

Vocal Teaching Reform Driven by Textile Aesthetics: the Construction of a Choral Part Coordination Training System Using Textile Patterns as Visual Aids

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ABSTRACT In vocal music education, choral part coordination training has traditionally relied on auditory judgment and conducting gestures, while the absence of intuitive visual references often leads to cognitive ambiguity in pitch control and vocal integration. Based on an interdisciplinary perspective, this study introduces textile aesthetic pattern elements into vocal teaching and constructs a choral part coordination training system using textile patterns as visual aids. Line direction, color layering, unit repetition, texture density, and pattern structure are extracted from textile patterns and transformed into teaching parameters such as part-entry prompts, pitch visual mapping, volume intensity guidance, and spatial positioning cues. Three core modules are designed: pattern-guided vocal training, vocal part spatial positioning simulation, and quantitative coordination assessment. A 24-week teaching experiment is conducted with 120 university choir students divided into experimental and control groups. The results show that the experimental group improves significantly in pitch deviation rate, vocal part integration, and auditory spatial perception. The findings demonstrate that textile patterns can enhance the visualization, systematicity, and measurable feedback of choral coordination training.

INDEX TERMS textile aesthetics, vocal music teaching, choral training, voice part coordination, visual aids

I. INTRODUCTION

CHORAL singing which is an important component of vocal music education aims at the coordination and cooperation of these multiple voices. Traditional choral teaching is based mostly on the hand gestures of the conductor and auditory judgment of the students. This one-dimensional training model has some limitations when looking at the overall understanding of voice relationships in students. In practice, students for example often have problems like pitch deviations, imbalance in volume leading to masking of the voice. The underpinning cause can be a delay in auditory feedback, and inability to stabilize voice positioning references. Therefore, breaking through the limitation of traditional training model, and exploring the method of multisensory collaborative vocal music teaching is an important direction of the current vocal music education research.

As an important branch of visual arts, textile aesthetics has a sense of order and hierarchy in the composition of the pattern clearly. Features such as continuous patterns, color gradations, and unit repetition in textile patterns have an inherent correspondence in visual structure with the

primary and secondary relationships, entry sequence, and dynamic levels between the choral vocal parts. Based on this understanding, this study suggests applying the use of textile patterns as visual aid into the training of choral vocal coordination, through a systematic model of teaching. The crux of this model is the concretization of the abstract vocal relationships in visual pattern information so that students can create spatial positioning of vocal parts through visual reference during singing to improve the accuracy and stability of vocal coordination. This paper discusses this from the three levels until system construction, teaching implementation and effect verification, and exploring a feasible path for the reform of vocal music teaching driven by the textile aesthetic elements.

II. RELATED WORK

In the contemporary landscape of vocal music teaching research, technological empowerment and model innovation have become two core driving forces. Based on the era of the booming development of new media technology, Zhong [1] pointed out that this technology provides new ideas and perspectives for the reform and innovation of vocal music

teaching in college music majors. Yuan [2] focused on the application of artificial intelligence technology in the field of education and teaching, and explored various factors that affect the quality of vocal music teaching under the support of artificial intelligence technology. Xu and Xia [3] proposed and developed a speech recognition system based on Markov model, which is specifically applied to remote vocal music teaching scenarios. Ma and Zhao [4] analyzed the current situation of vocal music teaching in universities, and studied how to optimize teaching strategies on this basis. Duan [5] studied the specific ways of applying virtual reality technology to vocal music teaching, and analyzed how it changes the traditional teaching scenarios and models. Zhou [6] emphasized the importance of integrating aesthetic education concepts into vocal music teaching in colleges and universities, and pointed out that this helps to improve students' comprehensive qualities and achieve the deep goals of art education. Han [7] examined the specific application of information intelligent teaching methods and analyzed the actual impact of this method on the effect of vocal music teaching. Zhang and Zhang [8] explored how vocal music teaching can adapt to and utilize this new educational form. Li [9] proposed a series of innovative strategies for vocal music teaching in higher vocational music performance majors, aiming to better connect teaching with industry needs and improve students' professional abilities. Dou [10] studied the application and innovation of the flipped classroom teaching model in college vocal music teaching and demonstrated the innovative value of the flipped classroom model in college vocal music teaching. Existing explorations have not fully explored the potential teaching value of visual art elements - especially figurative textile aesthetic symbols - in vocal music cognition and vocal part coordination. This paper aims to construct a choral vocal part coordination training system with textile patterns as visual aids and explore new paths for interdisciplinary elements to empower vocal music teaching.

