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Research Article

Correlation Analysis between Cultural Differences and Normal Music Perception Based on Embedded Voice Multisensor

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In order to effectively improve the sense of difference brought by the extracorporeal machine to users and minimize the related derived problems, the implementation based on embedded multisensor has become a major breakthrough in the research of cochlear implant. To explore the impact of different cultural differences on timbre perception, effectively evaluate the correlation between cultural differences and music perception teaching based on embedded multisensor normal hearing, evaluate the discrimination ability of embedded multisensor normal hearing to music timbre, and analyse the correlation between cultural differences and timbre perception, it provides a basis for the evaluation of music perception of normal hearing people with embedded multisensor and the design and development of evaluation tool. In this paper, adults with normal hearing in different cultures matched with music experience are selected to test their recognition ability of different musical instruments and the number of musical instruments by using music evaluation software, and the recognition accuracy of the two tests is recorded. The results show that the accuracy of musical instrument recognition in the mother tongue group is 15% higher than that in the foreign language group, and the average recognition rates of oboe, trumpet, and xylophone in the foreign language group are lower than those in the mother tongue group, the recognition rate of oboe and trumpet in wind instruments was low in both groups, and the recognition rate of oboe and trumpet in foreign language group was high.

1. Introduction

The integration of high and new technology has caused structural changes in the world. With the emergence of network, the theme of industrial technology has shifted from measurement and control to information management and integration; the emergence of distributed intelligence makes the processing of information more flexible and in various forms [1]. Commercialized science and technology, open structure, enterprise integration and technology separation increasingly call for the emergence of a new industrial structure. Embedded multisensor will play an important role, the structure of traditional distributed measurement and control has changed, and embedded network has increasingly become the core of industrial application. As an independent node in the network, embedded multisensor can build an Internet-based measurement and control system on site for real-time and dynamic online measurement and control, which has changed the traditional wiring mode and information processing technology, it changes the composition of the traditional measurement and control system so that all kinds of field information can be dynamically released and shared in all kinds of LAN or WAN in real time and online [2]. At the same time, its remote operation and configuration function under the background of Internet adds a new landscape to the measurement and control field. It will develop and mature quickly, so as to effectively drive and promote the progress of modern measurement technology, that is, network measurement technology.

Embedded multisensor is a new type of sensor with Internet function developed on the basis of intelligent sensor. Its goal is to adopt standard network protocol and modular structure to organically combine sensor and network technology. After AD conversion and data processing, the analogy signal output by the sensitive element is encapsulated into a data frame by the network processing device according to the program setting and network protocol, plus the destination address, and transmitted to the network through the network interface [3]. In turn, the network processor can accept the data and commands sent by other nodes on the network to realize the operation of this node. In this way, the sensor becomes an independent node in the measurement and control network. Compared with traditional sensors, embedded multisensor is more reliable, cheaper, and more scalable [4]. Different from the traditional sensor output analogy signal, this sensor can process the original data internally and exchange data with the outside world through the Internet, so as to realize the miniaturization, networking, and intelligence of the sensor. More importantly, this embedded multisensor based on TCP/IP can realize the virtual presence of detection, manufacturing, and maintenance personnel through Internet network according to the actual needs, which brings great room for development to the expansion of the system [5]. It makes the measurement and control system rely on the enterprise intranet in data acquisition, information release, and system integration and makes the measurement and control network and information network unified, which has a wide range of significance [6].

The implementation of embedded multisensor has become the key to solve the problems of people's inferiority and autism, inconvenient social use, and so on. In order to minimize these derived problems, embedded multisensory helps to improve patients' confidence in artificial auditory implantation. As a cultural medium that can transcend the existence of cultural differences, music discusses the impact of different cultural differences on timbre perception, effectively evaluates the correlation between cultural differences and music perception teaching based on embedded multisensor normal hearing, and evaluates the discrimination ability of embedded multisensor normal hearing to music timbre. This paper selects adults with normal hearing in different cultures with matching music experience, tests their recognition ability of different musical instruments and the number of musical instruments with music evaluation software, and records the recognition accuracy of the two tests, in order to explore the impact of cultural differences and music perception teaching of normal hearing people based on embedded multisensor.

2. Related Technologies Based on Embedded Multisensor

2.1. Characteristics and Architecture of Embedded Multisensor. The essence of embedded multisensor is to realize informatization, networking, and intelligence on the basis of traditional sensors. Its core is to make the sensor itself realize TCP/IP network communication protocol and take the sensor as a network node to communicate directly with the computer network [7]. To be exact, embedded multisensor is no longer a sensor in a simple sense. It has covered the functions previously belonging to instruments and microcomputers.

The touchy unit is composed of a touchy component and a conditioning circuit. The sensitive issue converts the measured signal into an electrical signal, and the conditioning circuit completes the signal preprocessing aspects such as analogy filtering and amplification [8]. Intelligent processing unit is the core of intelligent sensor, which mainly completes signal data acquisition, processing, and data output scheduling. Based on the characteristics of high reliability, low power consumption, low cost, and micro volume of intelligent sensor, embedded microprocessor system is the best choice. TCP/IP communication protocol interface unit converts the sensor signal into a data stream that can comply with the protocol format transmitted over ethernet to realize seamless access between sensor information and network [9]. This unit is additionally the core of community sensor, in phrases of precept and structure, regular sensors solely account for a phase of embedded multisensor. The core part is the embedded good unit to entire signal processing, information exchange and control, and the TCP/IP neighborhood interface to complete statistics transmission. Embedded multisensor is mainly composed of three parts: sensitive unit, intelligent processing unit, and TCP/IP communication protocol interface. Its architecture is shown in Figure 1.

