, \gamma$; frequency resolution $d = \frac{1}{4.096s} \approx 0.244Hz$.

$$\text{Relative power } RP_x = \frac{P_x}{P_\delta + P_\theta + P_\alpha + P_\beta + P_\gamma}.$$

Frontal region alpha wave asymmetry index = F4 electrode alpha relative power - F3 electrode alpha relative power [16].

III. D. Assessment of Emotional Arousal Efficacy

The mean and standard deviation of the pupil diameters during the four types of ancestral house VR scene interactions are shown in Figure 3. The results of the paired-samples t-test showed that the pupil diameter of subjects induced by positive emotional behaviors (4.362) was significantly larger than that of neutral emotional behaviors (4.049) during the positive VR scene interaction. In contrast, negative emotional behaviors induced larger pupil diameters than neutral emotional behaviors during the negative VR scene interaction task. This suggests that positive emotional behaviors and sad emotional behaviors were able to induce larger pupil diameters in subjects. In addition, there was no significant difference in the pupil diameters induced by positive and negative VR scene interactions when neutral emotional behaviors were demonstrated in VR.

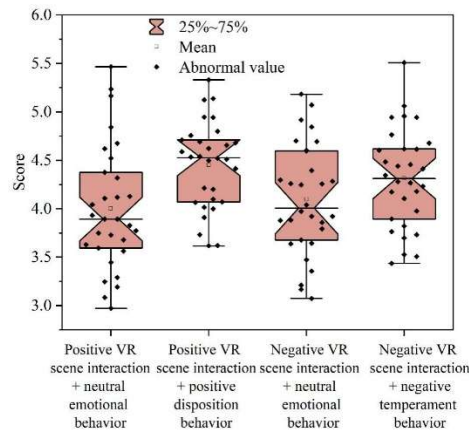


Figure 3: Eye data

The subjective emotional evaluation results of the subjects during the four VR scene interactions are shown in Table 3. The results of the paired-sample t-test show that: In the positive VR scene interaction process, compared with the neutral emotional behavior, the positive emotional behavior of VR (ancestral house scene) brought about

a significant increase in the emotional valence of the subjects, a significant increase in arousal, and no significant change in dominance. In contrast, in the negative VR scene interaction task, compared with the neutral emotional behavior, the subjects' affective valence brought about by the negative emotional behavior of VR (ancestral house scene) significantly decreased, arousal significantly increased, and dominance did not change significantly. This suggests that VR (Ancestral House Scene) positive emotional behaviors can enhance subjects' positive emotions, while negative emotional behaviors can enhance subjects' negative emotions.

When the VR (Ancestral House Scene) demonstrated neutral emotional behaviors, the positive VR scene interaction process elicited significantly greater emotional potency from the subjects than the negative VR scene interaction process, with no significant difference in arousal and no significant difference in dominance. This confirms that VR scene interaction processes can elicit changes in subjects' emotions.

Table 3: Subjective emotional evaluation data for subjects

	Valence		Arousal		Dominance	
	M	SD	M	SD	M	SD
Positive VR scene interaction + neutral emotional behavior	6.322	0.684	6.402	0.835	5.214	1.038
Positive VR scene interaction + positive disposition behavior	7.163	0.967	7.162	0.964	5.485	1.402
Negative VR scene interaction + neutral emotional behavior	3.857	0.904	6.236	0.789	4.871	1.263
Negative VR scene interaction + negative temperament behavior	2.936	0.885	7.068	1.027	4.781	1.207

III. E. Intrinsic Mechanisms of Emotional Arousal and the Construction of Cultural Identity

The typical path that produces a close correlation between emotional drive and the construction of cultural identity is a complex and multidimensional process that involves the interaction between the emotional response of the individual's inner world and the socio-cultural environment. We can sort out and recognize it in depth from the following aspects.

III. E. 1) The chain reaction of emotional arousal

Emotions, as we analyze and grasp them here, are instinctive human reactions to particular events, phenomena, or thoughts that influence behavioral decisions and mental activities. Emotion-driven implies that behavior is motivated by an individual's emotional experiences, which are usually deep and immediate. Emotion-driven is a hot topic in psychology and communication research in recent years, especially in the field of video content creation and distribution. The modern media environment is filled with all kinds of information and content, and viewers' acceptance of video content depends largely on the emotional response it triggers. Emotional drivers play a central role in this process, influencing not only how content creators produce their content, but also how it is distributed and how viewers ultimately react to it.

III. E. 2) The persuasive effect of cultural identity

Cultural identity refers to an individual's identification with and sense of belonging to certain cultural values, customs and symbols. This sense of identity is gradually built up through the interaction between the individual and the culture, as well as the individual's self-positioning in the cultural environment. In the context of globalization, the construction, communication and acceptance of cultural identity have become particularly important. Short video, as an emerging communication medium, provides a platform for individuals to express and shape their own cultural identity. Social constructivists believe that reality is constructed through social interactions, and individual cognition and behavior are deeply influenced by the socio-cultural environment.

III. E. 3) The stimulation and impact of emotional arousal on cultural identity

The drive of positive emotions (e.g., patriotic passion, national pride, etc.) can deepen an individual's identification with a particular culture. In contemporary society, branded short videos have become an important cultural communication tool, conveying cultural values through the power of visuals and emotions. In China, for example, many brands use short videos to promote national culture and inspire patriotic fervor, and such a strategy can significantly enhance viewers' identification with a specific culture. This is emotional resonance driving cultural identity. The common logic is that branded short videos usually evoke emotional resonance in viewers by telling touching stories or showing compelling images. When these stories and images are closely related to traditional Chinese culture or modern national achievements, such as showcasing traditional Chinese festivals, scenic spots, historical heroes, etc., they can inspire viewers' national pride and patriotism. This positive emotional experience deepens the audience's sense of identity and belonging to Chinese culture.

IV. Conclusion

Ancestral house VR scene, as an innovative technical means of cultural identity intervention, demonstrated significant effects in the emotional arousal of Chinese adolescents. The experimental data showed that the positive VR scene could effectively stimulate the positive emotional responses of the subjects, with an emotional potency score of 7.163 and an arousal score of 7.162, both significantly higher than the 6.322 and 6.402 scores in the neutral condition. The eye movement data further confirmed this finding, and the pupil diameter induced by positive emotional behavior was 4.362, which was significantly larger than that of 4.049 in the neutral emotion, indicating that the VR scene had a strong emotional infectivity. The group characterization of Chinese adolescents showed that 66% of the subjects wished to maintain the dual identity perception of Chinese and local, with an ethnic identity score of 5.52, reflecting a strong sense of cultural belonging and identity awareness.

There is a close intrinsic correlation mechanism between emotional arousal and cultural identity construction, and VR technology can break through the time and space limitations of traditional cultural education through visual immersion and emotional resonance, providing Chinese youth with intuitive and vivid cultural experiences. As an important carrier of Chinese cultural memory, the ancestral house scene contains rich emotional symbols and cultural connotations, which can effectively stimulate the individual's sense of cultural belonging and national identity. The application of eye-tracking technology provides an objective and reliable means of evaluating the effectiveness of emotional arousal, makes up for the shortcomings of the traditional subjective evaluation methods, and provides a new technological path and methodological support for the study of cultural identity intervention, which is of great theoretical value and practical significance for the promotion of the overseas transmission of Chinese culture and the construction of the identity of the Chinese adolescents.

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