III. METHODS

A. CONSTRUCTION OF THE MAPPING RELATIONSHIP BETWEEN PATTERN FEATURE EXTRACTION AND VOCAL TRAINING PARAMETERS

To effectively apply textile patterns in choral vocal coordination training, it is first necessary to systematically extract the visual features of textile patterns and establish a correspondence between them and the core parameters in vocal training. This study selected three typical textile pattern types as visual aids: continuous loop patterns, gradient layered patterns, and unit repetition structures. Continuous loop patterns have the visual characteristic of being connected end-to-end and infinitely extended; their cyclical rhythm highly matches the training format of cyclical entry and alternating rounds in choral singing. In the specific extraction process, the study selected three representative materials: traditional Chinese cloud patterns, Western paisley patterns, and modern geometric continuous patterns,

and converted them into dynamically displayable visual signals through digital processing. Gradient layered patterns present a clear progression through color transitions, which can be used to map pitch changes and the alternation of primary and secondary voices. This study selected seven colors (red, orange, yellow, green, cyan, blue, and purple) from the color wheel to form a gradient sequence, dividing it into seven levels. Each level corresponds to a different pitch range, from low to high, for a total of seven pitch levels. To avoid cognitive interference, volume intensity is no longer represented by color saturation, but instead by the brightness (lightness) of the pattern: higher brightness represents a louder volume, and lower brightness represents a softer volume, with seven brightness levels corresponding to a volume range from the softest (ppp) to the loudest (fff). The unit repetition structure is composed of multiple identical or similar visual units, which can intuitively reflect the parallel relationship and independence of each voice part in the texture. The study designed three basic geometric units: circle, square and triangle. Each unit corresponds to a voice part category. The size of the unit corresponds to the number of voice parts and the density of the unit arrangement corresponds to the activity level of the voice parts singing [11].

At the parameter mapping level, the study correlates the direction of lines in the pattern with directional cues for the entry of vocal parts. When lines smoothly flow from left to right, it indicates that the vocal part should enter smoothly; when lines turn upwards or downwards, it indicates that the vocal part should adjust its attack strength or breath depth. Color saturation is related to pitch; the higher the saturation, the higher the pitch; the lower the saturation, the lower the pitch. The number of unit repetitions is correlated with the number of times a vocal part is repeated; when three units appear side-by-side on the screen, it indicates that the vocal part should be repeated three times. Furthermore, this study established a mapping relationship between pattern texture density and vocal part activity and volume intensity: denser textures indicate higher vocal part activity and increased volume; according to the intensity-brightness correlation in psychoacoustics, a stronger volume is usually perceived as a brighter timbre. Sparser textures indicate more stable vocal part performance and reduced volume, resulting in a softer timbre. This mapping is based on the auditory masking effect and vocal cord closure mechanism—dense vocal part layering enriches high-frequency overtones, thereby perceptually enhancing timbre brightness. This study divided the spectral centroid frequency into seven levels (from 2000 Hz to 5000 Hz), each level corresponding to a texture density: the denser the texture, the higher the expected spectral centroid frequency (more focused timbre); the sparser the texture, the lower the expected spectral centroid frequency (softer timbre). The theoretical basis for this mapping relationship comes from cross-modal perception research: there is a characteristic similarity match between the density of visual texture and

the centroid frequency of the auditory spectrum—dense, repetitive visual units have high-frequency components in spatial frequency, and have structural similarity with auditory signals of high spectral centroid frequency in terms of the “fineness of energy distribution”; at the same time, cognitive load theory points out that dense visual information requires higher attentional focus, and this cognitive state will naturally guide the singer to adjust the vocal resonance cavity (such as pharyngeal cavity contraction and enhanced vocal cord closure) through the mirror neuron system, thereby producing a more focused and penetrating sound. By establishing this multidimensional mapping relationship, students can adjust their singing state in real time according to pattern information during the performance. For example, when the visual pattern presents a gradual change from light to dark stripes, students need to adjust the singing intensity according to the volume of the corresponding vocal part; when multiple parallel geometric units appear in the pattern, students need to understand the position of their own vocal part and its relationship with other vocal parts; when the pattern texture changes from sparse to dense, students need to change the position of their vocal part accordingly, so that the spectral centroid frequency moves closer to the preset target value. The construction of this mapping relationship laid the theoretical foundation for the design of subsequent teaching modules and also provided a basis for the standardized output of visual aid information [12-13].

