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Development of a Novel Breath-touch Electronic Instrument that Enables Beginners to Engage in Ensemble Playing

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Abstract In this study, we developed a new electronic musical instrument, Cymis, with which notes are played by touching a touch screen and the volume of the note is controlled by expiratory pressure. It can be played with about the same amount of exhalation as a keyboard harmonica. Performance experiments were conducted with healthy adults (11 persons) in their 20s. First, all were able to play solo using Cymis. Next, simulated ensemble performances were conducted. Using a system that can predict the ideal timing for sounding notes from visual information, six novice performers performed a piece (Amazing Grace) after having had from one hour to several weeks of practice. For each note in the ensemble performance, the difference between the actual and ideal times at which the note was produced, *td*, was measured. In the experiments, |*td*| was found to be less than 200 ms for more than 85% of the total number of notes played. In an ensemble performance in which five experienced performers listened to the sound of the performance, this result was more than 80%. This study shows that a novice performer using Cymis can play in an ensemble with about the same degree of temporal accuracy as an experienced performer.

Keywords: dementia, preprogrammed score, breath sensor, keyboard harmonica.

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1. Introduction

As the global burden of dementia increases, the lack of treatment for dementia underscores the need to identify factors that may improve cognitive reserve, or the ability to stave off cognitive decline in old age [1]. The Nun Study is one of the leading epidemiological studies strongly supporting cognitive reserve [2]. A recent review reports on evidence proving that dementia can be prevented by music therapy and playing musical instruments [3, 4]. There are two important reports on healthy elderly participants; one epidemiological [5] and the other a twin study [6]. In these reports, it was found that the risk of dementia was reduced by 69% and 64% by playing musical instruments. In addition, several recent reports have shown that playing musical instruments is effective in maintaining and improving cognitive function [7, 8]. An important issue here is whether a young person's cognitive reserve is involved when playing a musical instrument. Recently, several important reports have indicated that adults who engaged in music training at a younger age showed sharper neural processing and higher cognitive reserves in later years, regardless of their current level of musical engagement [9–11]. White-Schwoch et al. [9] examined neural timing of forty-four older adults (aged 55–76 years) and found that a moderate amount (4–14 years) of music training early in life was associated with faster neural timing in response to speech later in life, long after training stopped (more than 40 years). Wilson et al. [10] conducted clinical eval-

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uations in 964 older persons and showed that higher levels of foreign language and music instruction during childhood and adolescence are associated with a lower risk of developing mild cognitive impairment (MCI) in old age. Through an analysis of 60 years of longitudinal data from Wisconsin high school graduates, Romeiser et al [11] showed that instrument engagement in adolescence or adulthood may help to improve cognitive domains such as episodic memory. These previous studies have shown how important it is for young people to play musical instruments for acquiring cognitive reserve. However, many young people do not necessarily play musical instruments in their daily lives. In addition, according to statistics (Statistics Bureau, Ministry of Internal Affairs and Communications, 2016), the percentage of people who play a musical instrument decreases with age. Against this background, we believe that it is of great significance to develop a new instrument that can be played easily by adults with little or no playing experience.

Playing musical instruments such as flute, guitar and piano, is an enjoyable hobby or recreational activity. While many adults may aspire to play a musical instrument, the percentage of those who actually do so on a daily basis is not high. Training is essential for learning conventional acoustic instruments such as the piano and orchestral instruments. Some people give up because of the high learning threshold, while others are frustrated by the low efficiency of mastery. These may be the reasons for the low percentage. On the other hand, music therapy for stroke and dementia is intended for people with little or no playing experience. Electronic drums are used in the rehabilitation of stroke patients [12, 13], and percussion is often used in music therapy for dementia prevention [14]. Various accessible digital instruments have also been developed for people with severe disabilities [15]. Percussion instruments are attractive in terms of accessibility. On the other hand, accessible wind and string instruments have been developed but are not widely used in music therapy. Also, instruments developed for people with severe disabilities are generally not necessarily suitable for healthy adults.