The working mechanism of the whole sensor is as follows: the sensor converts the measured physical quantity into electrical signal, converts it into digital signal through AD, and transmits the result to the network after data processing by microprocessor; the data exchange with the network is completed by the network interface module based on TCP/IP protocol [10]. The internal memory of the embedded multisensor stores the physical characteristics of the sensor, such as offset, sensitivity, and calibration parameters; microprocessor realizes data processing, compensation, and output calibration; TCP/IP protocol realizes the direct network connection of sensors. Compared with traditional sensors, embedded multisensor based on TCP/IP is more reliable, cheaper, and more scalable. It can directly process and process the original data internally and exchange data with the outside world through the Internet [11]. Therefore, it has miniaturization, networking, and intelligence; the networked interface of sensors realizes the interconnection of Internet for information publishing and resource sharing.

Embedded multisensor has the following characteristics. First, it has the characteristics of high reliability and low cost. Second, it can judge and make decisions according to the input signal and has the functions of self-detection, self-calibration, and self-protection [12]. Third, different application systems do not need to use different sensors. On the basis of a single sensor, the function of the sensor can be changed through software design to meet the different needs of customers. Fourth, the most popular TCP/IP network communication protocol is used as the carrier to transmit sensor data and exchange information with the outside world through the Internet. Fifth, the control network composed of embedded multisensor communicates directly with the computer network. Technicians use the browser to manage the working state of embedded

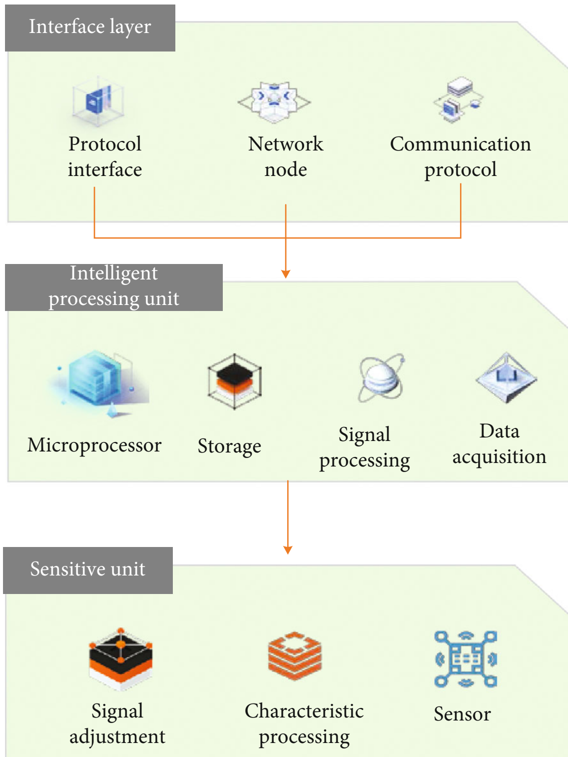


Figure 1: Architecture of embedded multisensor.

multisensor through the network and implement remote measurement and control [13]. Sixth, it realizes the transfer from traditional data collection and transmission to networked information management and integration.

2.2. Hardware Architecture Based on Embedded Sound Sensor Node. Embedded microprocessor is the heart of the whole sensor node. It is responsible for processing and transmitting the collected data. Therefore, the choice of embedded microprocessor must be cautious. Several problems should be paid attention to in the selection of embedded microprocessor: (1) performance, the microprocessor must have sufficient performance to meet various software and hardware requirements in the project; (2) tool support, which can support software creation, debugging, code integration, etc.; (3) operating system support, the microprocessor must be able to support at least one embedded operating system; (4) application support: according to the requirements of the system, it must be able to support specific applications and add some hardware according to the system requirements; (5) cost, according to the easily damaged characteristics of sensor nodes, we require that the price of microprocessors must be low enough; (6) power consumption, according to the low-power characteristics of sensor networks, the selected microprocessor is required to be low power and can manage the power of other modules.

Wireless transmission is the core of the whole sensor node and the core of wireless sensor network. The choice of wireless transceiver directly affects the transmission rate and performance of the whole sensor network. Based on the above characteristics of wireless sensor networks, we use the CC1000 module of Chicon company in this project [14]. Wireless transceiver CC1000 is a monolithic transceiver designed for low-voltage wireless communication applications. It no longer solely has the traits of low working voltage, low power consumption, small volume, no want of any off-chip filter circuit, and can without delay interface with exterior antenna, which is very suitable for integration, but also has the characteristics of programmable output strength and transceiver frequency. It adopts FSK modulation mode, the maximum baud rate is 76.8 kbps, and the external interface is similar to SPI, which can directly interface with microcontroller. It is very suitable for low energy consumption and small volume applications. The sound acquisition module is the key part of the whole design, what we want to achieve is high-precision and low-noise sound acquisition [15]. The sound sensor we pick out wm62a for acquisition, digital processing of sound sign is the key part, which has a giant and direct effect on speech recognition. Use an external chip to digitize the sound instead of using a microprocessor, chose Philips uda1380 chip. It is a single-chip stereo audio codec module, only 1.1 mm thick. The chip supports the application mode that different chip parts are disconnected in nonoperating states such as playback or recording. It has the function of filtering noise and adopts low-power design, which can save power and prolong battery life. This feature can save half the power under full load operation. The power management part is responsible for the power supply of other modules. Its main function is to stabilize the input voltage.

