三重大学教育学部研究紀要　第 67 巻　教育実践　（2016）　393 － 402 頁

Vocal Range Expansion of Patients Suffering from Alzheimer's Disease by The YUBA Method^{+}-[Hi]^{2}-Dementia with Karaoke

Toru YUBA[1], Yukari OKUBO[2] and Mamoru MATSUOKA[1]

カラオケを用いた「YUBA メソッド$^{+}$-[Hi]^{2}-認知症」プログラムによるアルツハイマー病患者の声域拡張

弓場　　徹・大久保友加里・松岡　　守

Abstract

The YUBA Method^{+}-[Hi]^{2}-Dementia a new non-pharmaceutical, non-invasive, interactive, operational brain treatment, based on Penfield's brain map, through cognitive exercises; voicing and singing mainly, dancing and acting with karaoke and an electric piano is a program to enhance Alzheimers' disease patients' quality of life developed by T. Yuba , expanded vocal ranges of patients with Alzheimer's disease by 8.3 semitones and enabled them to sing better. Until now, our project, based on curing vocal amusia and improving cochlear implant wearers' singing, and designed to produce brain plasticity and enhance efficiency of neurotransmission by giving numerous stimuli to brains in cognitive exercises through voicing and singing, showed improvements in QOL, new skill acquisition.

1. INTRODUCTION

WHO's report of April 2012, "DEMENTIA: A PUBLIC HEALTH PRIORITY" (WHO 2015) estimated 2010's total global societal cost of dementia at US$ 604 billion. Dementia population is now 35.6 million, 65.7 million in 2030 and 115.4 million in 2050. 2013's G8 Dementia Summit declared to promote coordinated efforts in establishing methods for preventing and treating dementia. It is desired to establish a non-pharmaceutical non-invasive treatment based on scientific evidence. We participated in an intervention conducted by Department of Dementia Prevention and Therapeutics, Graduate School of Medicine, Mie University, wherein TY (T. Yuba) provided a hypothesis and a therapy program, and TY and YO (Y. Okubo) provided a non-pharmaceutical treatment.

The hypothesis is on enhancement of dementia patients' QOL: Numerous stimuli to brains in cognitive exercises based on The YUBA Method^{+} - [Hi]^{2} - Dementia (YM^{+}-[Hi]^{2}-D for short) in voicing and singing+ training, produce plasticity and enhance the efficiency of neurotransmission, which result in improvements in brain performances and in actual singing. The therapy program YM^{+}-[Hi]^{2}-D, which stimulates brains interactively with numerous model stimuli for imitation, is effective in activating brains and

1 Mie University

2 Suzuka Junior College

motor organs, less costly, and can be free from side effects and invasiveness. It is based on TY's successful experiences of correcting off-key singing (vocal amusia) (YUBA 2000, NOMURA *et al.* 2001, YUBA 2003, MIYAMOTO 2004, MIYAMOTO 2005, HIROSE *et al.* 2009, KARIYASU *et al.* 2012, CHI 2014) (Video: https://www.youtube. com/watch?v = v913c DUVbKE) and improving cochlear implant wearers' singing at The University of Tokyo Hospital (YUBA *et al.* 2008 2009); both studies persuasively indicated powerful plasticity of brains. In the light of the human brains' special characteristic, plasticity, the present treatment uses a unique method to train motor functions for correcting off-key singing and expanding vocal ranges. The project demonstrated effectiveness of The Functional-Analytical Reading-Listening (FARL for short) in exercising brains through interactive Model-Hi-Imitation cognitive exercise with good results in treating patients. This paper describes in detail the method (The YUBA Method), The YUBA Theory, and the results, in particular, expansion of vocal ranges of the patients. When they are considered together with the complementary paper (SATOH *et al.* 2015), we believe the importance of the results of our research in coping with the grave issue of increasing dementia cases in the world will be fully understood by many people of the world.

2. MATERIALS AND METHODS

Due to recruiting difficulties ten patients (ages 69-87 years, mean±sd 78.1±7.0, 4 males and 6 females), all of whom were musically naïve (the therapy group), were given the intervention. They were formed into three groups: first (two females, one male); second (two females) and third (two females, three males). YM^{+}-[Hi]^{2}-D program (Fig. 1) was given for six months, and intervention periods of groups did not overlap.

The Department targeted patients with mild to moderate Alzheimer's disease (AD) to avoid heterogeneity of symptoms according to inclusion and exclusion criteria.

This study received approval from the Mie University Research Ethics Committee, and all patients provided written informed consent.