We are developing an electronic musical instrument, Cymis (Cyber Musical Instrument with Score) [16], which is a barrier-free electronic musical instrument that can be played easily by beginners of all ages, who do not fully understand musical scores. The human interface presented by Cymis is technologically novel in that it emphasizes the senses, and is characterized by information from its built-in musical score and its programs. As far as we know from our survey of the literature, Cymis is the only reported instrument with which classical pieces and popular melodies can be played easily. It has been applied to clinical research at institutions and medical facilities for more than 10 years, and the results have been reported [16–18].

Based on some of the previous studies mentioned above, playing a musical instrument, not only by older people but also by the young may improve cognitive reserve and prevent dementia. We developed a prototype breath sensor for Cymis and applied it to a patient with cerebral palsy in a nursing home [19]. We identified some issues with this sensor. First, the mouthpiece is in direct contact with the mouth, and must be safe in terms of hygiene. Therefore, it must be easily sterilizable, and ideally disposable. Second, it is desirable from a medical standpoint to have not only an exhalation function but also an inhalation function. Furthermore, from the performance standpoint, alternating between exhalation and inhalation produces pressure signal changes that allow quick sound control. Third, a wider dynamic range is needed for playing with the same level of exhalation required for a pianica.

Therefore, in this study, we developed a new version of this electronic musical instrument for healthy adults, the breath-touch type Cymis (hereinafter referred to as "Cymis"). The player plays the notes using the touch panel, and controls the volume by exhalation. The instrument is similar to a wind instrument. A wind synthesizer similar to Cymis is already available on the market, with the same breath sensor to control the MIDI sound source. However, the design concept is fundamentally different. Commercial wind synthesizers are intended for people who understand musical scores. They are designed to allow users to compete in note production skills through changes in pitch and timbre, and to enjoy advanced performance. In Cymis, on the other hand, the breath sensor only controls the sound volume. The air pressure inside the balloon, which varies at a relatively low frequency, is controlled and converted into volume. Cymis has a built-in programmed musical score and does not require the user to understand the score.

We believe that wind instruments are most enjoyable when played in an ensemble. Therefore, a visual aid system was adopted to facilitates beginners to play in an ensemble. We conducted an experiment simulating an ensemble performance to measure the time difference between the notes played by the performers and those from an ideal performance, and to compare novice with experienced performers. With this study, we were able to clarify the degree of temporal accuracy of the beginners' ensemble performance.

2. Methods

2.1 Outline of Cymis

The basic configuration of Cymis is shown in **Fig. 1**. A

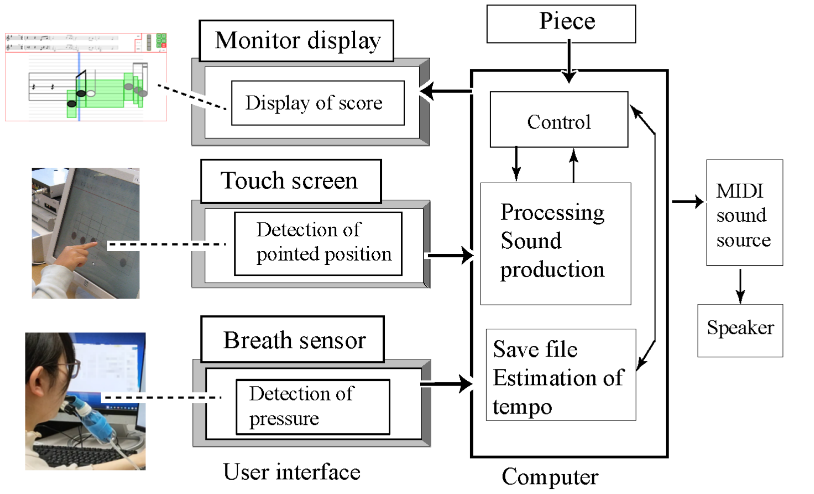

Fig. 1 Structure of breath-touch Cymis. The breath-touch Cymis consists of user interfaces (monitor display, touch screen, breath sensor), a PC, MIDI sound source, and a speaker. The user controls the musical scale by touching the notes, and controls the volume by sending air to the breath sensor.