The basic element of wireless sensor networks is sensor nodes. Sensor nodes must have the functions of data acquisition, information processing, wireless communication, and power management at the same time. For different application environments, the composition of nodes may be different, but the composition of other nodes is basically the same except for different sensors. A node is normally composed of sensor, microprocessor, memory, digital to analog converter, Wi-Fi transceiver, and strength supply. In this system, we integrate the microprocessor and memory into one to form a processing module and the sound sensor and digital to analog converter into one to form a sound acquisition module. The structure of the sound sensor node of the system is shown in Figure 2.

2.3. Implementation Process of Sound Sensor. The intelligent processing unit that completes signal processing and data exchange is mainly realized by the later generation of intelligent sensors of traditional sensors. For the network interface to complete data transmission, it is the core to realize the network sensor. Through the use of microprocessor, the sensor itself realizes the intelligence of data acquisition and processing and the TCP/IP networking of data transmission. Because the sensor can realize TCP/IP network communication protocol, it is the core of the whole system. The working flow of the auditory sensor is shown in Figure 3. Firstly, convert the sinusoidal waveform voltage accumulated via the left and proper microphones into top value, and begin the timer to measure the frequency of the sinusoidal wave. If the frequency value is smaller than the critical value, the peaks

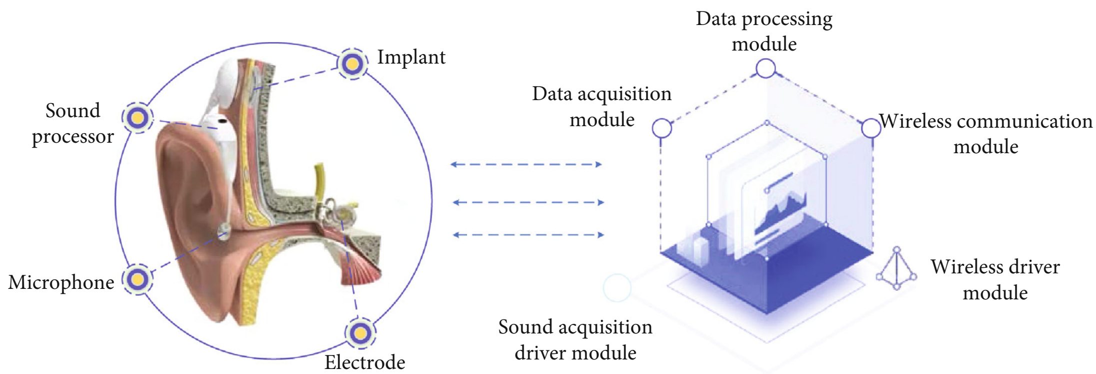


Figure 2: Overall design of embedded sound multisensor hardware.

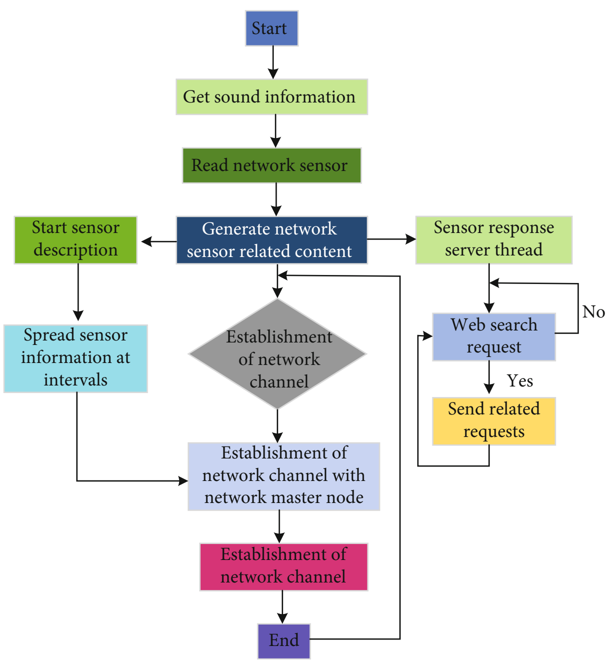


Figure 3: Implementation process of sound sensor.

and peaks of the two sine waves are compared [16]. If the peak value of the left channel is greater than that of the right channel and the difference between the two is greater than an experimental empirical value, turn your head to the left; on the contrary, turn your head to the right. The empirical value here is determined by experiment, which is equivalent to determining the sensitivity of auditory sensor [17].

Processing each short segment of sound signal is actually a transformation or operation on each short segment. The general formula is

$$Q_n = \frac{\sum_{m \longrightarrow -\infty}^{+\infty} |\text{sgn}\,[x(m)] - \text{sgn}\,[x(m-1)]|}{w(n-m)}. \quad (1)$$

In the case of discrete-time signal, when two adjacent samples have different algebraic symbols, it is called zero crossing, which represents the number of times that the signal waveform passes through the horizontal axis in a frame of sound. It can be calculated by the number of times that two adjacent samples change symbols:

$$Z_n = \frac{\sum |\text{sgn}\,[x(m)] - \text{sgn}\,[x(m-1)]|}{w(n-m)}. \quad (2)$$

Let $S_w(n)$ be a windowed sound signal, whose nonzero interval is $n \in [0, N-1]$, and the autocorrelation function of $S_w(n)$ is called the short-time autocorrelation function of the sound signal. Expressed by $R_w(l)$, see

$$R_w(l) = \frac{\sum_{n=-\infty}^{+\infty} S_w(n) S_w(n+1)}{\sum_{n=0}^{N-l-1} S_w(n) S_w(n+l)}. \quad (3)$$

