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VISUALIZATION OF AFFECTIVE INFORMATION IN MUSIC USING CHIRONOMIE

Kana TATSUMI[a], Shinji SAKO[b]

[a] *Nagoya Institute of Technology, Japan, tatsumi@lee-lab.org*
[b] *Nagoya Institute of Technology, Japan, s.sako@nitech.ac.jp*

ABSTRACT

The purpose of this study is to visualize affective information that cannot be conveyed by symbolic notation alone, to enhance the musical experience of the hearing impaired. To represent the rhythm of music effectively and uniquely, we focused on Chironomie, which represents the structure of rhythm with emotional impression. In general, Chironomie is drawn by a curve corresponding to the score, which is determined by whether a short segment of the score represents one of two classes, Arsis or Thesis. First, we utilized the machine learning technique to classify Arsis and Thesis from the score as input. We conducted experiments to confirm the accuracy of the classification, and the usefulness of the estimated Chironomie in conveying the rhythm of music. In the latter experiment, four types of stimuli combining visual and sound information were used to confirm the effects of Chironome: score only, Chironomie only, score and Chironomie, and score and sound. Results showed that Chironomie has certain usefulness in conveying the rhythmic structure of a piece of music. This paper mainly focuses on evaluation experiments and discusses experimental and analytical methods under these experimental conditions.

Keywords: *Chironomie, Music visualization, Rhythm, Hearing impaired*

1 INTRODUCTION

For the hearing impaired, sound-only music is hard to perceive and understand. Perceiving musical information with sensory systems other than the sense of hearing (e.g., touch, sight, etc.) will enrich their musical experience. In situations where sight is available, using visuals is considered the most versatile way. Therefore, we attempted to visualize music.

There are many studies and systems for music visualization for various purposes and methods (Khulusi et al, 2020). In many of these systems, the methods of representing music in color are used, and there are studies on the relationship between sound and color. However, Sato (2014) reported that individual differences in color impressions exist. Then, our study aims to visualize music with fewer individual differences. We focused on Chironomie as an effective and unique visual representation to achieve this goal. Chironomie is the Gregorian chant conducting method and represents the rhythmic structure with emotional impressions. In general, Chironomie is drawn by curves corresponding to the score.

Drawing of Chironomie to the score is not common in Western classical music, but Chironomie is commonly used today as a method of musical conducting (Mizushima, 1966, p.150). In addition, Chironomie may be applicable to Western classical music, and there are study cases of the application of Gregorian chant rhythm theory to classical music (Tsumagari, 1963), (Kobata, 2007, 2011).

This study attempts to visualize music by Chironomie for Western classical music and its derivatives. First, referring to the Solesmes Method, a free musical rhythm theory proposed by Mocquereau, we utilized machine learning technique to classify Arsis and Thesis which are the two classes that determine Chironomie from the score as input. Then, we conducted an evaluation experiment to confirm the usefulness of the estimated Chironomie in conveying the musical rhythm.

2 CHIRONOMIE

Chironomie is the projection of rhythm into space through hand gestures and a method of conducting in Gregorian chant. The curve which this is drawn on the score is also called Chironomie. In this study, we analyze the piece using the Rhythmic Chironomie by phrase, the most common in Gregorian conducting. The Rhythmic Chironomie represents a rhythm composed of one or more sequence of Arsis and Thesis. An example of Chironomie is shown in Figure 1.

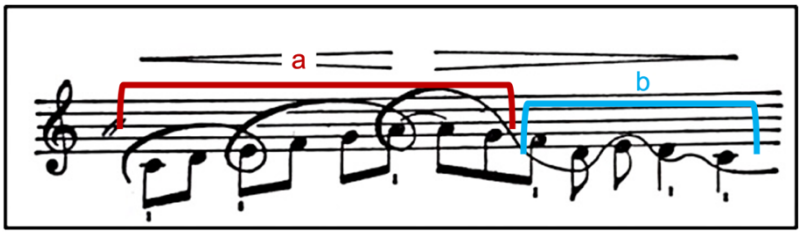

Figure 1. Example of Chironomie

A short line under the note indicates Ictus. Ictus resembles the first beat and marks the boundary of compound time. Arsis Chironomie is drawn as a curve that swings downward and then bounces back up. In the segment where Arsis is continuous, it is represented by a curve that indicates Ictus and jumps up again (segment a in Figure 1). Thesis Chironomie is drawn in a gentle curve (segment b in Figure 1).

