IASDR07
INTERNATIONAL ASSOCIATION OF SOCIETIES OF DESIGN RESEARCH THE HONG KONG POLYTECHNIC UNIVERSITY 12TH TO 15TH NOVEMBER 2007

A STUDY THE PSYCHOLOGICAL AND PHYSIOLOGICAL INFLUENCES OF THE ELDERLY IN TERMS OF FITNESS EQUIPMENT OF THE TENDON-MOTIONS

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ABSTRACT:

Nowadays it is widely believed that health preservation is more important than medical treatment. With the growing aging population, there is a boosted demand for fitness equipment for the elderly. The results of this research suggest that tendon-motion fitness equipment can help elderly to slow down the degeneration of their physical and psychological conditions. According to the measurement of the EMG the subjects' tendon-motion at 22° was most effective for muscle coordination and function. At this angle, the EEG also revealed that $\beta \rightarrow \alpha$ was most effective (for what?). The subjects responded in this angle for the tendon they felt most, comfortable, relax, soft, and flexible; for the brain, the conscious, sober, emotion, pressure is in the best situation.This research was expected to offer reference for the design of the fitness equipments or products, and according the experiment information, and analyze the difference situation to found out the design basis of the tendon-motion equipments.

Keyword: tendon-motion, fitness equipments, elderly

1. INTRODUCTION

The advancement of life quality and medical service means our population today enjoys a much longer life expectancy. One of the social challenges posed by an aging population is the rising cost of healthcare programmes for the elderly. However, innovative design may help to alleviate this problem.

The most efficient way to stay healthy is through exercise (楊木仁，2002). It is generally believed that exercise can improve one's blood circulation and physical function as well as preventing certain diseases. However, due to their age, old people should keep away from intensive exercise to avoid injury. Therefore tendon-motion exercise, which requires low physical strength, is more appropriate for the elderly. The aim of this study is to explore how tendon-motion exercise could affect an elderly through physical experiment and psychological test. It is expected that the results of this research could serve as reference for the future development of elderly healthcare equipment design. The primary objectives of this research are:

1. to examine the changes in subjects' muscular functions and brainwave after using the tendon-motion equipment and;
2. to explore the impacts brought by different angles of the tendon-motion equipment on the subjects.

2. BACKGROUND

2. 1. ELDERLY

Recently, there has been a rise of health related equipment for the elderly in the market. After middle-age, people may maintain or strengthen their physical conditions through appropriate exercise. The lack of physical activities or aging could weaken one's muscular and tendon functions which results in poorer physical motions and higher injury risks. (溫怡英，2004). For old people suffering from osteoporosis, this means that they may even suffer injury from doing daily activities at home.

This has led to some old people restricting their physical activities to avoid getting hurt who gradually lose their abilities to live independently gradually. They may then rely on others to look after them. Also any physical injury to an elderly could cause other health problems such as disability and loss of movement which lead to diseases or even death. The social cost will also be higher as a result of this. (潘慧芬，2002). To avoid such situation, appropriate exercise can improve the cardiopulmonary function, joints flexibilities, muscular strength and the sense of balance The trend of diseasa treatment has been replaced by how to prevent disease and promote health instead. (卓俊辰，2000). Promoting health means one when one is healthy, s/he should explore methods to keep oneself healthy(蕭淑芬，2003).

2. 2. FITNESS EQUIPMENT

The purpose of fitness exercise is that it could improve the physical strength and health condition, and the equipment for these is meant for improving the physical function, basic exercise training, and basic recovery.

According to the Ruuskanen and Ruoppila research(1995), regular exercise practice could help elderly to maintain or even improve their physical functions, health conditions and psychological well-being. Doing aerobics or muscle training could efficiently reduce the melancholia situation of the elderly (Paluska & Schwenks, 2000). In addition, extending body and muscle training are very important for the elderly (方進隆，1992). Men's muscular strength will drop after they reach 45-year- old, especially the explosive force.Elderly between 65~80 years old will have their muscle power and explosive force reduced by 1~2% every year. Because of the aging of the muscle, the numbers, and size of the myofibril will be reduced and result in a decrease of about 30%-40% of the human muscle mass. , especially for the lower limbs which affects the extending function of legs (林正常，1989).

2. 3. TENDON-MOTION

Tendon-motion exercise can improve the flexibility of a body and is an index of the physical condition age in which the flexibility of a body would also affect the internal organs and the blood circulation in our body(闕道隆，2001).