It is easy to prove that $R_w(l)$ is an even function, that is $R_w(l) = R_w(-l)$, and $R_w(l)$ are always 0 outside the $l = (-N+1) \sim (N-1)$ interval.

$$S_w(\exp(jw)) = \sum_{n=0}^{N-1} S_w(n) \exp(-jwn). \quad (4)$$

For the actual sound signal, although $d(n)$ is not equal to zero, its value is very small. These minima will appear at the position of integer multiple cycles. For this purpose, the short-time average amplitude difference function can be defined:

$$F_n(k) = \sum_{m=0}^{N-1-k} |x_n(m) - x_n(m+k)|. \quad (5)$$

The difference between the actual sound sample value and the sound prediction value obtained by linear prediction is called linear prediction sound residual.

$$\varepsilon_n(m) = S_n(m) - \sum_{i=1}^{p} a_i S_n(m-i). \quad (6)$$

By detecting the short-time average amplitude difference function analysis, the maximum peak value is detected in an appropriate range. Moreover, because the spectrum of the error signal obtained by inverse filtering of the original signal is close to flat and the formant effect has been removed, the more accurate pitch period can be extracted by calculating the residual signal.

3. Materials and Methods

3.1. Clinical Data. Inclusion criteria are as follows: (1) older than 16 years old; (2) all frequencies of binaural pure tone hearing threshold (250, 500, and 1000 air conduction thresholds) were 20 dB HL; and (3) none of them had received professional music training. 80 cases of adult mother tongue group and foreign language group with matching music experience were selected. Among the 80 cases of mother tongue group, 36 were males and 44 were females, aged from 18 to 60, with an average age of (31.7 ± 9.6). In the foreign language group, there were 38 males and 42 females, aged from 18 to 35 years, with an average age of (23.5 ± 4.4).

3.2. Test Materials and Methods. Munich music questionnaire was used to evaluate the music listening experience of normal hearing subjects based on embedded multisensor. The instrument recognition test and instrument number discrimination test in music test software are used to comprehensively evaluate the timbre perception ability of people with normal hearing based on embedded multisensor.

3.3. Statistical Analysis. SPSS 22.0 software was used for data statistical analysis. The t-test and Mann–Whitney U method were used to analyse whether the music experience of mother tongue group and foreign language group matched; one-sample Kolmogorov–Smirnov test is used to analyse the music test results of the two groups. If the distribution is normal, t-test is used to analyse the difference of music test results between the two groups. If it is nonnormal distribution, the Mann–Whitney U method is used to compare the music test results between the two groups.

4. Result Analysis

4.1. Comparative Analysis of Music Experience. From the analysis of Mumu questionnaire results, there is no significant difference in music experience between the two groups. Therefore, the music experience of the two groups of subjects in this study is matched. The specific results are shown in Figure 4.

4.2. Analysis of Musical Instrument Number Discrimination Results. The correct rate of identifying the number of musical instruments in the foreign language group (80.50 ± 16.32)% was slightly higher than that in the mother tongue group (73.25 ± 21.17)%, and the difference was not statistically significant ($P > 0.05$). See Figure 5 for the correct rate of distinguishing the number of musical instruments of the two groups. When playing 3~4 musical instruments at the same time, the discrimination accuracy of the two groups is similar, but when one musical instrument is played alone or two or five musical instruments are played at the same time, the discrimination accuracy of the mother tongue group is slightly worse than that of the foreign language group.

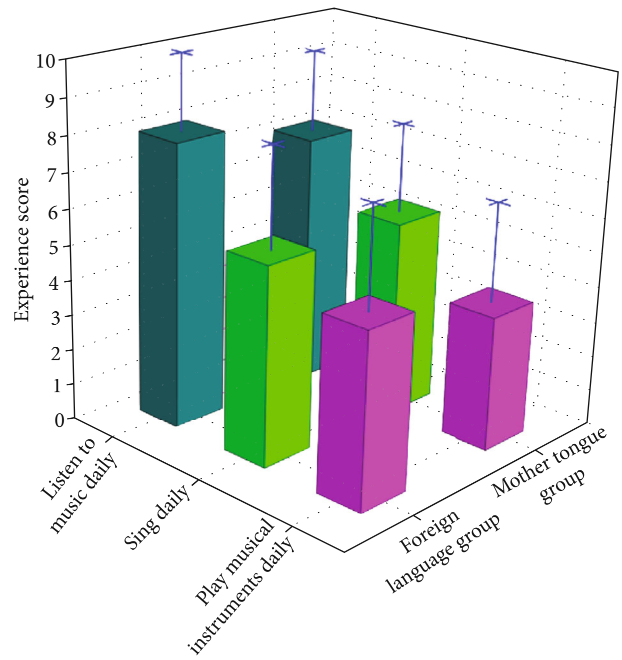


Figure 4: Comparison of music experience scores in the questionnaire.

