Tomatis® Audio Training on Memory Disorder of Patients with Stroke

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Abstract

Objective: This experiment aims to explore rehabilitative effects of Tomatis® training on memory dysfunction among patie nts with stroke.

Methods: A total of 80 stroke patients with memory dysfunction were sampled and divided into the control group (n=40) and the experimental group (n=40). Both groups received Tomatis® audio training in combination with routine intervention, while the only difference between the interventions was that the music tracks used in the control group was not specially modified. All participants received a 14-day session of program T and a 10-day session of program F, with a break of 3 0 days in between. During the training sessions, each participant received 60-90min training each time, once a day. River-Mead Behavioral Memory Test-second edition (RBMT-II) was conducted pre and posts the training.

Results: After two sessions of Tomatis® audio training, the scores of the experimental group obtained by RBMT-II increas ed significantly, as compared with that of the control group($P<0.05$), in the aspects of recalling names and appointments, recognizing pictures and faces, spatial awareness, and immediate and delayed recall of stories, routes and mails.

Conclusion: Tomatis® audio training can enhance memory of patients with stroke.

Key words: Stroke; Memory Disorders; Tomatis® Audio Training

About 75% of all survivors of stroke, which incidence has been rising by the year, are suffering from cognitive impairments [1], Memory dysfunctions, most commonly seen among these impairments, always affect the outcome of rehabilitation [2]. Tomatis® audio training [3], developed by a French doctor Alfred Tomatis®, employs modified music to induce stimulation on the cortex in order to improve cognitive function. The training is simple to deliver and does not put strict requirements on the environment. It can be used in a great variety of cases and at different stages of the course of disease. In other countries, Tomatis® training has been applied in cases of psychological and cognitive dysfunction [4], but data on its effects on the post-stroke memory dysfunction are still lacking. It was based on such grounds that this research was designed and conducted.

1 Subjects and Methods

1.1 Subjects

Between August and December in 2015, 80 inpatients with stroke were selected from the Rehabilitation Department in Tangshan Gongren Hospital. The inclusion criteria were: diagnosis of stroke based on the standard established by The 4th Conference of Chinese Cerebrovascular Disease in 1995 and confirmed by clinical examinations, age between 35 and 75, absence of moderate or severe encephalatrophy or leukoaraiosis, first onset, the course of disease being less than three months, abnormal scores of RBMT-II, absence of conscious, mental or psychological disorders, willingness to participate in the research and a signed version of informed consent. Patients with audiovisual dysfunction, severe organ dysfunction, malignant tumors, other critical conditions and addiction to drugs or alcohol were excluded.

1.2 Method

1.2.1 Grouping

The sample was composed of 80 inpatients with stroke (52 males and 28 females), selected based on the aforementioned criteria, with an average age of 56.76±8.573. Among all the participants, there were 55 cases of cerebral infarction and 25 cerebral hemorrhage; as to the location of the lesions, 32 participants were on the left, 35 on the right and 13 on both sides.

The participants were evenly and randomly assigned into the experimental group (n=40) and the control group (n=40).The difference between these two groups in the aspects of demographic information, course of disease, nature of disease and sides of lesions was not statistically significant($P > 0.05$)(see Table 1).

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Table 1 Comparison between Two Groups on Demographic Information

		Experimental Group (*n*=40)	Control Group (*n*=40)	Statistical Data	*P*
Sex	Male	25	27	0.220[1)]	0.815
	Female	15	13		
Age/Year	35~	2	3	1.699[1)]	0.637
	45~	16	15		
	55~	10	14		
	65~	12	8		
Educational Background	None	15	14	0.212[1)]	0.899
	Primary or Junior High School	17	19		
	Senior High School and Above	8	7		
Marital Status	Married	28	32	1.067[1)]	0.439
	Divorced or Widowed	12	8		
Occupation	Mainly Mental	26	22	0.833[1)]	0.494
	Mainly Manual	14	18		
Time since Onset /Month	1~	12	16	0.911[1)]	0.634
	2~	18	16		
	3~	10	8		
Nature of Disease	Cerebral Infarction	30	25	1.455[1)]	0.335
	Cerebral Hemorrhage	10	15		
Sides of Lesions	Left	15	17	0.459[1)]	0.795
	Right	19	16		
	Bilateral	6	7		
MoCA Score		13.48±3.030[3)]	13.05±3.137[3)]	0.616[2)]	0.539

1) value of x^2; 2) value of *t*; 3) value of x±s

1.2.2 Intervention

Both groups received Tomatis® training in combination with routine rehabilitation, including occupational therapy, physical therapy, transcutaneous electrical nerve stimulation, treatment on neural network plasticity and acupuncture. The only difference between the interventions on the two groups was that the music tracks used in the experimental group was specially modified as designed by the Tomatis® training.