The human bone structure requires flexible tendon to assist to work. Therefore, we need to often practise the tendon-motions that will help us to avoid suffering from serious or early aged problems. .

To straight the tendon will be active the cell in the tendon(Golgi apparatus) that would improve the extensive and brisk function of muscle(常春樂活健康網，2007).

Either of the movement and motionless ductility, the functions are related with the shape of the joints, flexibilities of ligament, and the extensive ductility of tendon(王宗吉，1989). Benefits of ductility exercise includes improving or reducing lower back pain, easing the aging problem, preventingor improving aging arthritis, reducing the body organization to stick together after surgical operation, increasing the balance in exercise, preventing exercise injury and so on(溫怡英，2004).

This research stressed on the tendon-motion of shank, because this part is the farthest body part from the human heart,. If the blood circulation system is malfunctioned, there will be some serious damage in the shank, especially for the old people who have a higher rate of this problem. . Due to this situation, this research will implement a design method to offer the elderly a piece of fitness equipment which helps them to reduce their dependence and enforce their independent living ability.

3. INCLUDING REFERENCES IN THE TEXT METHODOLOGY???

3. 1. THE EXPERIMENT SUBJECTS

Although the definition of aged people should be over 65 years old, it also depends on the physical situation. In this study, 20 subjects over 55 years were employed who have been confirmed that they who did not have any serious medical problems history on their limbs in the past.

3. 2. THE INSTRUMENT OF EXPERIMENT

An electromyography (EMG) was used to record the change before and after the subjects have used the tendon-motion equipment. Based on the information obtained from the EMG, we could receive the muscle function information of the subjects after tendon-motion exercise.

An electroencephalography (EEG) was used to record the subjects' brain waves activities after tendon-motion exercise. Given the different frequency, the brain waves could be categorized into four wave bands (Table 1).

Table 1.Four wave bands of the brain wave

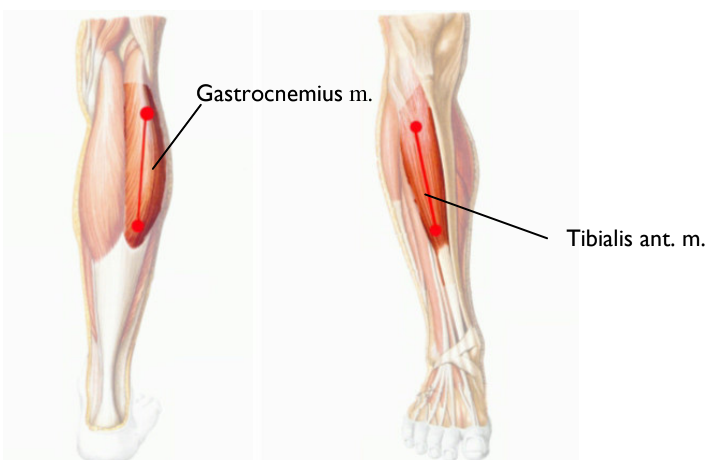
Hz	0-4	4-8	8-12	Over 12
Type of Brain wave	δwave	θwave	αwave	βwave
Situation	sleep	sleepiness	Relaxed and	Excited and nervous

			concentrated	
Conscious	unconscious	unconscious	Conscious and unconscious	Conscious

With reference tothe change of the brain wave record, we examined whether the subjects' brain waves would transfer to αwave from the higher frequency βwave or not after using the tendon-motion equipment.

3. 3. THE EXPERIMENT PLAN

This research examined the Gastrocnemius m., Tibialis ant. m. (figure 1) , Rectus femoris m., and Biceps femoris m (figure 2). The Gastrocnemius m. and Tibialis ant. m. are essential for angle exercise. The Rectus femoris m., and Biceps femoris m. control the extending function of the shank near the knee. The subjects would wear a EEG sensor belt on the forehead for collecting brain wave change in the experiment.