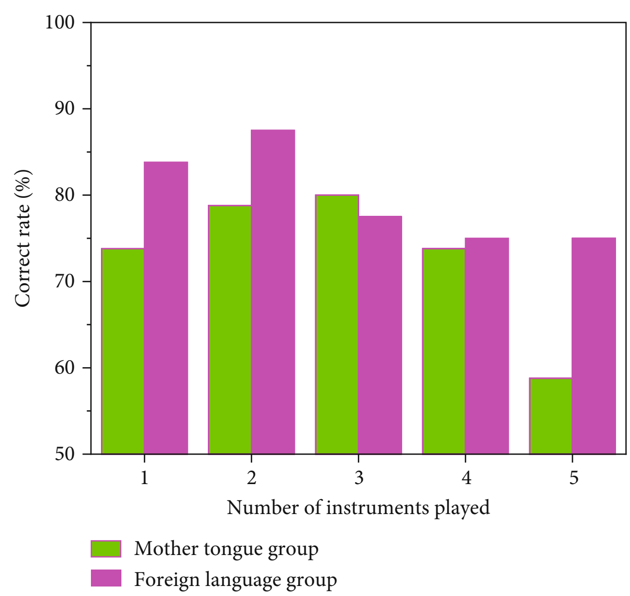
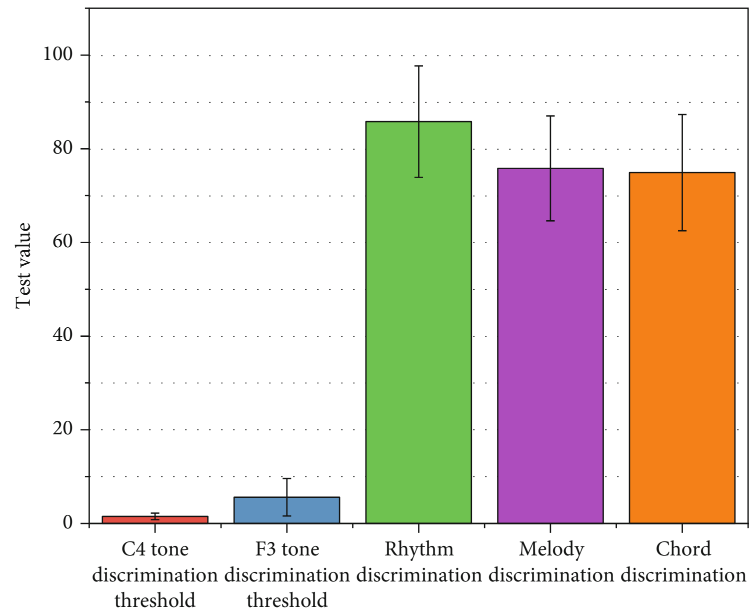


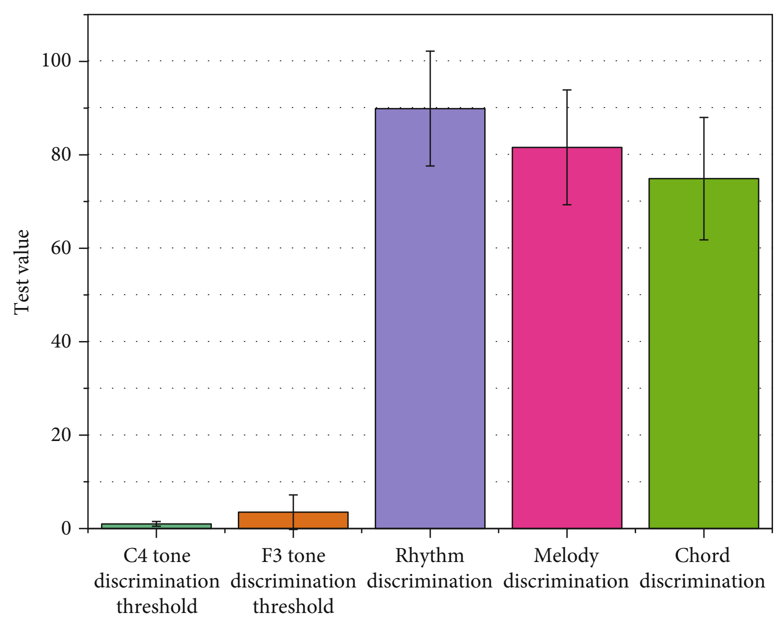
Figure 5: Comparison of test results of discrimination accuracy of the number of musical instruments played.

4.3. Objective Test Results of Music Elements. The results of F3 tone discrimination threshold and melody discrimination test in the mother tongue group were lower than those in the foreign language group ($P < 0.05$). There was no significant difference in C4 tone discrimination threshold, rhythm discrimination, and rotation discrimination between the two groups ($P > 0.05$). Comparison of music software test results is shown in Figure 6.

4.4. Subjective Test Results of Music Understanding. Figure 7 shows the results of music emotion test. The results of items