2.1. Development of YM^{+}-[Hi]^{2}-D

The therapy program for the hypothesis, comprises voicing and singing^{+} based on The YUBA Method and body movement with The YUBA Method [Hi]^{2} System ([Hi]^{2}S for short) (Fig. 2b, c, Fig. 3b, d), using karaoke and an electric piano. It consists of three parts: The YUBA Method plus activities of various body functions; [Hi]^{2}S on the Spiral-loop Learning System (Fig. 3) for applying the primary treatment method; and the subject and purpose. The expression of $^{+(plus)}$ of singing^{+} and The YUBA Method^{+} means that in addition to voicing and singing, other human activities of body functions are utilized to stimulate brain extensively. TY's approach is to select effective procedures and integrate them to form the program of stimulating brain to a higher level performance. The program uses instructions designed to stimulate body parts. Body parts were selected according to the brain

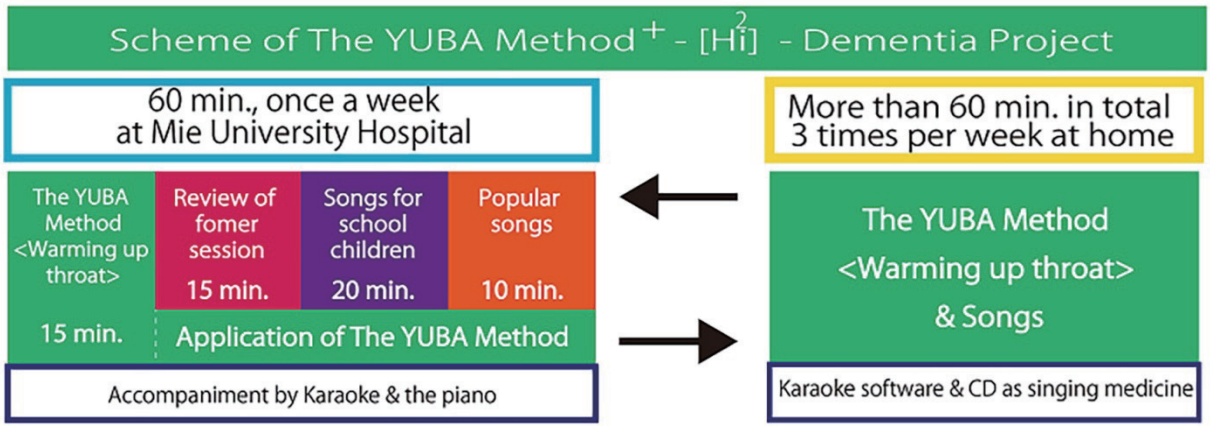

Fig. 1 The scheme of YM^{+}-[Hi]^{2}-Dementia Project. The YUBA Method <Warming up throat> (YUBA 2013) : With [Hi]^{2}S, mainly used to control intrinsic laryngeal muscular activities and the movement of vocal folds to expand the range, by producing falsetto and natural voices, and coordinating and interchanging between both registers.