The audio training was delivered daily by research staff between 18:30-20:00, since the participants were more relaxed during this period than other times of the day and they could also benefit from a good night rest after the training. The device used in this experiment was "TalksUp (SN: 150103-0000472)" developed in 2015 by the Tomatis® research institution in France and produced by the Tomatis® development agency in Austria. Specially, the training apparatus consisted of 2 hosts (one with specially modified music tracks and the other with regular ones) with touch screens, 2 wireless transmitters matched with hosts, 16 wireless headsets with additional vibrators for bone conduction (BC). Those headsets were equally divided between two groups, and 16 people (8 from either group) were trained at the same time.

Detailed Experimental Methods

Both groups received Tomatis® training in combination with routine rehabilitation[6], and the only difference in the intervention between these two groups was that the music tracks used in the control group were regular ones without any modification.

The principle of Tomatis® training is the perceptual contrast, realized by switching between two audio channels, Channel 1(C1) which features high frequencies and Channel 2(C2) which features low frequencies in both air conduction (AC) and BC, and thus the frequencies of the music constantly vary across the spectrum between 20Hz and 16000Hz. The time required to switch from C1 to C2 by BC is called “delay” while that in AC, once the switching in BC has finished, is named “precession”, and the gating speed is the sum of delay and precession. The constant alternation between these two channels in both AC and BC induce a large amount of stimulation onto the brain and other parts of the central nervous system [3].

The program used in this experiment was originally designed by Jean Pierre Granier, MD of Neurocognitive Psychology in Marseille University in France, and later discussed and approved by the research staff and experts from Neurology Department.

(1) Stage 1 was designed to for participants to adapt to the training, therefore the frequencies changed in a gradual mode to prepare the participants for the later, more intensive session. For such a purpose, program T was used, once a day, 60 minutes for the first 3 days and 90 minutes from day 4 and onwards. The music tracks consisted of 35% non-filtered music (MU), 26% mixed voice or Gregorian chant (GC), 21% low band-pass with a cutoff frequency of 6000HZ (Low BP) and 18% universal band-pass with the cutoff frequencies of 500HZ and 3000HZ (BPU1).

(2) Stage 2 was planned as a break between two sessions of intensive training, allowing enough time for the brain and the body to assimilate and integrate the changes induced by stimulation [6].

(3)Stage 3 was the essential stage, since till then the brain of the participants had gradually adapted to the stimulation caused by changes in frequency. This stage last for 10 days, with a daily session of 90 minutes. The music formula chosen for this stage was made up of 60% MU, 25% GC and 15% Low BP.

Music Selection

The music tracks used in this research were all preinstalled in the “TalksUp”, and research staff was in charge of operating the device and selecting among Mozart tracks and Gregorian chants.

(1) Mozart Tracks

A great variety of Mozart tracks, including Quartet in A Major, Concerto for flute and harp, Violin Concerto, D major and *Serenade* were used in this research, ensuring different music experience for each day. Researches have proved that the ratio of high frequency in Mozart's music is definitely higher than that in other music varieties, therefore, it can enhance the ability of spatial reasoning, increase alfa activities and activate cortical circuit (pertaining to memory and executive function) [7]. Moreover, Mozart music is featured by a lively tempo.

(2) Gregorian Chant: It is the source of Western music and its rhythm, similar to that of breathing and combined with a feature of legato, can sooth and relax the autonomic nervous system [4].

1.2.1 Evaluation

RBMT- II was conducted on all participants before and after the experiment, and 13 abilities including special orientation, recollection of first names, last names, dates, hidden objects, recognition of pictures and faces, immediate and delayed recall of stories, routes and mails were assessed.

The original scores were converted into a standard score: 0, 1, and 2, in which 2 meant adequate, 1 acceptable and 0 poor. Altogether 12 standard scores (the scores of immediate and delayed recall mails were combined) were calculated out and added up. As to the total score, 24 to 22 meant normal, 21 to 17 mild memory impairment, 16 to 10 moderate impairment, and 9 to 0 severe memory impairment [8].

1.3 Statistical Methods

Statistical software SPSS17.0 was used to test normal distribution and homogeneity of variance of collected data and then to conduct t test on measurement data (x±s) and x^2 test on enumeration data. “P＜0.05” was set as the standard to determine whether the difference was statistically significant.

2 Results

2.1 Comparison of RBMT- II Scores before Tomatis® Training

Before Tomatis® training, the overall difference and that of each individual aspect compared between the experimental group and control group were neither statistically significant (see Table 2).