B. DESIGN OF PATTERN-GUIDED VOICE COORDINATION TRAINING MODULE

Based on the mapping relationship between patterns and vocal parameters, three progressive training modules were designed: single-voice pattern following training, two-voice pattern comparison training, and multi-voice pattern fusion training. Each module contains several sub-tasks, forming a tiered training system. The monophonic pattern following training uses continuous, cyclical patterns as the primary visual material and comprises three sub-tasks. The first sub-task is basic following training, where students must closely observe the scrolling pattern trajectory on the screen while singing a monophonic melody. Students need to map the scrolling speed of the pattern (pixels per second) to the beat speed (BPM) and simultaneously change the note value ratio. The second sub-task is tempo variation following training, where the pattern's scrolling speed on the screen changes randomly. Students must adjust their singing rhythm based on these speed changes, cultivating the ability to synchronize visual signals with singing behavior. The third sub-task is training in emotional expression. The color saturation of the patterns changes with the mood of the music. Students need to adjust their volume and breath control based on these color changes to indirectly support emotional expression. It's important to emphasize that emotional expression involves multiple dimensions, including lyrics, harmony, and musical phrases. Color saturation

serves only as a visual cue, helping students perceive the general direction of the emotion, rather than mechanically mapping emotional investment to a single visual variable. Students still need to integrate their understanding of the lyrics and musical structure to comprehensively interpret the emotions during the training. The training objective of this module is to establish students' basic responsiveness to visual signals, enabling them to make an initial association between pattern changes and singing behavior, laying the foundation for subsequent more complex training. The training of contrasting patterns for two parts introduces a gradient pattern. Two different color gradient patterns are presented on the screen at the same time, corresponding to the high part and the low part respectively [14]. The high-frequency mode uses a warm color gradient with five saturation levels, from light red to dark red, corresponding to pitches from low to high; the low-frequency mode uses a cool color gradient with five saturation levels, from light blue to dark blue, corresponding to pitches from low to high. This module has two sub-tasks. The first sub-task is volume balance training. Students need to pay attention to the color change of the pattern corresponding to their own part during the singing process. When the color saturation of the pattern increases, the student needs to increase the singing volume; when the saturation decreases, the student needs to decrease the singing volume. At the same time, the student also needs to observe the pattern status of the other part through peripheral vision to adjust the volume balance between their own part and the other part. When the color saturation of the two parts tends to be consistent, the volume is indicated to be balanced. The second sub-task is alternating primary and secondary training. The brightness of the two patterns on the screen changes randomly. The pattern with higher brightness corresponds to the main melody part, and the pattern with lower brightness corresponds to the accompaniment part. Students need to quickly switch singing roles according to changes in brightness, cultivating their ability to flexibly grasp the primary and secondary relationships between vocal parts. The training focus of this module is to cultivate students' dynamic perception of vocal parts, enabling them to achieve coordination between vocal parts with visual reference.

The multi-part pattern fusion training uses a repetitive unit structure pattern. The screen displays a composite pattern composed of multiple geometric units, each unit corresponding to a vocal part. The arrangement of the units corresponds to the spatial distribution of the vocal parts on the stage: the front left area corresponds to the first high voice, the front right area to the second high voice, the rear left area to the first low voice, and the rear right area to the second low voice. The density of the unit's texture corresponds to the liveliness of the vocal part's performance; higher density indicates a more lively performance, while lower density indicates a more stable performance. This module has two sub-tasks. The first sub-task is spatial positioning training. During performance, students must determine the sound

image positioning based on the position of their own unit and maintain this positioning without drifting with changes in vocal intensity. The second sub-task is overall fusion training. When all vocal parts are sung simultaneously, the overall pattern presents a harmonious and unified visual effect. If a unit experiences a sudden change in texture or a positional shift, it indicates a performance deviation in that vocal part, requiring immediate adjustment. When all units are neatly arranged and the texture density is balanced, a complete textile pattern will appear in the center of the screen, providing students with positive visual feedback. The training objective of this module is to achieve holistic and integrated perception under multi-part coordination, enabling students to form a stable cognition of spatial positioning of voice parts with visual assistance.

