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Visualization of sounds from multiple musical instruments

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Abstract: Human beings recognize external world through multiple sensory functions. In recent years, it is getting obvious that sensory functions are not independent but affect each other. Also, this phenomenon is called cross-modality. In this paper, I focused on cross-modality of auditory and visual sensation and investigated relationship between sound from a musical instrument and shape which is reminded from sound. Firstly, I prepared 10 sounds from 10 different instruments (Piano, Organ, Guitar, Violin, Cello, Harp, Trumpet, Clarinet, Flute, Saxophone) and investigated trends of the shape felt from sound by making subjects draw sketches. From this investigation I found some trends from sketches and made 25 planer shape samples. Secondary, I conducted a survey by using 25 samples which I described. As a result, I found similar trends from samples which are chosen for some instruments. Especially, Harp, Trumpet and Flute had obvious and really similar trends to previous trends from sketches. From these results, I made 40 three-dimensional shape samples and conducted same survey as planer shape samples. Finally, I found harp, trumpet and flute had obvious and similar trends through all the surveys.

Keywords: *Cross modality, Sensory functions, Instruments, Sound*

1. Introduction

We humans recognize the external world through multiple sensory functions centered on the five senses. In recent years, it has become obvious that our sensory functions are not independent but that they affect each other. This phenomenon is called synesthesia or cross modality and there have been studies which focus on this phenomenon. For example, a study focusing on the long-known phenomenon of feeling color when listening to music or sound states that the scale corresponds to the rainbow.

In this paper, I focused on cross modality of sounds and shapes, and aimed to visualize sounds as abstract shapes in 2D and 3D. By investigating common points of shapes felt from sounds among multiple people, I expected the result may be useful in the range of development of new musical instruments.

2. Method

In order to investigate trends of shapes obtained from sounds, this research adopted an experimental method which makes subjects hear the sound. After examining the trends of shapes by experiments, we created and verified samples in the order of planar shape and three-dimensional shape.

2.1 Instruments

In order to investigate trends and difference of shapes, I used the sounds of keyboard instruments, stringed instruments, and wind instruments, which are highly known and highly used. Also, the instruments used in investigations were limited to acoustic instruments, and percussion instruments were excluded. After questionnaire about well-known musical instruments, I adopted 10 musical instruments, piano, organ, guitar, violin, cello, harp, trumpet, clarinet, flute and sax.

2.2 Tones

I used basic tones installed in GarageBand which is equipped in macOS. Also, in order to reduce influence from difference of note names and not to deviate from the range of the instrument we used “do” (C) which is at the center of the range. The tone names and note numbers used in all the surveys are as follows.

- Piano: Steinway Grand Piano, Note Number 60(C4)
- Organ: Cathedral Organ, Note Number 60(C4)
- Guitar: Acoustic Guitar, Note Number 48(C3)
- Violin: Smart Strings, Note Number 60(C4)
- Cello: Smart Strings, Note Number 36(C2)
- Harp: Harp, Note Number 60(C4)
- Trumpet: Trumpets, Note Number 60(C4)

- Clarinet: Clarinet Solo, Note Number 60(C4)
- Flute: Flute Solo, Note Number 72(C5)
- Sax: Saxophone, Note Number 48(C3)

2.3 Subjects

The subjects of the experiment are Japanese twenties students. It does not matter whether subjects had musical experience.

3 A survey by using sketches

Firstly, I conducted a survey which makes 30 subjects (male:22, female: 8) draw an abstract sketch felt from sounds for each 10 musical instruments after listening to sound. The purpose of this survey is to find out the trends of shapes felt from sounds of each instrument, and the difference in shapes due to the difference in instruments. Figure 1 is an example of sketches which were appeared frequently in results.