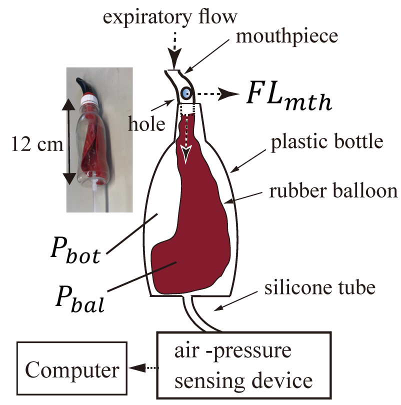

Fig. 2 Outline of breath sensor. The breath sensor consists of a mouthpiece from a keyboard harmonica, a plastic bottle, a rubber balloon, and an air-pressure sensing device. The mouthpiece has a hole at the side.

pre-programmed score is built into Cymis, and signals from the user interface (touch screen, breath sensor) are sent to a PC (Windows 10) for processing. Sound control signals are sent to the MIDI sound source, and the sound is produced from the speakers. The touch screen is a Dell P2418HT (23.8" diagonal). To play a note, the player touches a symbol displayed on the touch screen (a rectangle surrounding the note, hereinafter referred to as a "note-box") (see **Fig. 3**), and controls the volume by exhalation to the breath sensor (see **Fig. 2**). The overall system is shown in **Fig. 3**. The breath sensor is fixed to a microphone stand so that the performer can perform the touch operation with both hands. The visual aid system is a guide bar display. The guide bar refers to the blue vertical bar shown in **Fig. 3**, which moves from left to right on the monitor screen at a constant speed dependent on the tempo of the music. The position of the guide bar indicates which note is being played. The ideal time to play a note is when the guide bar reaches the note-box represented by the green rectangle. The length of the note-box on the horizontal axis corresponds to the value of the note. The ideal time for sounding each note and the actual time when each note was sounded in a performance can be recorded. The performance can be recorded in MIDI format.

2.2 Development of breath sensor

2.2.1 Structure

The composition of the breath sensor is shown schematically in **Fig. 2**. When the player blows into the sensor, the rubber balloon expands, resulting in an increase in pressure, P_{bot}, inside the plastic bottle, which is measured by an air pressure sensor (SSCDRRN001PD2A5, Honeywell, ± 6.9 k Pa, ± 0.25%). This pressure signal is sent to a PC. Inhalation is also supported. The configuration of the breath sensor was designed for the following reasons: first, it is necessary to measure the expiratory pressure indirectly because a dry-gas-only air pressure sensor is used; second, it is necessary to consider disinfection to prevent infection; and finally, all parts other than the electronic circuitry have to be disposable.

2.2.2 Size of the side-hole

The mouthpiece has a hole at the side (hereafter called the side-hole) so that the audience can enjoy the feeling of playing. The size of the side-hole was chosen so as to give a similar sensation to that of playing a 'keyboard harmonica' (Yamaha Pianica P-37D). The hole size was determined in an experiment in which three healthy adult males in their 20s participated. First, the pressure in the mouthpiece was measured when a participant pronounced "la" on the keyboard harmonica for 4 seconds. This pressure is defined as P_{harm}. Next, the participant controlled exhalation so that the pressure P_{bot} at the breath sensor was approximately equal to P_{harm} for about 4 seconds. The size of the side-hole was determined based on the subjective evaluation of the three participants in this experiment. In addition, the characteristics of the breath sensor with the side-hole size determined were measured. The characteristics were analyzed by simultaneously measuring the pressure, P_{bot}, flow rate, and FL_{mth}, when feeding air into the breath sensor using an electric blower. The flow rate was measured with a flow

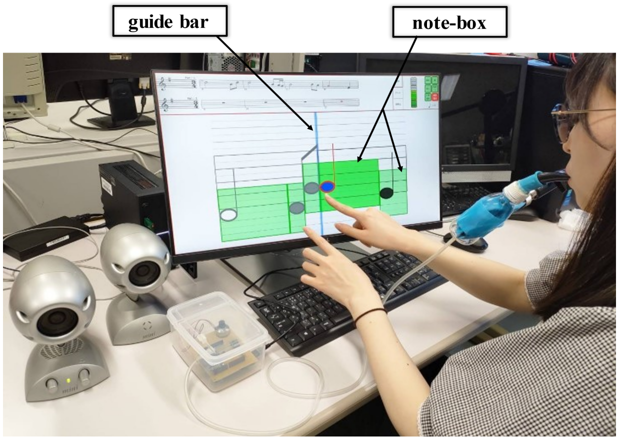

Fig. 3 Cymis system.
The player controls the note by touching a note-box displayed on the touch screen, and controls the volume by sending air to the breath sensor. The guide bar (vertical bar) displayed on the touch screen moves from left to right at a constant speed dependent on the tempo of the music, and the time when the guide bar reaches the note-box is the ideal time for the note to be played.

meter (VT-112T, Nihon Kohden).