(a) Mother tongue group



(b) Foreign language group

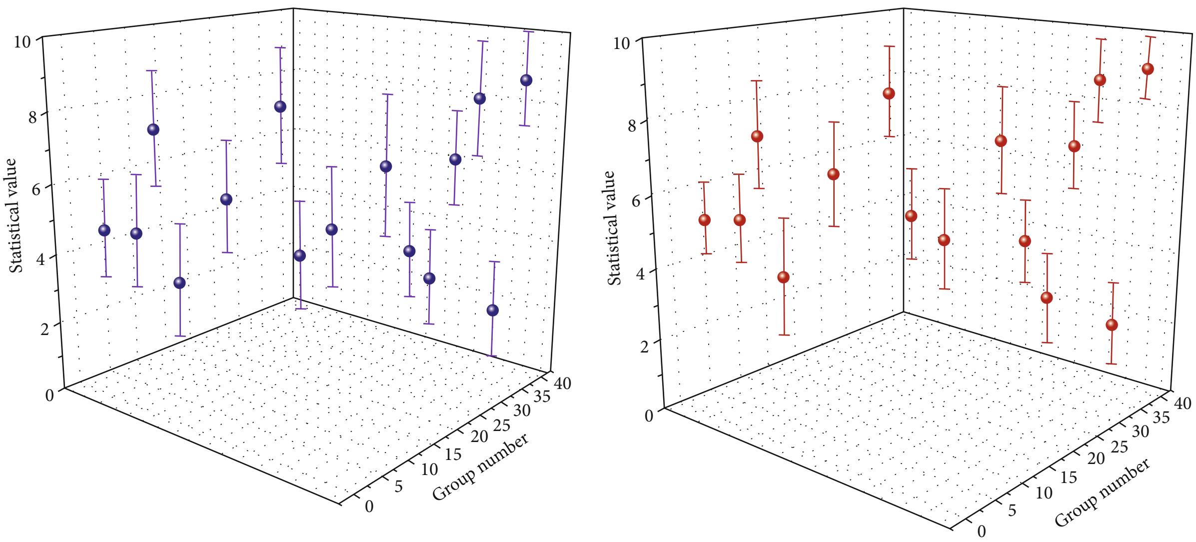
Figure 6: Comparison of music software test results.

21, 5, 13, and 32 in the mother tongue group are lower than those in the foreign language group, and the difference is statistically significant ($P < 0.05$).

Figure 8 shows the disharmony test results. The results of items 32 and 34 in the experimental group are lower than those in the control group, and the difference is statistically significant ($P < 0.05$).

5. Discussion

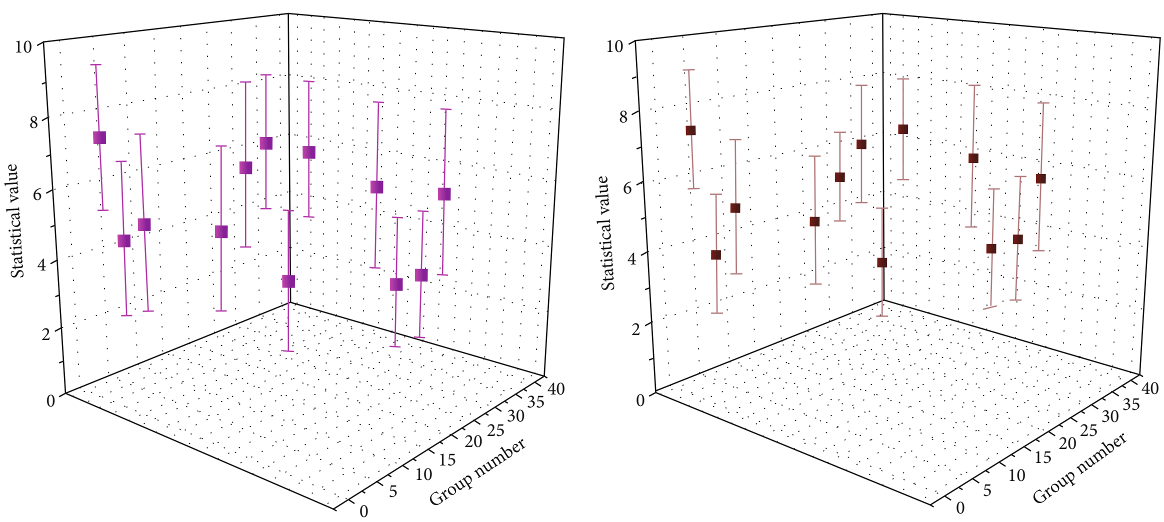
Different regions have different historical and cultural backgrounds. Music, as the essence of culture, is influenced by it; different regions have different forms of music, resulting in a strong national character of music. In the previous research of this research group, there are significant differences in music tone and melody discrimination between foreign normal subjects and Chinese normal subjects, while the results of rhythm discrimination, music emotion perception, and discord perception are basically the same, suggesting that cultural differences do have a certain impact on music perception, especially in melody perception. Based on the previous research, this study explores the differences in the perception of music timbre among normal hearing people based on embedded multisensor [12]. Timbre is one of the basic elements of music; it is an auditory perceptual attribute that enables the listener to distinguish two similar sounds



(a) Mother tongue group

(b) Foreign language group

Figure 7: Analysis of music emotion test results of different numbered music.



(a) Mother tongue group

(b) Foreign language group

Figure 8: Analysis of disharmony test results of different numbered music.

when the tone, rhythm, loudness, and duration are the same. It is a sound characteristic formed by the same pitch frequency but different numbers of overtones. Timbre perception ability is to evaluate the ability of listeners to distinguish different musical instruments or speakers according to different timbre when the tone, duration, and loudness are consistent [13]. Therefore, timbre perception plays a very important role in listeners' understanding and appreciation of music. The listener's perception of timbre is mainly reflected by the ability to distinguish different musical instruments. Due to the differences in the cultural characteristics of the development of musical instruments and the differences in the production materials, materials, and attributes of musical instruments, different types of musical instruments have been formed in China and the West [18]. In this study, instrument recognition test and instrument number discrimination test in music evaluation software were used to evaluate the timbre perception ability of Chinese and foreign subjects, respectively, and to explore the correlation between cultural differences and timbre perception.