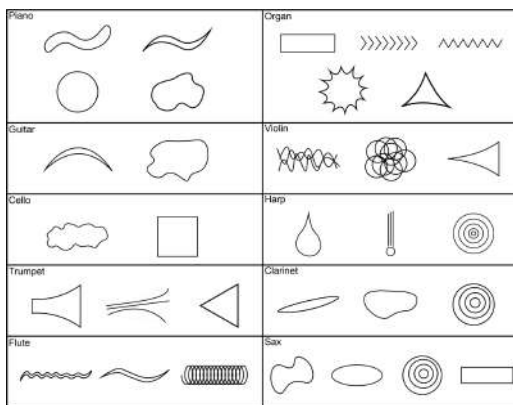


Figure 1: Examples of sketches

In this result, I found shapes had difference in trends depending on instruments. Especially, harp, trumpet and flute had obvious trends, also piano, cello and sax had variations of trends.

4 Planer shape samples

4.1 Development of samples

From results of previous survey, I made 25 planer shape samples (figure 3). Firstly, I chose 6 planer shapes, “square”, “triangle”, “sphere”, “curve”, “splinters” and “regular arrangement” as basic samples. Secondary, based on 6 basics I created 25 samples. Figure 2 is an example of developments.

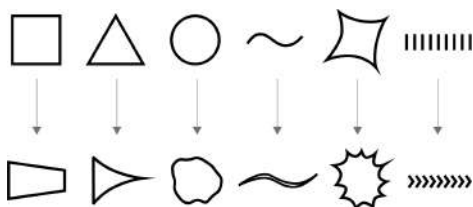


Figure 2: Development of sketches

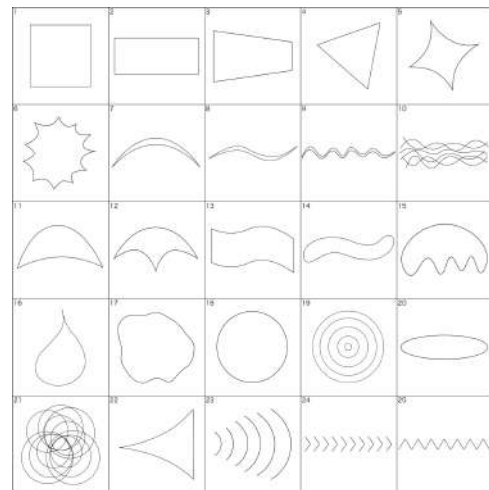


Figure 3: 25 planer shape samples

4.2 A survey by using planer shape samples

I conducted a survey with 25 planer shape samples to investigate trends of samples chosen in this survey and compare results from this survey and previous survey. In this survey, I used Google Form and made 41 subjects (male: 25, female:16) choose no more than 3 samples after listening to sounds.

From a result, I found guitar, violin, harp, trumpet and flute had similar trends to trends from previous survey.

By comparing between 2 results from a survey by using sketches and a survey by using planer shape samples, I specified planer shape samples which are felt from guitar, violin, harp, trumpet and flute. (figure 4)

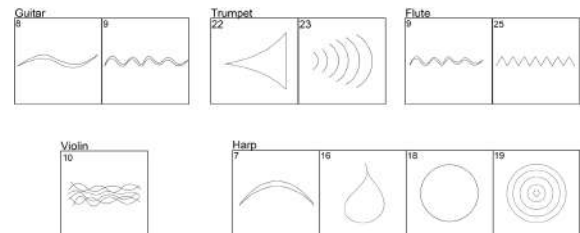


Figure 4: Planer shape samples felt from instruments which are specified

In this result, harp, trumpet and flute especially had obvious and quite similar trends to previous trends from survey by using sketches.

5 Three-dimensional shape samples

5.1 Development of samples

Based on a result from a survey by using planer shape samples, I made 40 three-dimensional shape samples. (Figure 6) Firstly, I excluded some planer samples which are obviously not chosen in previous survey. Secondary, to compare, I made 2 kinds of three-dimensional shape samples, one is the shape which is simply extruded from

original planer shape and the other is the shape which is curved. Figure 5 is an example of development of three-dimensional shape samples.