C. QUANTITATIVE EVALUATION METHODS FOR VOICE PART COORDINATION

To objectively assess the impact of pattern-assisted training to improve vocal coordination, a quantitative evaluation system with three indicators was built. The first is indicated by pitch deviation rate. Pitch information from the singing of the students was extracted using professional audio analysis software and deviation of the actual pitch of each vocal part of the song from the standard pitch was calculated on average. This deviation rate is expressed as a percentage, where the lower the value the stronger the pitch control. The second indicator is that of the degree of vocal blending. Spectral analysis technology was applied to identify overlapping regions of audio signals from each of the vocal parts, and the harmonic overlap rate between vocal parts was determined. A higher rate of overlap represents better blending of the voice. The third indicator is auditory spatial perception accuracy. A simulated stereo sound field was used to test the ability of students to judge the spatial localization of different vocal parts. During the test, independent audio signals for each singing vocal part were randomly presented and students were made to note the position of each singing vocal part in the auditory space. The accuracy rate was computed as a percentage of correct judgment out of the total number of tests.

All three indicators were gathered in a standardised teaching environment. The test piece has been treated uniformly by a cappella choral work called “The Half Moon Rises” and the test duration has been controlled with precision of 8 minutes. The rate of deviation of the pitch was calculated in reference to the standard pitch of the twelve-tone equal temperament. The spectral analysis range for voice part integration by way of setting to between 80Hz and 1200Hz. The auditory spatial perception test made use of an 8-channel surround sound simulation system. All training for both the experimental and control groups was conducted in a dedicated multimedia choral classroom equipped with the same 8-channel surround sound simulation system, and testing was also performed within the same system environment. The speaker layout, sound field param-

eters, and signal routing of this system remained constant throughout the 12-week experiment. During training, the spatial localization sub-task of the multi-part mode fusion training module (see Section 3.2) relied on this system to present the virtual spatial positions of each part in real time, enabling students to develop spatial awareness of each part in an auditory environment completely consistent with the actual test. Therefore, the improved accuracy of auditory spatial perception reflected in the post-test was not due to short-term adaptation to the testing equipment, but rather a genuine improvement in ability resulting from the teaching intervention. After all the data collection was finished, paired-samples t-test was employed to analyse the significant difference between the pretest and posttest data of the experimental group and the control group in order to verify the real teaching effect of pattern-assisted training. This study was approved by the Ethics Committee of Yang-En University, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

D. CONTROL MEASURES FOR THE NOVELTY EFFECT

To eliminate the potential interference of the novelty effect on the experimental results, the following control measures were implemented during the experimental design phase: First, the control group received a similarly novel vocal training activity during the 12-week teaching period, but unrelated to the visual mapping of textile patterns. This involved rhythmic following exercises using abstract geometric shapes (such as randomly changing circles and squares), with no systematic mapping relationship between the shape changes and pitch, volume, or vocal space. This activity maintained consistency with the experimental group’s pattern-assisted training in presentation (dynamic visual stimuli on the screen), training duration, and interaction frequency, lacking only the structured mapping between textile pattern features and vocal parameters. Second, neither group of students had prior exposure to any form of visually assisted vocal training, and both groups were taught by the same teacher with identical teaching progress and practice pieces. Through this design, a balance was achieved between the “fun of encountering new methods” and the “novelty of visual stimuli” for both groups, allowing the post-test differences between groups to be more reliably attributed to the textile pattern mapping mechanism itself, rather than simply the novelty effect.

IV. RESULTS AND DISCUSSION

A. INTERGROUP COMPARATIVE ANALYSIS OF PITCH DEVIATION RATE

After 24 weeks of teaching experiment, the study assessed the pitch deviation rates of the experimental and control group before and after testing. In the pre-test phase, the deviation rates of the two groups’ pitch was relatively similar with the experimental group having an average deviation rate of 17.8% and the control group having 18.1%

and the difference is not statistically significant. In the post-test phase, the rate of pitch deviation in the experimental group was reduced to 9.3% and of the control group to 15.2%. In terms of the extent of decrease, the decrease rate of the experimental group was 8.5 percentage points, and that of the control group was only 2.9 percentage points, indicating that the improvement effect of the experimental group was significantly better than that of the control group. (See Table 1).