2.3 Experimental Evaluation of Solo and Ensemble Music

2.3.1 Participants

Eleven healthy adults (six males and five females in their 20s) participated in the experiment. Five of them had more than 10 years' experience playing piano and/or wind instruments. They are hereinafter referred to as experts. The only instrumental experience the other six had was playing the recorder in music classes at elementary and junior high schools. They are hereinafter referred to as novices. The player controlled the note by touching the note-box displayed on the touch screen, and controlled the volume by breathing into the breath sensor. The guide bar (vertical bar) displayed on the touch screen moved at a constant speed from left to right. The time when the guide bar reached the note-box was the ideal time for the note to be played, which facilitated the performer to predict the ideal time. The breath sensor was attached to a microphone stand and fixed to the performer's mouth so that the performer was able to perform the touch operation with both hands. The performance was heard through a loudspeaker in front of the performer.

2.3.2 Method of experimental evaluation

The participants were instructed to play the instrument using the touch screen and the breath sensor so that the note would be played at the ideal time. The results of the

Fig. 4 Piece of Amazing Grace.

performance were recorded. The piece was "Amazing Grace" (**Fig. 4**) (60 bpm, 17 measures, N = 44 notes). The timing of the start of the performance was given by visual information displayed on the monitor (countdown of four beats). Of the eleven participants, six began the ensemble experiment (see 2.3.4) after completing all the solo performance experiments (see 2.3.3), and the other five participants only performed in the ensemble experiment. The side-holes of the breath sensor were based on the values determined in the experiment described in 2.2.2; three holes (2 mm in diameter) were used.

The following three methods were used to prompt the performer the ideal time to play the note. In the first method, a guide bar was displayed as a visual aid. The time when the guide bar reached the note-box was the ideal time for the note to be played. The performer was able to predict the ideal time easily. This performance is referred to as G-mode (guide-mode). The second method used the sound of a song performance (the same part). The time at which each note was played from the speaker was the ideal time for the note to be touched. This performance is called A-mode (acoustic-mode). The third method was a performance method in which two types of information; G-mode and A-mode, were given simultaneously. This method is called AG-mode (acoustic-guide-mode). The ideal time to sound the note was exactly the same for the two types of information.

2.3.3 Procedures of solo experiments

Six participants (three novices and three experts) were given instructions on how to play Cymis. The experimental performances were repeated six times, generally once a week. Each time, the participant selected a favorite piece (Choucho-Butterfly, Under the spreading chestnut tree, or others) and practiced freely until he/she was satisfied with the performance. An experimental evaluation was conducted after the practice sessions. The performance method was G-mode. After the experiment, the performers listened to their own performance (MIDI sound source) once.

2.3.4 Procedures of ensemble experiments

At the beginning of each session, eleven participants (six novices and five experts) played a song of their choice until they became familiar with the operation. Then, an experimental evaluation was conducted. The experimental evaluation for the experts was an A-mode performance, and the experiment was repeated three times with a short interval in between. The experimental evaluation for the novices consisted of A-mode and AG-mode performances, and were conducted approximately once a week. Experiments were conducted three times for each performance method. To control for order effects, the order of the two performance methods was interchanged for half of the participants.

2.3.5 Evaluation method

The performance was evaluated focusing on the time the note was sounded. We denote the difference between the ideal time of sounding the note and the time when each note was sounded from the Cymis (hereinafter referred to as the "note onset time difference") as *td*.

$$td\ (i) = \text{Cymis sound onset time}\ (i) - \text{ideal note onset time}\ (i) \quad (i = 1,\ 2, .., N) \tag{1}$$

where *i* is the number of notes from the beginning of the piece (performance part) and *N* is the number of notes generated. To evaluate the accuracy of the overall performance, we counted the number of notes that were sounded with an onset time difference less than xx (*N-xx*), and calculated the percentage of *N-xx* to the total number of notes as follows:

$$R\text{-}xx = \left(\frac{N\text{-}xx}{N}\right) \times 100\ [\%] \tag{2}$$

where *xx* is 200 ms. *N*-200 ms is the number of notes satisfying the condition $|td| < 200$ ms. Similarly, *N*-100 ms corresponds to the condition $|td| < 100$ ms.