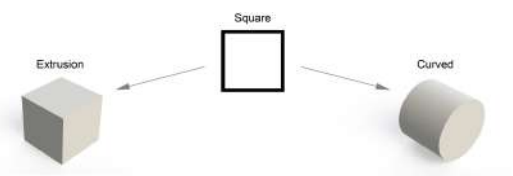


Figure 5: Development of three-dimensional shape samples

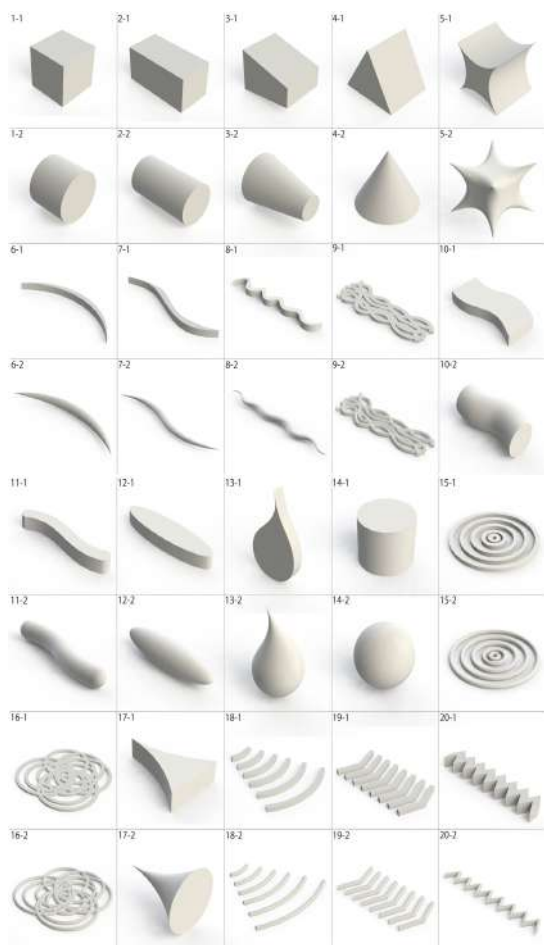


Figure 6: Three-dimensional shape samples

5.2 A survey by using three-dimensional shape samples

I conducted a survey with 40 three-dimensional shape samples to investigate trends of samples chosen in this survey and compare trends of planer shape samples and three-dimensional shape samples. In this survey, I used Google Form and made 40 subjects (male: 20, female:20) to choose no more than 3 samples after listening to sounds. From a result, I found guitar, violin, harp, trumpet and flute had similar trends to trends from

previous survey.

By comparing between 2 results from a survey by using planer shape samples and a survey by using three-dimensional shape samples, I specified three-dimensional shape samples which are felt from guitar, violin, cello, harp, trumpet and flute.

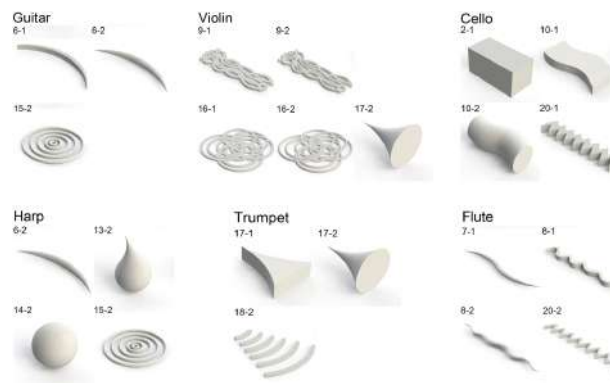


Figure 7: Three-dimensional shape samples felt from instruments which are specified

In this result, I found especially harp, trumpet and flute, same as previous survey, had obvious and quite similar trends to trends of planer shape samples.

6 Analysis through all surveys

- Piano

From a result of a survey by using sketches, gained sketches are various and I could not find trends of sketches. Besides, 2 trends from 2 surveys by using planer shape samples and by using three-dimensional shape samples were quite different.

- Organ

Through all 3 surveys, I could not find consistency of trends, although each survey had a trend partly.