3 EVALUATION EXPERIMENT

This section describes the evaluation experiments, which have the objective to investigate the usefulness of Chironomie in the visual perception of rhythm. We set up four presentation methods for the music: score only (Pattern A), Chironomie only (Pattern B), score and Chironomie (Pattern C), and score and sound (Pattern D) (Table 1). We evaluate Chironomie by analyzing the subject's responses in two evaluation methods: an experiment to answer rhythmic features of each piece of music presented by these four presentation methods and a post-experimental interview.

Compare Patterns A and C to investigate whether the presence of Chironomie helps to understand music. Also, compare Patterns B and C and consider how Chironomie is presented. Furthermore, comparing Pattern D with Patterns B and C to investigate whether the visual information obtained from Chironomie is consistent with the auditory information of music.

Table 1. Presentation methods for the music

Pattern	score	Chironomie	sound
A	+	-	-
B	-	+	-
C	+	+	-
D	+	-	+

3.1 Experimental Methods

A total of eight pieces that are monophonic and not well-known were prepared: two for each of the four presentation patterns. The length of each piece is 8 bars. The pieces were presented to the subjects by means of videos output by MuseScore3. MuseScore3 is a free music notation software. MuseScore3 can display a blue square indicating the performance position while playing back. In the experiment, this function was used to easy for any subjects to identify the position of the performance on the score. The image of a video of each presentation pattern is shown in Figure 2.

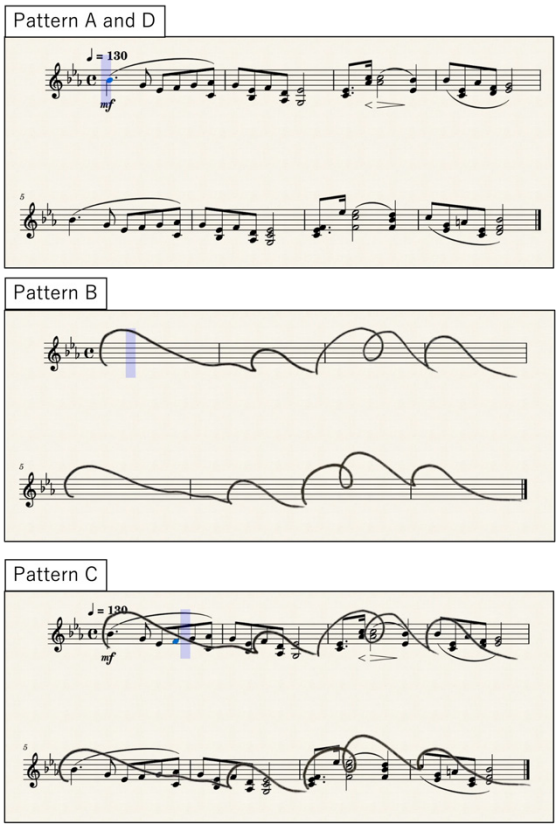

Figure 2. Example of video

The answer sheets used in the response experiment did not mark the boundaries of the time composes but used a general score. In each presentation pattern, the display items are the same as in the video: score only in Patterns A and D, score without notes drawn Chironomie, score with notes drawn Chironomie.

Undergraduate students (males and females, n=8) participated in this experiment. Half of them have experience with the instrument and can read score, while the other half have no experience and cannot read it. They were Japanese and have no prior knowledge of Chironomie.

3.2 Response Experiment

After watching the video, subjects fill out answer sheets with their answers to the tasks. The tasks are listed below.

- Surround the parts where you feel that tension rises.
- Square off the parts where you feel that tension relaxes.
- Draw a double line vertically where you feel the rhythm borders.

3.3 Post-experimental Interview

After the response experiment, the author interviewed the subjects verbally. The questions are listed in Table 2.

Table 2. Questions of post-experimental interview

No.	Questions
1	What did you think Pattern B was?
2	What were some of the difficulties?
3	Which was easier to answer in Patterns A and C?
4	Did Chironomie help you understand the structure of the music?
5	Were your impressions of the rhythm of the piece consistent with Chironomie?
6	Do you think Chironomie is useful?

4 RESULTS

4.1 Response Experiment

In the tasks, the part where tension rises corresponds to Arsis, the part where tension relaxes corresponds to Thesis, and the rhythm border corresponds to the boundary between Thesis and Arsis when Arsis follows Thesis. If the subject's answer and the estimated Arsis and Thesis are consistent, the answer is correct.

The average percentage of correct answers for each presentation pattern in all tasks is shown in Table 3. Pattern C is 5.3% more correct than Pattern A. The difference between Pattern B and Pattern C is as small as 0.7%.