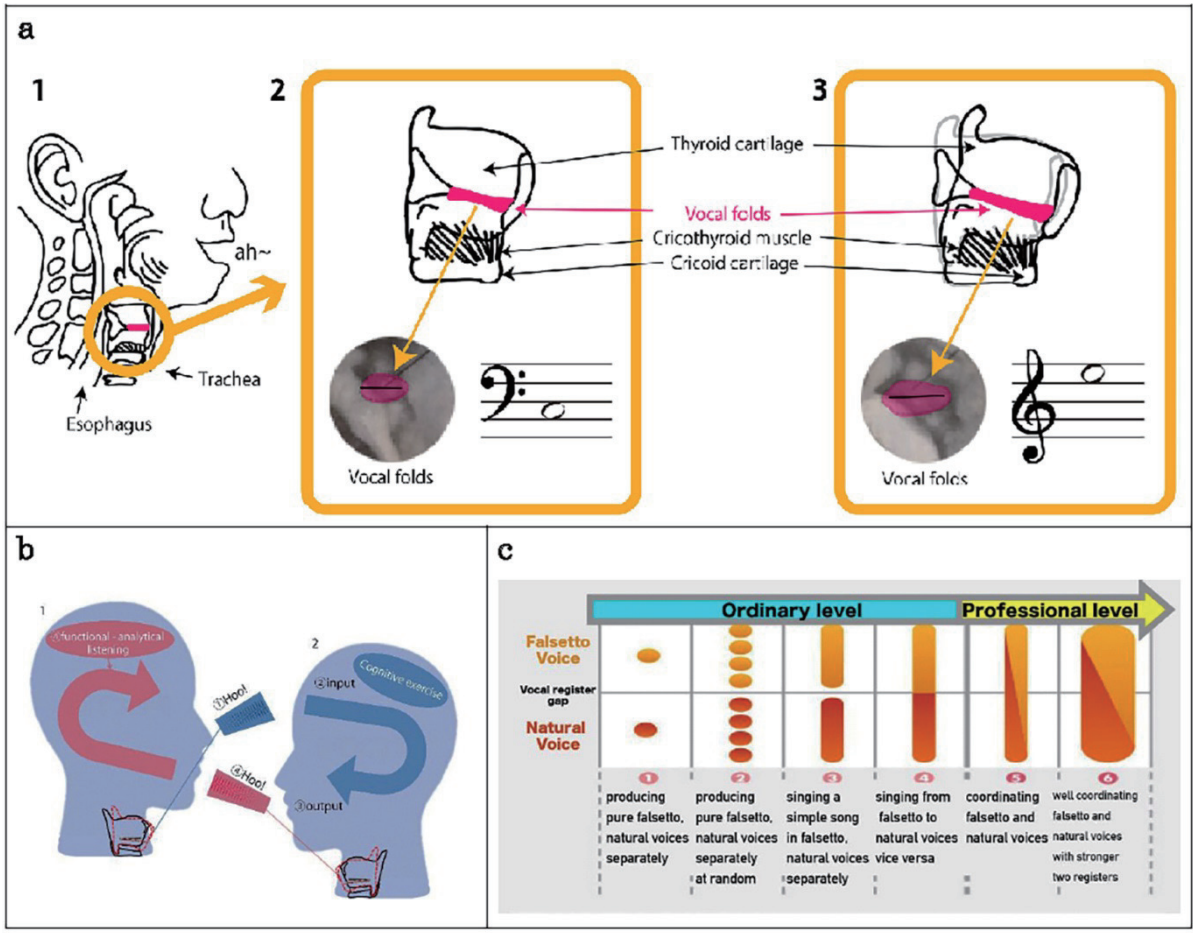

Fig. 2 Voicing mechanism, cognitive exercise and training procedure of The YUBA Method. a, Pitch–raising mechanism. 1, Position of the larynx in the throat. 2, State of vocal folds producing a low note in the natural voice. 3, State of vocal folds producing a high note in the falsetto voice. b, Controlling the voicing / Singing mechanism through cognitive exercise with $[Hi]^2S$. c, Training procedure of the method.

structure of Penfield's diagrams (PENFIELD *et al.* 1950) which show relationships between various body parts and the sensory area and between body parts and the motor area (Fig. 3e).

We performed YM^+-$[Hi]^2$-D group sessions at Mie University Hospital once a week, with homework 3 times per week, for 6 months (Fig. 1). All instructions are based on FARL (Fig. 2b-1) (YUBA *et al.* 2008, KARIYASU *et al.* 2012) and The Spiral-loop Learning System with Model-Hi-Imitation Module (Fig. 3d-1) (XING 2012).

2.2. Details of the Therapy Program

The program developer, professional singer and educator TY, and an instructor-accompanist YO carried out each session for one hour. First, voice training with "The YUBA Method <Warming up throat>" (YUBA 2013) (Fig. 1) was performed for 15 minutes, YM^+-$[Hi]^2S$. By producing falsetto and natural voices, and interchanging between both registers, this method mainly aimed to control intrinsic laryngeal muscular activities and the movement of vocal folds in order to expand the range. The muscles are used to generate sound sources of falsetto and natural voices and to coordinate these two types of voice. Second, a 15-minute review of the former session was held in which the songs practiced during the previous week were sung. Third, participants practiced familiar nursery songs and songs for school children for 20 minutes. The last 10 minutes section was a so-called recreation time (XING 2012). It used: songs that were popular when the patients were young; three unfamiliar songs, one composed in 2009, one popular around 2002 and a rap music (tongue twister) (Fig. 1). These songs were chosen according to difficulty and required vocal ranges, to avoid overloading patients. In general, the level of difficulty of songs was raised when patients' abilities were improved. The therapy of the second, third and fourth sections were actually applications of the method: For example, when a note was too low, the