Rear view of foot From view of foot

Figure1.The position of electrode past on Gastrocnemius、Tibialisantm

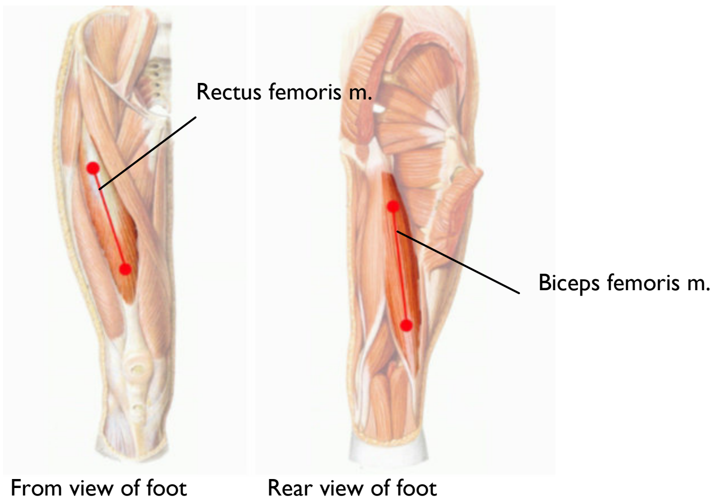


figure2. The position of electrode past on Rectus femoris m, and Biceps femoris

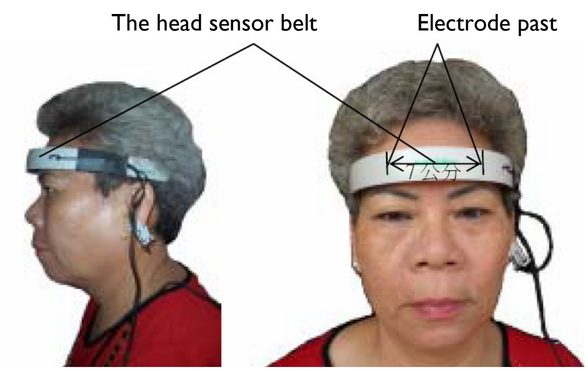


Figure3. The head sensor belt position of EEG

3. 4. THE EXPERIMENT VARIABLE

There were three experiment variables:, independent variable, dependent variable, and controlling variable in this research.

（I）Independent variable

Based on body measurement information, an adult's ankle flexible angle is 20°on average. The experiment in this research implemented three different angles 22°、24° and26° degree to explore the effects on the subjects.

350mm

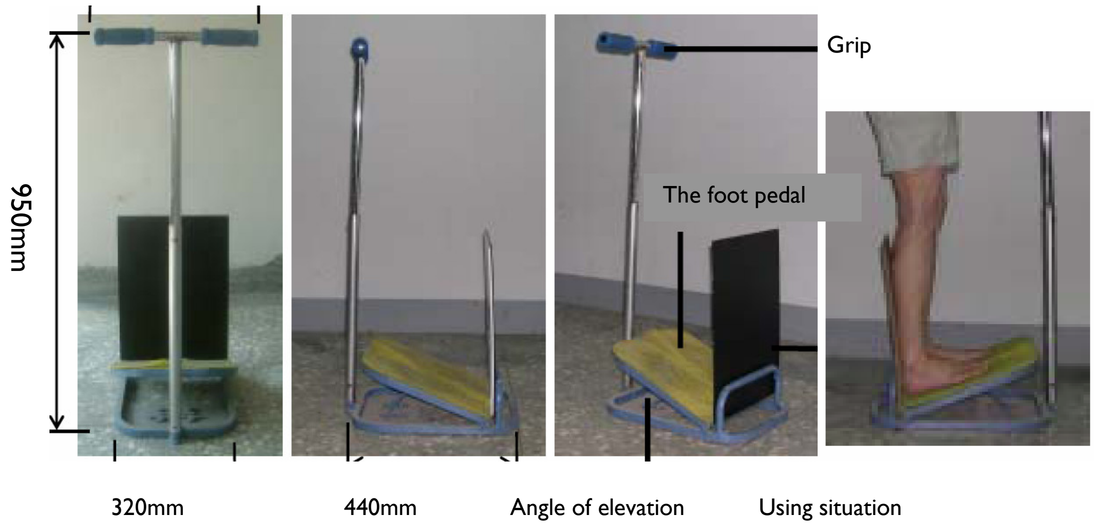


Figure4. Experiment equipment

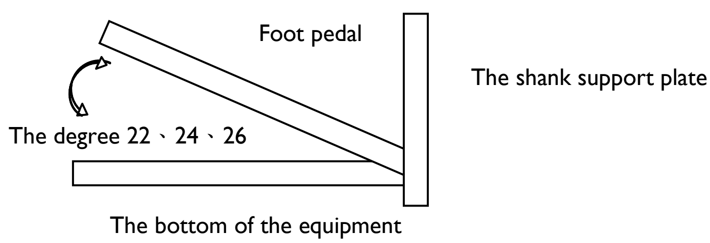


Figure5. Experiment angle

（2） depended variable

The EMG and EEG variables of the Gastrocnemius m.,Tibialis ant. m., Rectus femoris m.,and Biceps femoris m. after the subjects have practiced the leg tendon-motion.