TABLE 1. Comparison of pitch deviation rates between the two groups of students before and after the test (%)

Group	Pre-test average deviation rate	Post-test average deviation rate	Decline rate
experimental group	17.8	9.3	8.5
control group	18.1	15.2	2.9

The data indicates that the great improvement of the pitch control in experimental group was closely related to the pattern guided training. The single voice pattern after training received visual cues about the attack of the notes (through the constant cyclical changes in the patterns) causes less deviations in the pitch, due to the inaccurate timing. Color gradient cues in two-voice training allowed students to better comprehend dynamic changes in volume, eliminating pitch deviations that are caused by too big or too little volume. The parallel presentation of repetitive unit structures in the multi-voice training helped to resensitize the students to the placement of the individual voice within the texture of the ensemble structure and thereby allowed to reduce the interference of pitch values in between the voices. The control group, without the extra visual reference support of the visual-vocally linked-cued auditory training, had the pitch deviation rate reduced mainly through the development of muscle memory from repeated practice, hence the improvement was fairly modest.

B. SPECTRAL DETECTION RESULTS OF VOICE PART INTEGRATION

The sound blending degree was measured by using the spectral analysis and the harmonic overlap rate of each sound's audio signal within the overlapping frequency bands was mainly calculated. In Figure 1, in the phase of pre-test, the degree of sound blending of the experimental group was 62.4% and 63.1% in the control group which is nearly equal between the two groups. In the post-test period, the sound blending degree of experimental group and control group were 81.7% and 69.5% respectively. The experimental group's improvement by 19.3 percentage points was far beyond the 6.4 percentage points improvement of the control group, and so the blending effect of the experimental group was far better than that of the control group.

The better vocal blending represents the enhanced control students have over the harmonic relationship between the vocal parts. In traditional training of choral singers, students

are often limited to the pitch and rhythm of the part they sing, and have no explanation of the overall harmonic effect of the music. Pattern assisted training, whereby the visual presentation of vocal relationships enables the students to see intuitively the textural overlap of each vocal part. When all the vocal part pattern units are neatly arranged and the texture density is good, students can see harmonious visual feedback, thus enhancing the pursuit of the vocal blending. The substantial improvement in blending in the experimental group in the post-test suggests that the visual-assisted training successfully compensated for the lag in the auditory feedback that allowed the students to modify the harmonic relationships between their own vocal part and other vocal parts in the singing in real time. Due to the lack of visual reference, the improvement of vocal blending by the control group was mainly dependent on the error correction prompts from the conductor, and the improvement was relatively slight.

C. COMPARISON OF AUDITORY SPATIAL PERCEPTION ACCURACY

The accuracy of the auditory spatial perception was tested by using an 8-channel surround sound simulation system. Independent audio signals from each sound source were randomly played and students had to determine the position of each sound source in the auditory space. As shown in Figure 2, in the pre-test phase, the average accuracy rate of the experimental group was 64.7%, and in the control group, the accuracy rate was 65.2%, which shows that there is no significant difference between the two groups. In the post-test phase the accuracy rate of experimental group now came to 83.4% and the control group came to 71.8%. The experimental group's improvement was 18.7 percentage points and the control group's improvement was only 6.6 percentage points, which means that the spatial perception ability of the experimental group was better than that of the control group.

The improvement of auditory spatial perception is closely related to spatial positioning simulation on pattern training. In multi-part pattern fusion training, the location of each part in the space of the screen is the same as the position of the different parts of the voice on the stage. While singing, students not only fixate on the state of their individual unit but need to sense the position of other units in relation to them in the form of visual references. This spatial positioning training allows the student to progressively develop spatial relation between hearing and sight in order to better judge the space orientation of each vocal part in the post-test. In the control group the training did not involve the use of visual references for the positioning in space and only the auditory experience could be used by the students to judge the position of the vocal parts. The accuracy increased with long-term auditory accumulation and the effect of improvement was relatively slow. The data obtained from the experimental group indicate that using pattern for assisting training can be effective to accelerate the cognitive