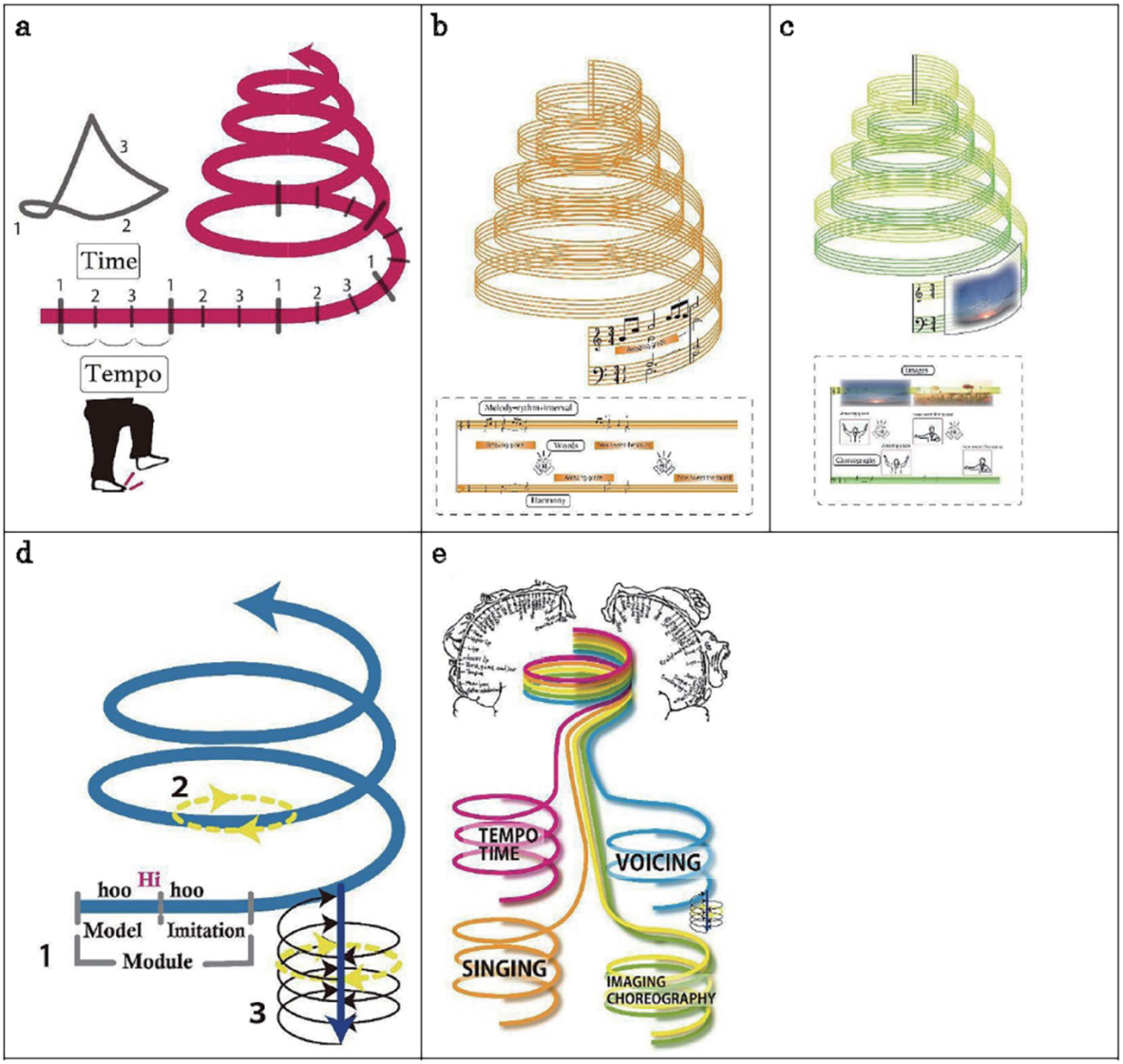

Fig. 3 Spiral elements to be integrated. a, Tempo＋time spiral. 1, Three-four time is kept by drawing a triangle. 2, Tempo is kept by stamping alternately. b, Singing (words＋melody＋harmony) spiral. c, Images＋choreography spiral. d, Voicing spiral. 1, One module (model, Hi and imitation). 2, Loop (repeating the same phrase/phrases). 3, Small spiral (repeating various phrases). e, Full integration of elements. 1, Sensory area based on Penfield's diagrams (PENFIELD *et al.* 1950). 2, Motor area based on the diagrams.

instructor taught the patient to increase the falsetto voice tendency and increase the level of exhalation; When the voice was too high, the instructor taught the patient to increase the natural voice tendency and to weaken exhalation; and when the patient lost the correct pitch around the vocal-register-gap because of the vocal register shock, the instructor taught how to coordinate two registers to reduce the shock (YUBA 2000, NOMURA *et al.* 2001, YUBA 2003, KARIYASU *et al.* 2012, CHI 2014).

Please refer to a complementary paper. This paper is essential in understanding the complementary paper for conducting further experiments (SATOH *et al.* 2015).

2.3. The YUBA Method, The YUBA Theory and [Hi]²S

In human body, if we wish to apply laws of physics rationally and practically, we have to understand voicing, relying on a functional-anatomical physiology for voicing. To use the voicing mechanisms, we need a voice control theory. The YUBA Method is an applied physics for voicing, more specifically, The Multifactor-Interactive Dynamic Theory for Voicing (Fig. 2a). Now, voicing is controlled by the commands given from the brain and various feedback mechanisms. The unique voicing and singing training method is based on a new phonation or voice production science, The YUBA Theory, which is a voice control theory based on the functional-anatomical physiology for

voicing in a narrow sense. In a wider sense, the theory contains both the voice control theory and a functional-anatomical physiology for voicing (YUBA *et al.* 2008, KARIYASU *et al.* 2012).

The method consists of: separating falsetto and natural voices respectively; strengthening both registers under separate conditions; coordinating the two registers; keeping steady sound source by minimizing any loss of articulating motions, as if imitating a ventriloquist, and adding the articulation movement little by little to make the singing more natural (Fig. 2c).

Byproducts of applications of the method include: Curing vocal amusia, improving cochlear implant wearers' singing ability (YUBA et al. 2008 2009 and rejuvenating voice (HIROSE *et al.* 2009).

[Hi]^{2}S is a kind of imitation learning system which uses a Japanese cue word "Hi" in instructing learners in voicing and singing+ training. "Hi" instructs learners to respond to and repeat the instructor's model voicing or singing (Fig. 2b, Fig. 3b, c, d). [Hi]^2 (pronounced High High) shows that the cue word "Hi" is used repeatedly in the training session (XING 2012).

According to the method, to neutralize or reset voicing system, patients are encouraged to produce voice freely to utter a sound as if they were animals, forgetting being humans, using an image of wolves howling at the full moon in the night. This is to free patients' voicing functions from cultural and social restraints limiting the voice range, volume, duration, tone quality and vowel. They can experience new voices liberated, to some extent, hearing their in-a-way primitive voices freed from social norms. TY believes that such experience gives catharsis to patients from daily problems and negative feelings and makes them more positive and optimistic. He experienced such expressions of exaltation among patients under the present therapy. He also noted similar exaltation among audiences of his presentations on the method when they practiced such voicing. This neutralization and resetting is one of essential elements of the method.

2.4. The YUBA Theory

The YUBA Theory is a new approach in understanding voicing and voice control, through examining the control of joints and muscles movements. The voice control theory is a non-linear control theory of multiple interacting elements for generation of a sound source and articulation of voices: This control theory explains voice generation and articulation mechanisms by clarifying interactive relationships of various organs involved.

We, human being, have no so-called “vocal organs.” Our voicing is an activity using larynx being the changeover mechanism between digestive and respiratory systems. The muscles which control the vocal folds are semi-voluntary muscle or semi-involuntary muscle (originally named by TY) rather than so-called voluntary muscle which we cannot control directly.