All statistical analyses were performed with EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria) [20]. More precisely, it is a modified version of R commander designed to add statistical functions frequently used in biostatistics.

This study was approved by the Ethics Committee of Niigata University (No. 2021–0068) and the Ethics Committee of Setsunan University (No. 2021–026), and was conducted in accordance with the Code of Ethics of the Declaration of Helsinki.

3. Results

3.1 Dynamic properties of the breath sensor

The results of subjective evaluation by three participants are as follows. First, a hole with a diameter of 4 mm was very different from that of the pianica. Second, two holes with a diameter of 2.5 mm were closest to the pianica. From these results, we concluded that the appropriate size of the hole was an area of approximately 10 mm^2. The mouthpiece used in this study for solo and ensemble performances had three holes with diameters of 2 mm.

A pianica was used to measure the expiratory pressure during the production of the sound "la". The result is shown in **Fig. 5(A)** (average of five responses). The pressure was generally between 0.4 and 0.5 kPa during sounding. Next, **Fig. 5(B)** shows the time response of the expiratory flow rate FL_{mth}, and expiratory pressure, P_{bot}, at the breath sensor having two side-holes with diameter of 2.5 mm. The flow rate was gradually increased using an electric blower, and the expiratory pressure increased monotonically with increasing flow rate. This indicates that the expiratory pressure at the breath sensor can be controlled easily.

3.2 Results of solo performance measurements

We measured the note onset time difference, *td*, of approximately 1600 notes from 6 solo performances by each of the 6 participants (36 solo performances in total). The *td* values were mostly positive. The mean, standard deviation, and maximum value of *td* for each performance were calculated. The mean *td* ranged from 117 to 162 ms, standard deviation from 38 to 70 ms, and maximum value from 302 to 444 ms for the 36 performances. For approximately 65% of all notes measured, |*td*| was within 200 ms. No particular differences were found between novices and experts. These results indicate that novices can perform "Amazing Grace" as easily as ex-

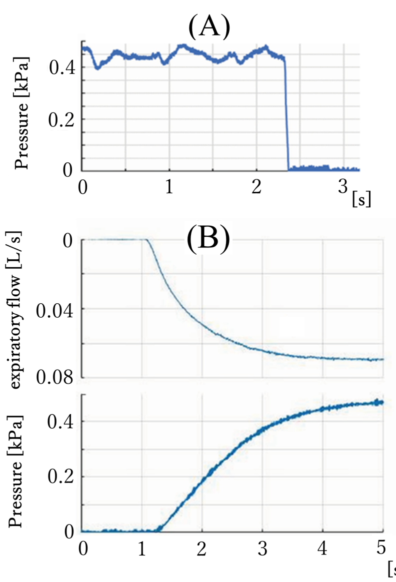

Fig. 5 Time courses of pressure in playing a pianica and the breath sensor. (A) air pressure in the pianica, (B) air flow and pressure in the breath sensor (**Fig. 2**).

perts using the breath-touch Cymis.

3.3 Results of Ensemble Measurements

3.3.1 Note onset time difference for each note

The A-mode performance by the experts is represented as group (a), the AG-mode performance by the novices as group (b), and the A-mode performance by the same novices as group (c). **Fig. 6** shows the results of the first performance by each group. The horizontal axis shows the note number. The vertical axis is the mean *td* of the performers. There was no significant difference between group (a) [**Fig. 6(a)**] and group B [**Fig. 6(b)**]. The mean *td* for all notes in group (a) was 125 ms with standard deviation of 57 ms and maximum of 302 ms. The mean *td* for all notes in group (b) was 91 ms with standard deviation of 66 ms and maximum of 285 ms. There was little difference between group (a) and group (b) in the first performance. In contrast, group (c) had a mean *td* of 252 ms, standard deviation of 95 ms, and maximum of 571 ms. The delay in sounding the note compared to the ideal time was more than 200 ms for many notes.