The results of this study show that the timbre recognition ability of the mother tongue group is significantly better than that of the foreign language group. It is speculated that the reason is that the difference of cultural background leads to the fact that the normal listening mother tongue group in this test is not familiar with western musical instruments, and even the mother tongue group has less contact with some musical instruments such as oboe, resulting in the reduction of the accuracy of timbre recognition and evaluation of the mother tongue group. In addition, through the confusion matrix of different musical instruments, it can be seen that for piano, violin, xylophone, tenor, and soprano, the recognition rate of the two groups of subjects is or basically close to 100%, indicating that these five timbres are familiar to Chinese and foreign subjects, so the recognition rate is high [19]. For the oboe and trumpet, the subjects in both groups were confused, and the confusion rate of the mother tongue group was high, because the timbre recognition was mainly realized through the physical and acoustic characteristics of sound [20]. The oboe, as the representative of woodwind instrument, and the trumpet, the representative of brass instrument, belong to the family of woodwind instruments, and their appearance and sound production principle are similar; in addition, the mother tongue group is less familiar with these two traditional western instruments, so it is easy to be confused compared with other families such as string instruments or keyboard instruments [21].

Musical instrument recognition is a general evaluation method of timbre perception ability. As early as 2002, Greller and others evaluated the subjects' timbre perception ability through the recognition of eight musical instruments. The results showed that the correct rate of musical instrument recognition in the normal hearing group was 91%. In 2009, Kang et al. reported that the musical instrument recognition rate of normal hearing subjects in the United States reached 94.2% [22]. Domestic related research was carried out relatively late, mainly focusing on the series of studies of this research group. In 2012, Wang and others conducted a timbre recognition test on Chinese adult patients with cochlear implant and those with normal hearing, which showed that the recognition rate of 12 normal hearing people's musical instruments was 88.3%, and the correct recognition rate of the number of musical instruments was 73.5%, which was consistent with the results of this study. In the study of Brookmeyer et al., the discrimination accuracy of the number of musical instruments of 67 German hearing normal people was 77.3%, and the discrimination accuracy gradually decreased with the increase of the number of musical instruments [23, 24]. It can be seen that the instrument number identification test is more difficult than the instrument identification test. The timbre perception results of foreign subjects in this study are slightly better than those reported in foreign studies. The possible reason is that five western instruments and tenors and sopranos that are easy to identify are selected in the instrument recognition in this study, which makes the test items less difficult than those in foreign studies; the combination and matching difficulty of the five musical instruments selected in the identification of the number of musical instruments is also less than that of foreign studies [25].

In the instrument number discrimination test, the results show that although the discrimination rate of the foreign language group is slightly higher than that of the mother tongue group, there is no statistical difference, indicating that the correlation between instrument number discrimination and cultural differences is not significant. The results of this study show that when playing 3~4 musical instruments at the same time, the discrimination accuracy of the two groups of subjects is similar, but when one musical instrument is played alone or 2 and 5 musical instruments are played at the same time, the discrimination accuracy of the mother tongue group is slightly worse than that of the foreign language group [26, 27]; and the discrimination rate of the two groups of subjects playing 1~3 musical instruments at the same time is higher than that of playing 4~5 musical instruments at the same time, so it can be concluded that the more musical instruments are played at the same time, the more significant the discrimination difficulty is, which is consistent with the results of foreign studies. However, because the musical instrument number discrimination ability is based on the musical instrument recognition ability, it is still difficult for people with normal hearing and there are obvious individual differences. Therefore, in the future test of timbre perception ability of cochlear implant recipients, our research group will add the musical instrument number discrimination test as appropriate to adjust the appropriate test difficulty and time.

The perception of timbre is affected by the listener's music background, cultural background, and other factors. Different listeners' cognition, familiarity, professional or amateur music training experience, and cultural and educational background will have an impact on timbre recognition. For those with normal hearing based on embedded multisensor, the perception of timbre is more complex. In addition to the limitations of technology itself, the music background and national cultural background of those with normal hearing based on embedded multisensor also affect their timbre perception ability and then affect their perception and appreciation ability of music.

6. Conclusion

Different cultural differences have a significant impact on timbre perception. It is suggested that in the future, when designing and developing music perception assessment tools, we should combine the characteristics of music culture and select assessment materials suitable for the population on the selection of musical instruments and related differences, so as to truly meet the actual situation of the population. Therefore, this experiment intends to compare and study the music listening behaviour and music perception ability of people with normal hearing based on embedded multisensor and analyse the correlation between cultural differences and music perception, in order to provide a theoretical basis for the design and development of music evaluation tools for people with normal hearing based on embedded multisensor.

Data Availability

All data, models, and code generated or used during the study appear in the submitted.

Conflicts of Interest

No potential conflict of interest was reported by the authors.

References

[1] M. Kamei, H. Sato, and Y. Odashima, “Comparison of music perception between hearing-aid modes in normal subjects and subjects with hearing impairment,” *Practice Oto-Rhino-Laryngological*, vol. 109, no. 6, pp. 439–444, 2016.

[2] Y. Jiang, “Analysis on cultural differences and accuracy in Japanese teaching,” *Chongqing and the World*, vol. 31, no. 7, pp. 68–72, 2014.

[3] L. Zhao, “Analysis of cultural differences between British and American literal translation in cross cultural context,” *Journal of Heihe University*, vol. 9, no. 5, pp. 151-152, 2018.

[4] S. M. Prentiss, D. R. Friedland, J. J. Nash, and C. L. Runge, “Differences in perception of musical stimuli among acoustic, electric, and combined modality listeners,” *Journal of the American Academy of Audiology*, vol. 26, no. 5, pp. 494–501, 2015.