（3） controlling variable

All subjects were tested at the same location with the same equipment. They also needed to walk five steps to record the basic reference signal from EEG and EMG.

Furthermore, to reduce the effects from the subjects' own difference, the were asked to practice before the experiment to ensure that the personal effects could be minimized.

3. 5. EXPERIMENT PROCEDURES

The subjects followed the steps below to participate in the four experiments.

（1）The fist step is to introduce the experiment process, and establish the subjects' background information.

（2）Check the EMG and EEG are in the working position.

（3）Paste the electrode of EMG.

Figure6. The paste position of the electrode

（4）Adjust the angle of the tendon-motion equipment.

（5）EMG and EEG Test 1

Ask the subjects to walk a 5M distance, and then record the information from EMG and EEG. This step would establish the basic reference information to compare the subjects after the tendon-motion experiment in the following steps.

（6）EMG and EEG Test 2

Ask the subjects to practise the tendon-motion exercise 20 times without the experiment equipment, and then the subjects should walk a 5M distance. The EMG, and EEG signals are again recorded. This step would provide the experiment information about the subjects practice with tendon-motion exercise without using the equipment,

（7）EMG and EEG Test 3

Ask the subjects to practise the tendon-motion exercise 20 times with the experiment equipment, and then walk in a 5M distance. During this step, would ill record the EMG,and EEG signals about the subjects practice with the tendon-motion equipment in continuous movement are recorded.

（8）EMG and EEG Test 4

Ask the subjects to stand still on the tendon-motion experiment equipment, and then walk in a 5M distance. During this step, the EMG and EEG signals about the subjects practice with the tendon-motion equipment in still motion are recorded.

（9）Experiment data analysis

T-test(significant value P<0.05) will be implemented between each experiment test to check the EMG and EEG signals from the different angles of the Gastrocnemius m.,Tibialis ant. m., Rectus femoris m., and Biceps femoris m..

（10）The subjects' personal feeling evaluation

This test will evaluate the subjects' psychological conditions after using the tendon-motion equipment.

4. RESULT ANALYSIS

4. 1. THE EXPERIMENT DATA

The following two tables present the data of the experiment.

Table2. The electric potential of the EMG test

	Tibialis ant. m.				Gastrocnemius m.			
	1	2	3	4	1	2	3	4
V	0.10	0.11	0.12	0.12	0.13	0.14	0.16	0.17
	Rectus femoris m.				Biceps femoris m.			
	1	2	1	2	1	2	1	2
V	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12

Table3. The frequency of the EEG test

	1	[illegible]

The EMG data is recorded in Table 4. A is the difference of the muscle power and balance between Test 2 and Test 3; B is the difference of the muscle power and balance between Test 3 and Test 1. C is the difference of the muscle power and balance between Test 4 and Test 1.

Table4. The data from the EMG signal of the every part muscle ($P<0.05$ statistical significance):

Table4.1. Tibialis ant. m.

	22 degree		24 degree		26 degree	
	T value	P value	T value	P value	T value	P value
A	3.7074	0.0015	3.7074	0.0015	3.7074	0.0015
B	4.6598	0.00017	4.2727	0.0004	*	*
C	4.6161	0.00017	4.0597	0.0007	*	*

Table4.2. Gastrocnemius m.

	22 degree		24 degree		26 degree	
	T value	P value	T value	P value	T value	P value
A	5.5418	0.00003	5.5418	0.00003	5.5418	0.00003
B	5.2438	0.00005	5.1804	0.000053	*	*
C	6.0914	0.000008	5.5365	0.00004	*	*

Table4.3. Rectus femoris m.

	22 degree		24 degree		26 degree	
	T value	P value	T value	P value	T value	P value
A	5.1514	0.00006	5.1514	0.00006	5.1514	0.00006
B	7.0542	0.000001	6.2820	0.000005	*	*
C	8.0267	0.0000005	6.8416	0.0000018	*	*

Table4.4. Biceps femoris m.