3.3.2 Note onset time difference in three different performance modes

Figure 7 shows the distribution of the note onset time difference, *td*, in a box plot for the 1st, 2nd, and 3rd performances of each group. The data for the 1st performance in **Fig. 7** corresponds to the data in **Fig. 6**. For all performances, group (c) had the largest variance. A Bartlett test showed no equal variances ($p < 0.01$) for the first and second performances. Next, Steel's test for multiple comparison was performed with group (a) as the reference group. There was a significant difference ($p < 0.01$) between groups (a) and (b) for the first performance. Novices had a smaller note onset time difference than the experts. However, there were no statistically significant differences ($p > 0.01$) between these groups for the second and third times. In conclusion, there was no marked difference between novices and experts. On the other hand, there was a statistically significant difference ($p < 0.01$) between groups (a) and (c) for all the performances. Without a visual guide display, the novices were clearly behind in the note onset time.

3.3.3 Relationship between the number of the performance and *R*-200 ms

Figure 8 shows the results of the analysis of how *R*-200 ms changes with the number of the performance. The vertical axis is *R*-200 ms and the horizontal axis is the number of the performance. Group (b) had *R*-200 ms of 85% or higher from the first to the third performance, and group (a) had *R*-200 ms of 80% or higher from the first to the third performance. A multiple comparison Bonferroni's test showed no statistically significant difference ($p > 0.01$) between groups (a) and (b) in terms of *R*-200 ms for any of the performances. In other words, the timing accuracy with which the note was sounded was similar.

On the other hand, in group (c), the *R*-200 ms were

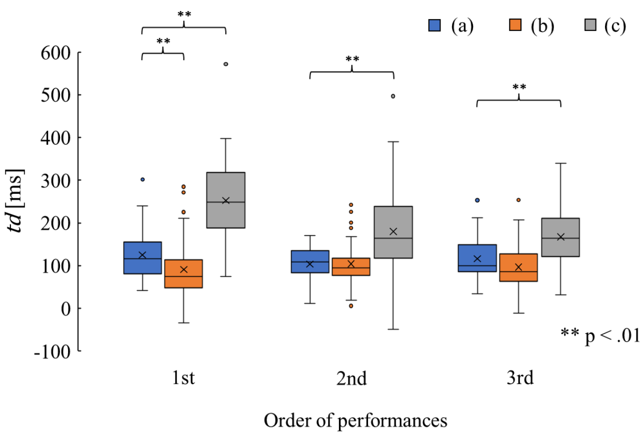

Fig. 7 Note onset time differences, *td*, in three performance modes.
(a) A-mode performance (5 experts), (b) AG-mode performance (6 novices), (c) A-mode performance (6 novices).

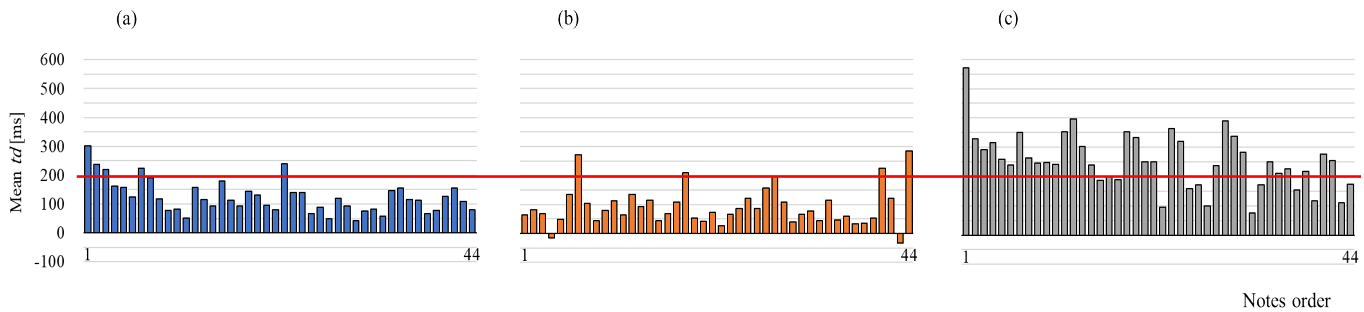

Fig. 6 *td* of each note in the three performance modes.
td : the time difference between the ideal time and the sounding of the note in the cymis performance; the first performance, (a) A-mode performance (5 experts), (b) AG-mode performance (6 novices), (c) A-mode performance (6 novices).