(1) Humans have no specific vocal organs. Humans vibrate vocal folds, which are in the thyroid cartilage located above the trachea, to use them as sound source. We resonate their vibrations in the vocal tract to speak or sing. The larynx has a fundamental role of sustaining life by switching between the digestive and respiratory systems. Our ability of speaking or singing is a secondary one obtained in the process of evolution.

(2) Two vocal registers (falsetto and natural)

A vocal register is a series of sounds of the same quality generated by one mechanism. There are only two vocal registers. Each vocal register has its own tone color clearly differing from each other.

Control of intrinsic laryngeal muscles, which produce falsetto and natural voices, provides the basics of voicing and singing. Intrinsic laryngeal muscles comprise: Cricothyroid muscle to extend vocal folds by bringing closer cricoid cartilage and thyroid cartilage; vocal muscle to shorten and swell vocal folds; closing muscles group to close the glottis; and posterior cricoarytenoid muscle to open the glottis.

(3) The YUBA Theory

If the cricothyroid muscle has tension, the cricoid cartilage and the thyroid cartilage come closer to each other, and vocal folds get longer and thinner, and their vibration results in a higher pitch. If the cricothyroid muscle is predominant over the closing muscle group, the glottis closure is imperfect, and this results in breathy falsetto voice. When the closing muscle group works and the glottis is closed, if the function of the vocal muscle is weak, only peripheral parts of the vocal folds will vibrate. It results in non-breathy falsetto, which allows you to sing a longer phrase than breathy falsetto voice with

a single breath. When the closing muscle group works predominantly over the cricothyroid muscle, and the vocal muscle works better, the glottis will be closed tight, and it will result in natural voice with the entire vocal folds vibrating.

(4) The Yuba Hypotheses on vocal register shock phenomenon

A vocal register shock is a shock which is physically felt or heard when the register switches to the other. As to how it occurs, there are two hypotheses developed by TY. One is that it is caused by a sudden change in the balance of forces among cricothyroid muscle, vocal muscle and closing muscle group. The other is that as the forms and movements of cricoid cartilage and arytenoid cartilage are complex, rapid changes in the movements of their joints cause a vocal register shock when the vocal folds are controlled by the above mentioned these muscles.

(5) Movements of skeletal muscles, and control of vocal folds

Glottal sounds, which are generated by the works of intrinsic laryngeal muscles controlling the vocal folds and by respiratory muscles, are modulated into speech and singing sounds in the vocal tract by the works of articulational muscles (laryngeal muscles, suprahyoid and infrahyoid muscles, masticatory muscles, lingual muscles, facial muscles, etc.). The works of articulational muscles for generating vowels and consonants have significant effects on the works of the intrinsic laryngeal muscles which are the main muscles for generating glottal sounds, and vice versa.

(6) Once the characteristics (pitch, volume, length, tone quality and vowel) of the sound to be produced are determined, the expiratory flow for producing the sound will be automatically determined.

2.5. The Spiral-loop Learning System (S-lLS)

YM^{+}-$[Hi]^{2}$-D (Fig. 1) is based on The Spiral-loop Learning System (Fig. 3) wherein both spiral and loop comprise modules, a module comprises a model, a “Hi,” and an imitation, and a spiral comprises many modules (Fig. 3d-1). The model can have any contents to meet the requirement. When one identical module is repeated or a series of varied-yet-related Model- Hi-Imitation Modules are repeated in a spiral to refine it or for its better integration or for better performance in basic functions, repeated modules are called a loop (Fig. 3d-2,d-3). When various modules are consecutively added together in a therapy, these added modules are called a spiral, and this spiral is for expanding and integrating modules as one entity, for example, a song (Fig. 3b). This cumulative and repetitive approach is intended to enhance brain plasticity (Fig. 3e).

Spiral training process: One session of the training consists of many modules of interactions between the instructor and patients (Fig. 2b, Fig. 3d-1). In principle, one module comprises one model plus "Hi" plus one imitation, the size of the model is varied. Each module consists of, for example, following interactions:

The instructor sings "Hoo------." At the same time, patients hear "Hoo------" and recognize the pitch, tone quality, strength, vowel, and length. Next, the instructor says "Hi!" Then, patients sing "Hoo------" and simultaneously recognize their voices and compare them with the instructor's voice "Hoo------" to understand differences between their voices and the instructor's voice and correct their voices and sing "Hoo------." (Fig. 2b)

These interactions are very short in time. If the instructor judges that patients' responses are inappropriate, the instructor slows down the pace of modules. If one imitation is found to be difficult for patients, the instructor repeats the model until patients can accomplish it satisfactorily. Thus modules are repeated, using the piano, to reach a culmination of the spiral wherein all patients are able to sing along with karaoke happily and satisfactorily.

The use of the piano is useful in training patients to sing according to YM^{+}-$[Hi]^{2}$-D. After each model voice is given by the instructor, patients start to repeat the model voice upon hearing "Hi." Then the instructor analyzes patients' responses and gives a new model voice which is designed, on the basis of FARL and sense of musicality, to obtain a correct or better responses from patients. This is a sophisticated human process, especially when better musicality is desired (Fig. 3).