	22 degree		24 degree		26 degree	
	T value	P value	T value	P value	T value	P value
A	4.4505	0.0003	4.4505	0.0003	4.4505	0.0003
B	5.1025	0.00006	4.9583	0.00009	*	*
C	5.8163	0.00002	5.2055	0.00005	*	*

The information about angles from the experiment results are concluded in Table 5. The results show that when the equipment angle is at 22° and 24°, the tendon-motion practice is efficient for the Tibialis ant. m., the Gastrocnemius m., the Rectus femoris m., and the Biceps femoris m., especially at 22°. However, when the angle is at 26°, the practice of tendon-motion exercise will become a burden for all the tested muscles.

Table5. The tendon-motion efficient intensity of the muscle in different angle.

Tibialis ant. m.	Gastrocnemius m.	Rectus femoris m.	Biceps femoris m.
22＞24＞26	22＞24＞26	22＞24＞26	22＞24＞26

The intensity of the experiment in Test 4's movement tendon-motion exercise is more efficient than Test 3's motionless tendon-motion for the Tibialis ant. m. whereas for the Gastrocnemius m., the Rectus femoris m. and the Biceps femoris m., the motionless tendon-motion exercise is more efficient.

Table6. The tendon-motion efficient intensity of the muscle in different types(motionless and movement) oftendon-motion exercise.

Tibialis ant. m.	Gastrocnemius m.	Rectus femoris m.	Biceps femoris m.
B ＞C ＞A	C ＞B ＞A	C ＞B ＞A	C ＞B ＞A

Checking the EEG signal. A is the ☐ wave difference between Test 1 and Test 2; B is the ☐ wave difference between Test 3 and Test 1; and C is the ☐ wave difference between Test 4 and Test 1(Table 7).

Table 7. The data from the EEG signal in different angle. (P<0.05 statistical significance):

	22 degree		24 degree		26 degree	
	T value	P value	T value	P value	T value	P value
A	3.9051	0.001	3.9051	0.001	3.9051	0.001
B	5.5991	0.00003	4.9999	0.00008	4.4650	0.00027
C	6.6916	0.000002	5.9827	0.00001	4.9138	0.0001

The results show that brain wave would transfer from the lower frequency wave, ☐ wave, to the higher frequency wave, ☐ wave, at the three different angles, especially at 22° (Table 8).

Table 8. The brain wave changes intensity at different angles.

□wave → □wave	22 ＞ 24 ＞ 26

Meanwhile if the subjects practisedTest 4 (motionless tendon-motion exercise), it will reveal a higher efficient to change the brain wave from the □ wave to □ wave than Test 3.

Table 9. The brain wave change intensity in different types of tendon-motion exercise.

□wave → □wave	C ＞ B ＞ A

To conclude the physical and psychological results, 22° is the most efficient angle for the subjects.

This research has also collected information from the subjects' perspective for this experiment by questionnaire after the subjects have practised the tendon-motion exercise. The aim of the questionnaire was to check the 8 personal subject feeling: comfortable, relaxed, soft, flexible, concentrated, conscious, emotionally stable, and no pressure to implement the 8 items to allow the subjects to respond. There were 5 scales in each item (strongly agree=5 , agree=4 , neither agree nor disagree=3 , disagree=2 , and strongly disagree=1). After some statistical calculation, an average score of 3.5~5 use the "□" symbol. It indicates the highest intensity for the 8 items, 2.5~3.5 scores use the symbol "□"which indicates the second highest intensity and 1~2.5 scores use the symbol "□"to indicate the normal intensity.

Table 10. The subjects feeling responded in different angle

		22 degree		24 degree		26 degree	
		movement	motionless	movement	motionless	movement	motionless
For the muscle part	comfortable	□	□	□	□	□	□
	relax	□	□	□	□	□	□
	soft	□	□	□	□	□	□
	flexible	□	□	□	○	□	□
For the brain part	concentrate	□	□	□	□	□	□
	conscious	□	□	□	□	□	□
	Emotion stable	□	□	□	□	□	□
	None pressure	□	○	○	○	□	□

From Table 10, the experiment equipment was set at 22°and the tendon-motion practice is movement that the scores for the 8 items will be the highest. For the muscle part, among the comfortable, relaxed, soft, and flexible factors, soft is the most efficient factor.

For the brain part, among the concentrated, conscious, emotionally stable, and no pressure, the conscious factor is the most effective and no pressure is most insignificant.