Table 3. Percentage of correct responses (All)

	Presentation Pattern			
	A	B	C	D
Experienced	18.0	24.2	20.7	18.7
Inexperienced	12.8	15.9	20.7	9.1
All	15.4	20.0	20.7	13.9

In addition, the average percentage of correct answers for each presentation pattern in the Arsis continuous parts is shown in Table 4. In Patterns A and C, the experienced subjects have similar percentages of correct answers in both patterns, but the inexperienced subjects have 30.8% higher percentages in Pattern C. Pattern B has a 17.5% higher percentage of correct answers than Pattern C. In Pattern D, the experienced subjects answered 52.9% of the questions correctly.

Table 4. Percentage of correct responses (Arsis continuous part)

	Presentation Pattern			
	A	B	C	D
Experienced	33.3	60.9	31.6	52.9
Inexperienced	26.3	64.7	57.1	21.7
All	30.0	62.5	45.0	35.0

4.2 Post-experimental Interview

This section summarizes the content and trends of the responses for each topic in the post-experimental interview.

Question No.1: What did you think Pattern B was?

Five subjects answered, “Pitch or Intensity”, a subject answered “Ascending and descending melodic line”, a subject answered “Sensory curves drawn to convey the mood of the music”, and a subject answered “Melody line and conducting image.”

Question No.2: What were some of the difficulties?

Four subjects answered, “To answer Pattern A.” A subject added, “Pattern A is like a row of symbols that I don’t understand.” Two subjects answered, “It was hard to follow the curve with my eyes.”

Question No.3: Which was easier to answer in Patterns A and C?

Seven subjects answered, “Pattern C.”

Question No.4: Did Chironomie help you understand the structure of the music?

All subjects answered “Yes.”

Question No.5: Were your impressions of the rhythm of the piece consistent with Chironomie?

All subjects answered, “Somewhat different, but generally in agreement.” Seven subjects answered, “In Arsis continuous part, just as imagined I got from Chironomie.” Six subjects answered, “In Thesis continuous part, there were more notes than I expected.”

Question No.6: Do you think Chironomie is useful?

Seven subjects answered “Yes.” As the reason, a subject added, “Even if I couldn't read the score, I could visualize the tune and rhythm of the music.”, and another subject added, “I found it easy to grasp the atmosphere and rhythm that could not be conveyed by music scores alone, thanks to the use of Chironomie.” Furthermore, a subject added, “I think Chironomie is too simple to use effectively. More structure would be good.”

A subject answered, “No. Chironomie is just a little more useful than score only.”

Additional Question: Presentation patterns that were easy to answer and those that were difficult to answer

Two subjects who have no instrumental experience answered, “Pattern B is the easiest.” The reason: “Pattern B was simple and easy to understand, while Pattern C was complex.”, “Less information made it easier to answer the questions.”

Two subjects who have instrumental experience answered, “Pattern D is the easiest, and Pattern B is the most difficult.” The reason: “I thought Pattern B lacks information as music.” They added, “Pattern C is the easiest, followed by Pattern D.”

5 DISCUSSION AND CONCLUSION

In this study, we attempted to visualize music using Chironomie as a new means of visually representing the structure of rhythm to enhance the musical experience for the hearing impaired. Results suggest that the presence of Chironomie has certain usefulness in understanding the rhythmic structure of a piece of music.

A comparison of Patterns A and C shows that adding Chironomie to the score makes it easier to grasp the rhythmic structure with emotional impressions. This and the results of the response experiment (Table 3, 4) suggest that Chironomie is useful in understanding music, especially in the Arsis continuous parts.

Next, Pattern B and Pattern C are compared. The results of the additional interview questions show that the evaluation of Pattern B depends on the user's attributes and experience. Therefore, the optimal method of presenting Chironomie cannot be determined and we need additional research.

Finally, consider the difference between Chironomie and sound. From the results of the response experiment (Table 4) and the post-experimental interview No.5, in the Arsis continuous parts, users receive visual information from Chironomie that matched the auditory information in music. By contrast, in the Thesis continuous parts, they feel strange. We consider that it is possible to reduce the sense of discomfort by adding fine structure to Thesis Chironomie.

This study found the usefulness of Chironomie in music visualization. However, it is difficult for the estimated Chironomie to get users to correctly perceive all the rhythmic features. We need to research to ensure that recognition by Chironomie is adequate. In future work, it would be possible to visualize the performance by estimating Chironomie from the performance as input.

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