For all four sections, the piano and a karaoke device (JOYSOUND CROSSO, XING INC.) were used. Patients in the therapy group were also required to practice voicing and singing at home. Every patient was provided with game-player equipment on which a karaoke software program (JOYSOUND Wii SUPER DX, XING INC.) could be played offline. More than ten songs ranging from narrow to gradually wider voice ranges were selected from seventy songs stored in the

program, and they were used for the treatment. Moreover, the voice training music piece, The YUBA Method <Warming up Throat>, and songs other than the seventy songs and sung by TY, were recorded on a CD, which was used by the patients for exercise at home. Synergetic effects can be obtained from receiving the therapy given by instructors and from using The Singing Medicine at home. Two recitals were held for patients of each of two of three groups, and one recital for one group to enjoy their achievements; patients' experienced pressures and stresses but they finally overcame them.

The use of S-lLS has special advantages: patients' blood circulation is enhanced when some activities (especially dancing) are integrated together; and sense of timing of patients is enhanced, which enables the patients to adjust their performances with the accompaniment of karaoke and the piano. One example of developments of S-lLS is DanSing (Dancing and Singing)–VoiSing (Voicing and Singing).

2.6. The Outline of the Project

Making piano accompaniment scores to sing with karaoke. Dementia patients were first instructed to sing along piano accompaniment. When patients succeeded to start to sing at the right timing and pitch, and to sing the entire song correctly, they were instructed to sing with karaoke.

The YUBA Method <Warming up throat>: It is an about three-minute program intended to guide singers to use throat efficiently, expand vocal ranges (KIOKA 2006, SATOH 2011, CHI 2014) and raise volumes before starting to sing songs. Training processes are designed to protect throats from unintended but highly probable damages. The program is the core of the method. The program is given on S-lLS (Fig. 3) with Model-Hi-Imitation Modules (Fig. 3d-1), cognitive exercise.

Importance of motivating patients: Motivation is an important factor in enhancing performances of patients through this therapy. The program motivates patients through emulation/competition, appealing to the desire to improve oneself to a higher level, imitation, and positive evaluation based on evidences of before- and- after singing skill differences of every attempt (YOKOMINE 2009).

2.7. Making Piano Accompaniment Scores to Sing with Karaoke

Generally speaking, the starting part of each song of karaoke is difficult for ordinary people as well as dementia patients. The karaoke score of the introduction is not available. So it was necessary for the instructor, YO, to make a score of the introduction and the rest of the karaoke accompaniment of each song for the piano. These piano scores are intended to assist patients to make a good start. In the case of the piano accompaniment, thanks to these scores, lengthy parts such as introduction and interlude of the karaoke accompaniment of the song can be excluded so as to make more efficient training. Furthermore, piano accompaniment scores including melody lines also help patients to study and understand respective songs more carefully, enhancing memory and the effectiveness of the therapy with $[Hi]^2S$.

Patients were provided with printed music or lyrics of the songs. During the therapy, patients were asked by the instructor to explain the background information (e.g., songwriters, year of release) of some songs, and patients tried hard to recall their memories associated with the songs. Singing instructions on stress, intonation, pronunciation, pitch, climax, musical nuance, tempo, phrase, conducting figure of time, etc. were written into music sheets by the patients or the instructor, if necessary, during the therapy, and the instructor was able to observe patients' physical and mental conditions. The music and lyrics were intended to assist patients in learning to sing songs during the therapy in the hospital and practice using the singing medicine at home.

2.8. Homework and Pitch Measurement

Instructions for operating the karaoke system were provided to caregivers. Patients were required to sing three times per week for 20 minutes for each session: In general, each patient actually did the homework for more than required 60 minutes per week. Caregivers were asked to report the amount of time spent in doing home practice every week.

Before and after the 6 month intervention period, the pitch range of each patient's singing voice using the musical scale was evaluated by TY and YO to determine the pitch range based on the number of semitones in front of two doctors, three assistants and caregivers.