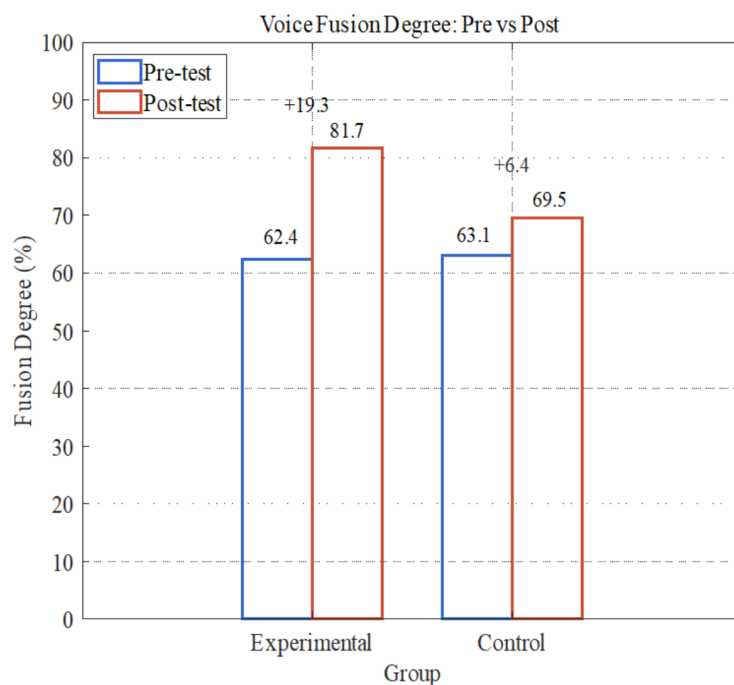


FIGURE 1. Comparison of vocal blending degree before and after tests for two groups of students (%)

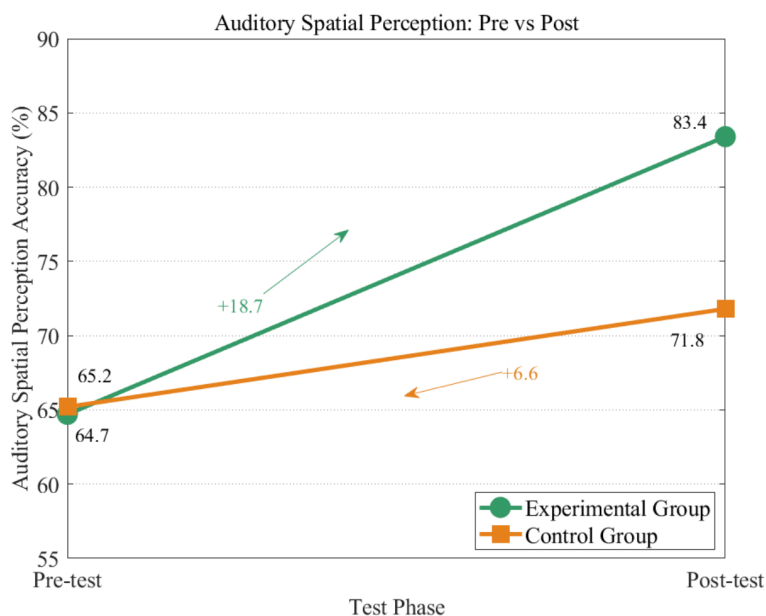


FIGURE 2. Comparison of auditory spatial perception accuracy rates before and after tests for the two groups of students (%)

construction of auditory space in students and to enhance the accuracy and stability of the position of the vocal part.

V. CONCLUSION

This study uses textile aesthetics as the starting point and investigates the teaching model of the textile pattern as a visual aid in the choral vocal coordination training. A full teaching system was created by the construction of a mapping relationship between features of patterns and the

vocal parameters, pattern-guided training module design, and a quantitative evaluation system. The results of a 12 week teaching experiment revealed that the experimental group had significantly improved the three core indicators: pitch deviation rate, vocal cohesion, and auditory spatial perception accuracy against a control group. The data was used to validate the effectiveness of textile pattern assisted training to improve vocal coordination. The importance of

this study is to overcome the constraints of traditional vocal teaching based on auditory feedback only, and to incorporate the visual dimension of vocal coordination training also. also offer an interdisciplinary solution with both 'theory value' and 'practical way' for reform of voice teaching. Future researches can further expand the varieties of textile patterns and the fields of application, and explore the adaptability of the patterns in training higher-level vocal works, and combined with various technologies such as eye-tracking, research the visual cognitive mechanism of the students in the process of pattern assistance training, to achieve more comprehensive empirical support of the intelligent development of vocal teaching.

AUTHOR CONTRIBUTIONS

Bei Wang designed, collected and analyzed the data, and drafted the manuscript. Bei Wang conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Bei Wang participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

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HUMAN RESEARCH SUBJECTS

This study was approved by the Ethics Committee of Yang-En University, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

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