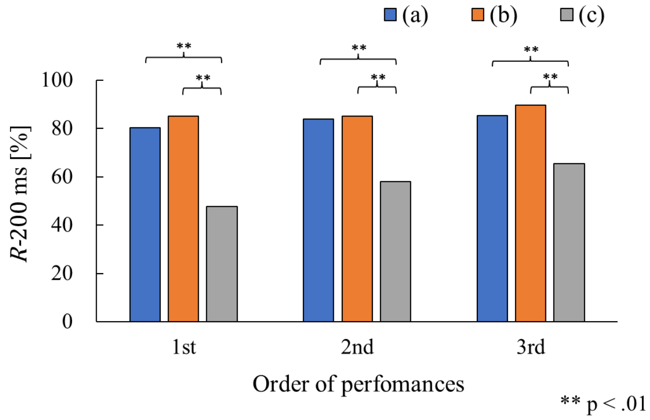

Fig. 8 Variation in *R*-200 ms with the number of performances.
R-200 ms: relative number of notes based on the note onset time difference.
(a) A-mode performance (5experts), (b) AG-mode performance (6 novices), (c) A-mode performance (6 novices).

48%, 58% and 66% for the first, second and third performance, respectively. Thus, *R*-200 ms increased as the number of performances increased. Group (c) was less accurate compared with groups (a) and (b). There was a statistically significant difference between group (c) and group (a), and between group (c) and group (b) ($p < 0.01$).

The important result here is that the number of notes sounded with an error less than 200 ms was more than 85% of all the notes sounded by the novices (b), which was comparable to the more than 80% of all the notes sounded by the experts (a).

4. Discussion

4.1 Musical Instruments for Adult Beginners

Playing musical instruments such as flute, guitar and piano is an enjoyable hobby or recreational activity. Generally, when a musician plays a piece of music using such an instrument, he or she recognizes and understands the musical score, and then works on the instrument with his or her hands and mouth to generate sound. The sequence of actions required to understand the score and operate the instrument requires proficiency, and these actions make playing a musical instrument difficult. For example, keyboard instruments such as the piano can be played with a single finger. However, it is necessary to understand the musical score. It is also difficult for beginners to play wind instruments such as the flute and shakuhachi to produce the notes of a specific scale. On the other hand, Cymis makes sound production and music comprehension easy even for beginners. The display shows musical information on the screen, and when the user touches a note on the screen, the same note played with the specified instrument is sounded via a MIDI sound source. We have already reported that elderly people with impaired motor functions are able to play a piece of music with relatively simple touch movements [16]. Since the long-term goal of this study is to reduce the risk of developing dementia, and since the subjects are healthy adults, the volume is not constant but changes according to the strength of exhalation/inhalation, so that they can experience the pleasure of playing. The relatively simple coordinated actions of touch and exhalation/inhalation allow the user to enjoy his or her own performance while varying the volume. Although it looks like a wind instrument in appearance, even beginners can easily "play" it by simply producing sounds after a short practice. The inclusion of inhalation playing is in accordance with suggestions from a medical standpoint. That is, we recognize that the method of playing music using a touch screen and a breath sensor is a simple action that can be easily performed by the user, and the performer can appreciate that he/she is playing music. We think that a novel breath-touch electronic instrument is a very useful device for reducing the risk of developing dementia.

4.2 Objective evaluation of performance

The breath-touch Cymis reported here has recently been further developed. It is necessary, therefore, to clarify whether beginners are able to perform solo and ensemble music easily using this instrument. First of all, it is easy to show that the sound is generated correctly. Next, an objective demonstration that the note on time and note off time can be accurately controlled is needed. This is a difficult task. In this study, both the ideal note onset time and the Cymis note onset time were measured for each note played, so that the difference between these times, *td*, could be calculated accurately for each note. We believe that we were able to objectively demonstrate the usefulness of the developed breath-touch Cymis.