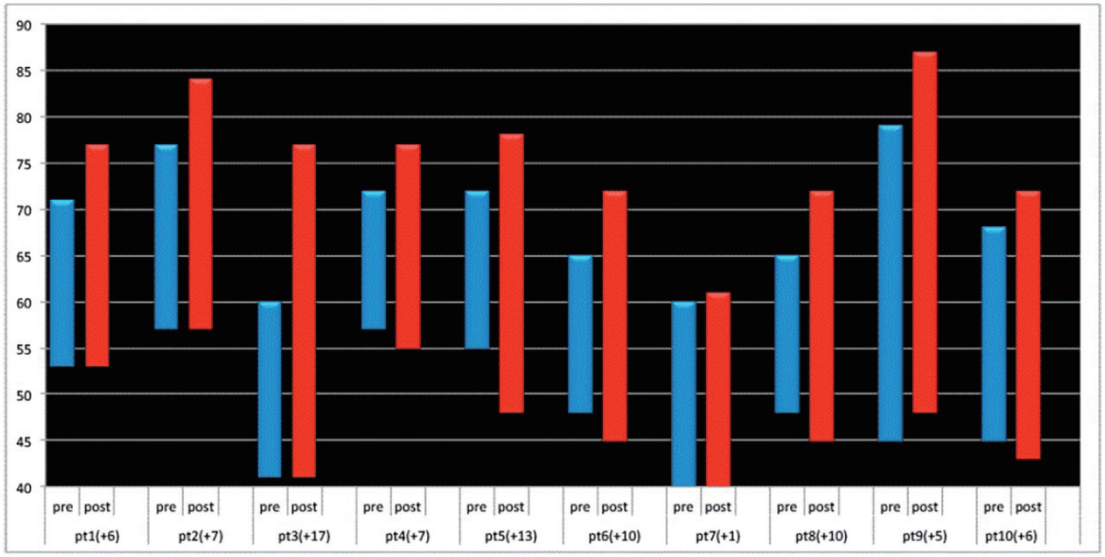

Fig. 4 Changes in case groups' vocal ranges before and after the intervention (KIOKA 2006, SATOH 2011, CHI 2014). Blue bars indicate vocal ranges before the intervention and red bars indicate vocal ranges after the intervention. Vertical axis indicates the MIDI number. Horizontal axis indicates patient numbers.

Table 1 Expansion of vocal range of therapy group.

Pt. No.	age	sex	vocal range (Before)	vocal range (After)	Expansion(s)
1	71	F	F3 – B4 (18 s.)	F3 – F5 (24 s.)	6
2	74	F	A3 – F5 (20 s.)	A3 – C6 (27 s.)	7
3	70	M	F2 – C4 (19 s.)	F2 – F5 (36 s.)	17
4	86	F	A3 – C5 (15 s.)	G3 – F5 (22 s.)	7
5	69	F	G3 – C5 (16 s.)	C3 – Fis5 (30 s.)	14
6	87	M	C3 – F4 (17 s.)	A3 – C5 (27 s.)	10
7	85	F	E2 – C4 (20 s.)	E2 – Cis4 (21 s.)	1
8	79	M	C3 – F4 (17 s.)	A2 – C5 (27 s.)	10
9	76	F	A2 – G5 (15 s.)	C3 – Dis6 (20 s.)	5
10	84	M	A2 – Gis4 (23 s.)	G2 – C5 (29 s.)	6
mean	–	–	–	–	8.3
Stdev	–	–	–	–	4.62

s.: semitones

3. RESULTS AND DISCUSSION

3.1. Effectiveness of the Therapy Program

The medical staff of the Department conducted neuropsychological assessments of therapy groups and control group. These results are reported separately by the Department (SATOH *et al.* 2015).

Patients' range measured by TY and YO (Y. Okubo) was significantly expanded ($P<0.001$) after voice training (Fig. 4) with the method (Fig. 2). The pitch range before and after the intervention was 18.0 ±2.5 semitones (mean±sd) and 26.3±4.8, respectively. All patients except one (Pt. No.7) could sing with higher and lower pitches than before (Fig. 4, Table 1).

None of patients in the therapy group dropped out during the intervention period (Fig. 1). Out of the total number of sessions possible (24 or 25 sessions), every patient participated more than 20 sessions (mean ± sd 92.6±5.7%). As for homework task, the mean practice time was 75 (sd±22) minutes per week. Only one patient practiced less than 60 minutes per week (mean 44 minutes).

3.2. Discussion

TY developed the main hypothesis, working hypotheses and treatment program, gave the intervention, and made feedback throughout the intervention. Here TY discusses the intervention on the basis of some results which are not covered by the complementary paper, from a viewpoint of the very person who conducted the intervention.

To understand the difficulties the patients face in the voicing training, it is necessary to understand that "the higher is the frequency of a voice, the shorter is the time required to control the related muscles. This, in turn, requires much faster and much more exact performances of the brain and neural networks.

We cordially request the readers to read this paper together with its complementary paper and consider, in the light of the recorded improvements in the patients'

vocal ranges, the relationship between YM^{+}-$[Hi]^{2}$-D including this voicing training intervention and the changes in the performances of the brain and neural networks in a much wider general perspective.

In developing the therapy program, we intended to guide patients to acquire new skills as well as their once-lost skills. This is to make the therapy more challenging and interesting for patients. Such new skills include voicing, singing new songs (quick-tempo songs, rap music etc.) and dancing. We actually learned, through the therapy, that patients were wishing and enjoying to acquire such new skills and feel that they fully engaged with the present-day world. As a result, to our surprises, patients dramatically expanded their vocal ranges (KIOKA 2006, SATOH 2011, CHI 2014) by 8.3 semitones in average in 6 months (Fig. 4) and learned to sing new songs as well as songs which they could not sing before the intervention, thanks to their expanded vocal ranges. For reference, using The YUBA Method, 20 junior high school students expanded 5.4 semitones in one month (SATOH 2011), 17 kindergarten children expanded 6 semitones in 20 days (KIOKA 2006, YUBA 2010), and 5 university students expanded 10.5 semitones in one month (CHI 2014). We believes that these results clearly indicate the plasticity of the brains of the patients.