5. CONCLUSION

This research found that the experiment equipment at an angle of 22°will have the most efficient result to improve the balance of muscles, enhance the power of muscles, and increase the □wave frequency.The tests have also verified that tendon-motion exercise can promote the elderly physical functions and reduce their psychological aging problems (figure 7). Results from this study could be applied and developed in the following product areas:

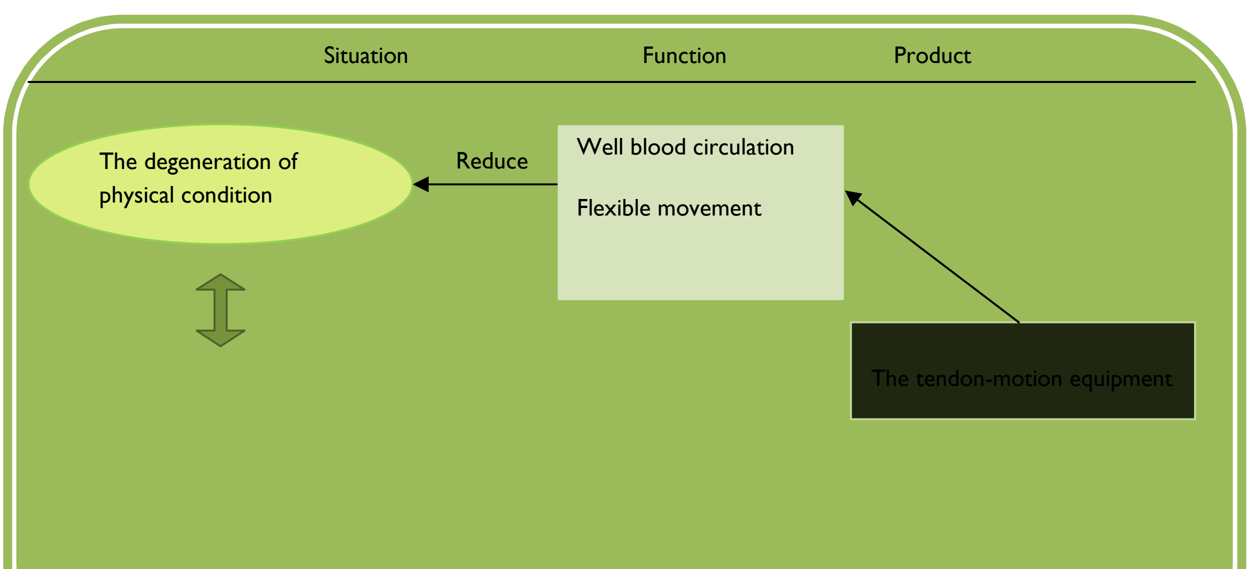
(1) The single function fitness equipment

(2) Multi-function fitness equipment such as to combine the fitness equipment for other physical parts, or some physical condition monitor function equipment.

(3) To improve the exercise equipment driven by foot, such as a bike

(4) A whole new type of fitness equipment or transportation tool

Integrating the ergonomic experiment and industrial design method could help to develop safer, more reasonable and user-friendly fitness equipment to fit the elder health requirements and prevent aging problems, We can also coordinate the technique with a related company to lower the risk of the new product development to promote the value of innovative products.



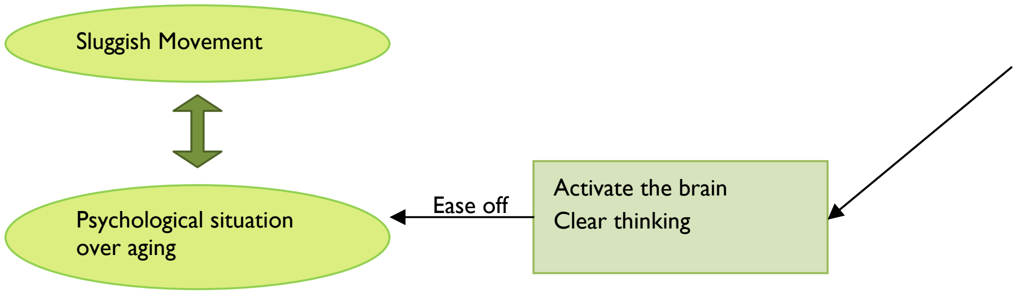


Figure 7. The tendon-motion exercise will ease othe physical and psychological aging problem.

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