[5] Y. Li, X. Rui, S. Li, and F. Pu, “Investigation of global and local network properties of music perception with culturally different styles of music,” *Computers in Biology and Medicine*, vol. 54, no. 4, pp. 37–43, 2014.

[6] S. A. Huff, R. T. Dean, and K. N. Olsen, “Interrater agreement in memory for melody as a measure of listeners’ similarity in music perception,” *Psycho-musicology*, vol. 27, no. 4, pp. 297–311, 2017.

[7] B. Gao and W. Zhou, “Analysis and translation strategies on cultural differences between Chinese and Western,” *Sino American English Teaching*, vol. 11, no. 12, pp. 952–961, 2014.

[8] L. Zhou, “Cochlear implant correlation music perception music quality,” *Journal of Clinical Otorhinolaryngology, Head, and Neck Surgery*, vol. 33, no. 1, pp. 47–51, 2019.

[9] X. Tong and J. Wu, “Application of embedded server in wireless sensor networks,” *Wireless Interconnection Technology*, vol. 18, no. 12, pp. 25-26, 2021.

[10] J. Yin, X. T. Chen, Y. Shen, and D. C. Liu, “Application of open-source embedded platform in the teaching of sensor courses of Internet of things,” *Chinese Journal of Multimedia and Network Teaching*, vol. 12, no. 10, pp. 13–16, 2021.

[11] S. H. Pu, Y. Guo, and T. W. Lei, “Influence of step difference on measurement of embedded static pressure sensor,” *Electronic Technology and Software Engineering*, vol. 12, no. 7, pp. 69-70, 2020.

[12] Y. R. Liu, “Design and implementation of intelligent control terminal based on embedded sensor network,” *Digital Communication World*, vol. 15, no. 7, pp. 99–102, 2019.

[13] W. Huang, “Design and application of embedded system sensor,” *Nanfang Agricultural Machinery*, vol. 50, no. 9, pp. 222–226, 2019.

[14] Y. T. Wu, B. C. Xu, and Y. F. Guo, “Research progress on music perception of cochlear implant recipients,” *Chinese Journal of otology*, vol. 19, no. 3, pp. 518–521, 2021.

[15] L. P. Yang, L. Lu, L. Liu, G. T. Liang, H. Jin, and D. D. Tao, “Study on the correlation between Chinese tone perception and music perception of cochlear implant users,” *Chinese Journal of otology*, vol. 17, no. 6, pp. 905–909, 2019.

[16] Q. Li, B. Feng, and J. Liu, “Study on the effect of cochlear implant on music perception in post lingual deaf adults,” *Chinese Journal of Otology*, vol. 17, no. 4, pp. 564–567, 2019.

[17] Z. Zhou, X. Gu, and B. Liu, “Study on music tone perception of cochlear implant users,” *International Journal of Otolaryngology Head and Neck Surgery*, vol. 15, no. 4, pp. 193–199, 2019.

[18] Y. L. Ding, Z. Zhou, and B. Liu, “Tone recognition and music perception in patients with binaural and bimodal hearing aids,” *International Journal of Otolaryngology Head and Neck Surgery*, vol. 13, no. 2, pp. 98–102, 2019.

[19] Z. Zhou, X. Gu, and L. Bo, “Sound quality perception and music perception of adult cochlear implant users,” *Journal of Clinical Otolaryngology Head and Neck Surgery*, vol. 33, no. 1, pp. 47–51, 2019.

[20] J. Q. Cai and H. Z. Zhang, “Research progress on music training and central remodelling of cochlear implants,” *Chinese Journal of Medicine*, vol. 98, no. 26, pp. 2134–2136, 2018.

[21] W. Sun and H. Zhang, “Speech evaluation of adult cochlear implant,” *Chinese Journal of Medical Frontier*, vol. 8, no. 10, pp. 7–13, 2016.

[22] X. Gu, Z. Y. Liu, B. Liu, B. E. Qi, R. J. Dong, and S. Wang, “Correlation analysis between cultural differences and music timbre perception,” *Journal of Clinical Otolaryngology Head and Neck Surgery*, vol. 30, no. 20, pp. 1589–1592, 2016.

[23] G. Qu, P. Yu, J. N. Li, and S. M. Yang, “Research progress on music perception of cochlear implants,” *Chinese Journal of Otology*, vol. 13, no. 4, pp. 742–745, 2015.

[24] Y. Zheng, B. Liu, R. J. Dong et al., “Study on the development of musical ability after cochlear implantation in children,” *Journal of Clinical Otolaryngology Head and Neck Surgery*, vol. 28, no. 16, pp. 1188–1191, 2014.

[25] Y. T. Mao, Z. Y. Nie, D. H. Xie, and W. J. Wu, “Research status of cochlear implant technology and music conversion,” *Chinese Journal of Otology*, vol. 12, no. 1, pp. 158–164, 2014.

[26] R. J. Dong, S. Wang, Y. Zhou, B. E. Qi, X. Q. Chen, and B. Liu, “Study on the normal value of music evaluation system,” *Journal of Clinical Otolaryngology Head and Neck Surgery*, vol. 27, no. 13, pp. 712–716, 2013.

[27] P. Gu, X. Xi, D. Y. Han et al., “Research on pitch and speech perception of cochlear implant users using fine structure coding strategy,” *Journal of Clinical Otolaryngology Head and Neck Surgery*, vol. 27, no. 10, pp. 481–484, 2013.