3.3. Concrete Examples: Pitch Matching and Singing of the First Group

The group comprised three patients; two females and one male. One female had previous experience of singing in a chorus group and her voice range was wide, and she sang with beautiful voice and could carry a tune. The male sat next to her. He had a little less than one and a half octaves vocal range. His pitch matching capability was weak in the higher portion of his vocal range, and he sang one octave lower than the normal key. As a result, his singing did not fit well with others. By the voice training of The YUBA Method, he could produce falsetto voice, natural voice and their mixed voice, and extended his vocal range to three octaves. He was taught to sing scale, arpeggio, and one octave jump, successfully. It was understood that he had established a sound scheme in his brain because he could sing these tasks stably and correctly. The other female could not sing falsetto voice, so her vocal range was limited up to the transition point between the falsetto and natural voices. Her transition point was between B4 and C5, and the highest note of the school song being taught at the time was D5, therefore, naturally, she could not match it in singing. However, after about five months, she finally could produce falsetto voice dramatically, and eventually she could produce her falsetto voice regularly. She thus expanded her vocal range by getting to be able to produce the voices in both falsetto and natural voices. She could sing two voices freely; from natural to falsetto and vice versa. Finally she could sing the song which she had not been able to sing previously.

ACKNOWLEDGEMENTS

The authors would like to express our gratitude to the researchers (H. Tomimoto, M. Satoh, H. Kida) of Department of Dementia Prevention and Therapeutics, Graduate School of Medicine, Mie University for giving us the opportunity to collaborate in the project. We would like to express deep gratitude to Dr. M. Yoshioka for his coordination of writing this paper.

REFERENCES

CHI, T. (2014) Verification of Correcting Off-key Singing by The YUBA Method: For Introducing the Method to Singing-voicing Education et al. in China, Graduate School of Education of Mie University (Master's Thesis).

HIROSE, H., SHIROMOTO, O., KOIKE, M., ENDOH, Y., NAMAI, Y. (2009) Voice Disorder Diagnosis Manual for Speech Therapist (in Japanese), Interuna Publishers, Inc., Tokyo.

KARIYASU, M. SHIROMOTO, O., SAKAKIBARA, K., OGAWA, M., YUBA, T., et al. (2012) Revised Voice Disorders (in Japanese), Kenpakusha Co., Ltd., Tokyo.

KIOKA, N. (2006) Verification of Effects on Vocal Ranges of Preschool Children of Voice Training with The YUBA Method Teaching Material for Preschool Children, Graduate School of Education of Mie University (Master's Thesis).

MIYAMOTO, K. (2004) The Effects of The YUBA Method on the Vocal Pitch Accuracy of Inaccurate Elementary Singers (Doctor's Thesis), UMI Number 3129869.

MIYAMOTO, K. (2005) Effects of a Remedial Singing Method on the Vocal Pitch Accuracy of Inaccurate Elementary School Singers, *Research and Issues in Music Education*. 3, No 1.

Edited by NOMURA, T., HONJOH. I., KOATSUZAKI, A., YUBA, T. (2001) Clinical Trends in Oto- Rhino-

Laryngology, Head and Neck Surgery Part3 (in Japanese), (Nakayama-Shoten Co., Ltd., Tokyo.

PENFIELD, W., RESMUSSEN, T. (1950) The Cerebral Cortex of Man: A Clinical Study of Localization of Function, Macmillan, New York.

SATOH, M., YUBA, T., TABEI, K., OKUBO, Y., KIDA, H., SAKUMA, H., TOMIMOTO, H. (2015) Music Therapy of Singing Training Improves Psychomotor Speed in Patients with Alzheimer Disease: a Neuropsychological and fMRI Study, accepted in *Dementia and Geriatric Cognitive Disorders-Extra*.

SATOH, Y. (2011) Verification of Expanding Vocal Ranges of Junior High School Girls with The YUBA Method Voice Training DVD (Master's Thesis).Mie University Scholarly E-collections: http:// miuse. mie-u.ac.jp/ handle/ 10076/12851 (accessed 2015.06.12)

XING INC. (2012) Kingdom of Health (a brochure), KING1207-SSP-30000-DC, XING INC., Tokyo.

YUBA, T. (2000) Method for Curing Motor-related Off-key Singing "Is tone deafness really deafness?" *The Japan Journal of Logopedics and Phoniatrics*, 41, No.3: 250–4.

YUBA, T. (2003) Cause of Off-key Singing and Its Curative Education. *Special Issue on: Journal of the Indian Musicological Society*, 34: 75–82.

YUBA, T., ITOH, T., YAMASOBA, T., KAGA, K. (2008) Advancement in Singing Ability Using The YUBA Method in Patients with Cochlear Implants, *Acta Oto-Laryngologica*, 128: 465–72.

YUBA, T., ITOH, T., KAGA, K. (2009) Unique Technological Voice Method (The YUBA Method) Shows Clear Improvement on Patients with Cochlear Implants in Singing, *J. Voice*, 23:119–24.

YUBA, T. (2010) Super-Easy Voice Training for Future Genius Based on Model-Imitation (in Japanese), Asahi Shinbun Publications Inc, Tokyo.

YUBA, T. (2013) You Can Sing Beautifully in One Week! (with a DVD: The YUBA Method〈Warming up throat〉), ASA Publishing Co., Ltd, Tokyo.

YOKOMINE, Y. (2009) Four Switches for Making Children a Genius, Yokomine System in DVD, Nihonbungeisha Co., Ltd, Tokyo.

WORLD HEALTH ORGANIZATION (2012) DEMENTIA: A Public Health Priority. http:// apps. who.int/ iris/ bitstream/ 10665/ 75263/ 1/ 9789241564458_eng.pdf?ua=1 (accessed 2015.06.12).