We evaluated *td* on the basis of 200 ms, which is approximately a sixteenth note (250 ms) for a 60-bpm performance. For a typical performance, this is a large value that cannot be ignored. The significance of a Cymis performance is that beginners who have no performance experience can enjoy the performance experience to some extent. Therefore, we set the standard at 200 ms, which is a good interval, based on the subjective judgment of the performance results. First, **Fig. 6(a) and (b)** shows that many notes have $td < 200$ ms. In this case, the experimenter did not feel any discomfort when listening to the performance. On the other hand, in **Fig. 6(c)**, both the experimenter and the performer were aware of the delay in the performance. Clearly, many of the notes exceeded 200 ms. As **Fig. 8(a) and (b)** shows, if *R*-200 ms is less than 20%, the 200 ms time difference would be absorbed in the flow of the performance and would not be perceived as significant. This study aims to demonstrate how important it is for young people to play musical instruments from the perspective of reducing the risk of developing dementia and to develop a new instrument that can be played easily by novice adults with little or no playing experience. Therefore, the participants were young healthy adults in their 20s. The above evaluation of the performance results was also obtained under these conditions. When applying Cymis to middle-aged and older adults in the future, it will be necessary to identify the limitations through actual experiments, construct an ensemble system, and conduct evaluations. This is an important issue for the future.

4.3 Expected effects of the use of Cymis in preventing dementia

Karp et al. [21] pointed out that reducing the risk of dementia can be achieved through three different approaches: mental, physical, and social. Musical performance using Cymis is an effective mental approach because it is an activity that can be enjoyed. It is also clearly a physical activity, since it requires hand movements and exhalation. Moreover, ensemble music is a social activity in which all the members of a performance group can cooperate and share the enjoyment with their musical companions. In addition, continuous activities are important. A person with severe dementia got pleasure out of playing Cymis with a music therapist [18]. This is because it is also an enjoyable activity. Finally, intellectual activities are also necessary. Previous studies have shown that musical training or learning to play a musical instrument may alter brain function and brain structure [22–26].

There is a concern that performances using Cymis may quickly become boring. There is no need to be concerned about this. More than 10 years of clinical research experience has shown that many users, including people with disabilities, have enjoyed performing with Cymis and continue to do so to this day [16]. The newly developed "breath-touch Cymis" allows the user to vary the volume freely and play the music of his or her choice, so the user rarely gets bored with the music.

4.4 Toward the realization of ensembles

Our next step is to realize an ensemble performance by multiple players using the breath-touch Cymis and ordinary musical instruments, and to evaluate its effectiveness. The use of a visual information guide seems to be appropriate as a first step for novices. With the guide, they can participate in the ensemble at about the same level as experts in terms of producing the notes on time. On the other hand, in an unguided ensemble, the novices' performances were far from ideal [see **Fig. 7(c)**]. With this low level of performance, it is difficult for novices to participate in the ensemble. It is imperative to create a practice program that will allow novice players to play in an ensemble without a guide. Since continuous performances are necessary for reducing the risk of developing dementia, enjoyment of the performance is an important factor for this purpose. Therefore, we asked the participants briefly about their impressions of the Cymis and the performance method, and obtained the following results. First, they answered that they enjoyed the experience of playing the music itself. Some of them were interested in the new system using the touch panel and breath sensor, and were enthusiastic about practicing before taking part in the evaluation experiment. The opinion of the majority was that the AG-mode was easier to use. This is because they were instructed to match the timing of playing the notes. On the other hand, the opinion of some participants was that the A-mode was more enjoyable because it gave a sense of playing by themselves. Currently, no practice program has been created for Cymis. A future challenge is to create a practice program that takes into consideration not only the accuracy of the performance, but also the psychological factor of participant enjoyment.

5. Conclusion

We developed a new electronic musical instrument, Cymis, which has a touch panel and a breath sensor. Using a visual aid system, we demonstrated that six novice players in their 20s were able to perform as accurately as five experts in a simulated ensemble.

Conflict of Interest Discloser

We have no conflict of interest with any company or commercial organization.

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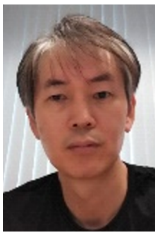

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