- Guitar

Through all 3 surveys, I found partly similarity and consistency of trends. “Sharp curve” is mainly chosen in all 3 surveys as shown in figure 28.

- Violin

Through all 3 surveys, I found partly similarity and consistency of trends. Expression of overlapped lines is common through 3 surveys as shown in figure 29.

- Cello

Through all 3 surveys, I found partly similarity and consistency of trends. Expression of a bold line or a thick

shape are common through 3 surveys as shown in figure 30.

- Harp

Through all 3 surveys, I found obvious similarity and consistency of trends. All 3 trends from each survey are quite similar as shown in figure 31.

- Trumpet

Through all 3 surveys, I found obvious similarity and consistency of trends. All 3 trends from each survey are quite similar as shown in figure 32.

- Clarinet

Through all 3 surveys, I could not find consistency of trends, although each survey had a trend partly.

- Flute

Through all 3 surveys, I found obvious similarity and consistency of trends. All 3 trends from each survey are quite similar as shown in figure 33.

- Sax

Through all 3 surveys, I could not find consistency of trends. I found quite small similarity but that was too small to be considered as a trend and consistency.

7 Conclusion

In this paper, I investigated the relationship between sounds of multiple musical instruments and shapes felt from sounds and proposed planer shape and three-dimensional shape samples felt from sounds of musical instruments. From results of all 3 surveys, I finally specified samples which express guitar, violin, cello, harp, trumpet and flute. (figure8) Especially, I found obvious trends of samples of harp, trumpet and flute through 3 surveys. However, I could not specify other instruments, piano, organ, clarinet and sax.

In conclusion, I found differences of musical instruments cause differences of trends of shapes felt from sounds. However, I could not find how extruded samples and curved ones make difference. Also, I need to verify the relationship between sounds and shapes by conducting a survey from shapes to sounds. They are the future tasks.

After this, by further clarifying the relationship of sounds and shapes, I expect development of new ways to express music by using both sounds and shapes.

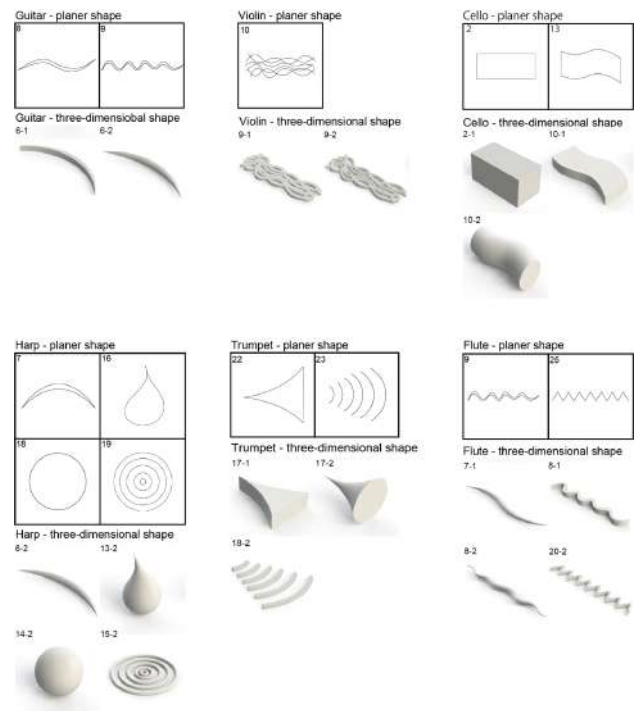


Figure 8: Specified samples

REFERENCES

- [1] Itoh, K., Sakata, H., Kwee, I. L., & Nakada, T. (2017). Musical pitch classes have rainbow hues in pitch class-color synesthesia. *Scientific reports*, 7(1), 17781.
- [2] AKAI, Y., & LEE, S. (2014). Analysis of Relationships between Timbre and Cool or Warm Colours that Distinguish Different Tonal Structures. *Transactions of Japan Society of Kansei Engineering*, 13(1), 221-228.