Table 2 Comparison of RBMT- II Scores before Training ($\bar{x} \pm s$)

RBMT-II	Experimental Group	Control Group	*t*	*p*
Recollection of names	0.84±0.632	0.94±0.316	-0.896	0.660
Recollection of Hidden Objects	0.95±0.472	1.00±0.816	-0.318	0.754
Recollection of Appointments	0.84±0.632	1.14±0.876	-0.878	0.391
Recognition of Pictures	0.80±0.422	0.90±0.483	0.493	0.628
Recognition of Faces	0.94±0.568	0.80±0.516	1.236	0.660
Immediate Recall of Stories	0.90±0.738	0.84±0.632	0.976	0.749
Delayed Recall of Stories	0.70±0.483	0.80±0.632	-0.397	0.696
Spatial Orientation	1.40±0.516	1.15±0.738	-0.543	0.306
Recollection of Dates	1.25±0.422	1.35±0.675	1.053	0.694
Immediate Recall of Routes	1.05±0.667	0.90±0.568	0.316	0.722
Delayed Recall of Routes	0.34±0.597	0.60±0.516	-1.342	0.196
Delayed Recall of Mails	0.50±0.527	0.64±0.483	-0.885	0.388
Overall Score	10.51±3.071	11.06±3.302	-0.471	0.476

2.2 Comparison of RBMT- II Scores after Tomatis® Training

After Tomatis® training, the overall difference and that of each aspects compared between the experimental group and the control group were both statistically significant ($P < 0.05$) (see Table 3).

Table 3 Comparison of RBMT- II Scores after Training ($\bar{x} \pm s$)

RBMT-II	Experimental Group	Control Group	*t*	*p*
Recollection of names	1.54±0.527	1.04±0.471	2.236	0.038
Recollection of Hidden Objects	1.25±0.667	1.10±0.876	-0.287	0.777
Recollection of Appointments	1.84±0.316	1.24±0.919	2.278	0.035
Recognition of Pictures	1.40±0.516	0.95±0.632	2.324	0.032
Recognition of Faces	1.34±0.699	0.84±0.675	2.278	0.035
Immediate Recall of Stories	1.40±0.732	0.94±0.738	1.555	0.037
Delayed Recall of Stories	1.60±0.516	0.90±0.738	2.458	0.024
Spatial Orientation	1.80±0.422	1.20±0.632	2.496	0.022
Recollection of Dates	1.30±0.483	1.40±0.699	-0.372	0.714
Immediate Recall of Routes	1.50±0.422	0.94±0.667	3.207	0.005
Delayed Recall of Routes	1.24±0.483	0.70±0.416	2.777	0.012
Delayed Recall of Mails	1.45±0.526	0.85±0.632	2.324	0.023
Overall Score	16.16±3.919	13.10±4.050	3.308	0.001

3 Discussion

Memory is the brain's function in identifying, remembering, reconstructing and recognizing objects and events, and it is the basis of senior psychological activities including thinking and imagining[9]. The human memory is closely related to changes of various complex structures and chemicals in the brain [10].

Cognitive impairments, caused by local brain damage during the stroke which is usually the result of hypoxia and ischemia, are mainly manifested as difficulties in remembering, learning and executive functioning [11]. Consequently, both daily activities and rehabilitation are unfavorably affected. Fortunately, it has been discovered that the structure and function of such damaged tissues on the central nervous system is highly plastic [12], which indicates the possibility of being reshaped and strengthened through training [13].

The result of this experiment shows that after Tomatis® training, the difference between RBMT- II scores of the two groups was statistically significant ($P < 0.05$) in the aspects of special orientation, recollection of first names, last names, dates, hidden objects, recognition of pictures and faces, immediate and delayed recall of stories, routes and mails, suggesting that Tomatis® training can effectively relieve memory impairments in patients with stroke.

The device used for Tomatis® training is highly sophisticated, because:

① AC and BC can be realized by one headset, while the latter will facilitate the sound reception[14];

② the music tracks used are specially modified.

The mechanism of Tomatis® training can be summarized as follows.

① The sound across the spectrum can induce stimulation onto the limbic system located at the central region of the brain, which is responsible for emotion, memory and knowledge acquisition;

② High frequency sounds energize the cortex through the cochlea, and during the process the limbic system and the prefrontal cortex can be activated, resulting in a rise in efficiency of auditory working memory [15]. Therefore, the impairments that interfere with cognitive function, psychological well-being, language or balance can be alleviated.

③ Music tracks and their modification vary from session to session in order to keep the participants interested in the training. As a result, the brain will always receive fresh stimulation caused by changes in sound frequencies and the memory function will eventually be enhanced.

④ The soothing and relaxing feature of music will further facilitate rehabilitation.

4 Conclusion

Tomatis® training is a convenient intervention not strictly limited by location and environment. With wireless device, several patients can receive the training simultaneously, making this intervention time- and cost-effective. More importantly, under a relaxing atmosphere, the patient can benefit from this training without potential side effects. However, limitations on time and sample size necessitate further researches to identify long-term efficacy of Tomatis® training.

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