


Synaesthesia Design Research of Motion Game in Order to Cure the White-Collar's Cervical Spondylosis

Yuan Liu , Shiguo Li, and Baisong Liu

School of Design, Jiangnan University, Wuxi City, Jiangsu Province, China
Yuanliu199111106@gmail.com, shiguo_edu@qq.com,
Baibainquit@gmail.com

Abstract. Cervical vertebra disease has become another defining characteristic of the White-collars, following with good benefits and high income. Cervical spondylosis usually occurred due to long-term working and lack of exercise, and can be very hard to recover from. Yet in the early stage of the disease it can be relieved by frequently doing a kind of cervical gymnastic and developing good exercise habits. In recent years, young people's neck-shoulder problem has become ever more serious, but they haven't pay enough attention, and did not take the corresponding action to the situation. In the mean time, crossing over both sports and entertainment, motion games are getting more popular among White-collars, allowing them to exercise after stressful works, but yet has not yet successfully realized it's potential in medical field. In this paper, we will discuss this newer area of HCI, that is using motion game as a media, summarize and modularize the method of working out shoulder and neck. Also by using the knowledge of synaesthesia design, finally we acquire the design method and game model, that shows how to use synaesthesia design in motion game to achieve the desired effect.

Keywords: Motion game · Cervical spondylosis · Synaesthesia design

1 Health Condition of the White-Collars

The term "Sub-healthy" indicates a kind of condition where the body is either healthy or sick, organs are still technically healthy but function not as well as before. At this point, how to treat the body decides how the health condition will be. The white-collar class is one crowd where this condition is mostly seen, and lacking of physical exercise is the most important reason to that. The lifestyle of a white-collar usually consists commuting by car, constant sitting down and working overtime, leaving them no time to exercise. Over time, problems in cardiovascular system, digest system, immune system and neck malfunction would occur [1].

Among all the diseases, neck is a mostly affected area. Cervical spondylosis is also called cervical vertebra syndrome, which includes cervical vertebra osteoarthritis, hyperplasia of cervical spine, syndrome of cervical nerve root and cervical intervertebral disc herniation, is a disease on the bases of degeneration. If the patient have the conscious to keep doing proper neck exercise during its' early stage, the condition can be prevented,

and the pain can be effectively relieved or even eliminated before any irreversible damage happen.

2 The Possible Solution of Cervical Spondylosis

2.1 Damage of Cervical Spondylosis

Cervical spondylosis hurts people in many ways. It will endanger digest system, causing loss of appetite, nausea, vomiting, constipation, weight loss, etc., so the modern medical has the second name for cervical spondylosis as “cervical stomach syndrome”. Cervical spondylosis can make it hard to swallow, and some of the cervical spondylosis patients often feel sick when eating hard food, they may feel a burning and stabbing pain in breastbone; Cervical spondylosis can also be bad for the heart, that also affects writing and eyesight; Cervical spondylosis can cause abnormal blood pressure and so on [1].

Once cervical spondylosis attacks, it will bring incalculable damage to work and life. Early prevention and treatment of cervical spondylosis in today’s society is of great significance and has much research to do in the future.

2.2 Prevention and Cure of Cervical Spondylosis

In modern medical science, it is difficult to completely cure advanced cervical spondylosis, due to the needing of regular hospital consultation and medical treatment. But patients in the early stage, or people did not evolve into the disease but just have pain in the shoulder, cervical gymnastic is a good choice for the prevention and treatment of cervical spondylosis. It is not only easy to operate, but also not limited by time and environment. Twice a day by scientifically moving the neck, can keep the neck pain away from you.

3 Synesthetic Design

3.1 The Concept of Synesthetic Design

In our subconscious, the taste of sweet is always represented by red, the taste of acid is represented by yellow-green or lemon yellow. And when we say we feel “blue” today, It’s a subconscious association to combine color and feelings together.

People explore their surroundings with by their senses, as a person’s main sensory organs,— eye, ear, tongue and nose, each has a clear division of responsibilities. This phenomenon not only take place between two different senses of feeling, but also can appear among variety of senses. Although these senses have different functions and range of activities, they combined together sometimes and has mutual expressions with each other. For example, in the field of visual food advertising, visual feelings can cause reaction in the sense of taste, red for sweet and yellow for acid. The so-called “color, aroma and taste”, is the emphasis on the combination of vision, smell and taste all together. “Color” for the vision, “sweet” for the taste, they are set to stimulate taste

reaction therefore to generate appetite. That is why food packaging and advertising is always set to the pursuit of better taste association.

As demonstrated, synaesthesia is a common psychological phenomenon in our daily life, a corresponding psychological reaction due to the external things act on human's senses, causing the synergy of one or more other feeling [2].

3.2 The Synesthetic Interchange in Synaesthesia Design

In the field of synesthetic design, many experiments have already been carried out to discuss how the senses of human work together and how they use themselves to express other feelings. In the research below, two professor from Politecnico di Milano, G. Anceschi and D. Riccò, designed some experiments to see the relationship between vision and gustative sensations—visual restitution of one of the three gustative sensations: sweet, bitter and acid.

As in the image they give, we can see gustative sensations can be easily transformed into colors with shapes, consists with point, line and surface [3].

- sweet sensation is mostly represented with round lines and circle shapes;
- acid and salad sensations is with fragmented lines and angular shapes;
- bitter sensation is with irregular lines and shapes (Fig. 1).

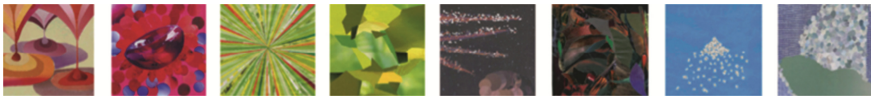


Fig. 1. Examples of exercises on gustative and chromatic sensations

4 Motion Sensing Game

4.1 Relevant Concepts

Motion-sensing game is a kind of recreation which uses our body as instruments to control and interact with games. Different from using game stick, keyboard, mouse to control the game, the recognition of human motion input introduces a variety of sensing equipment instead of the traditional controllers. It emphasized the interaction both between games and players, players and players, thus to make the players feel they were better immersed in the game; When it comes to entertainment, all kinds of sports and athletic games are the first choice for motion-sensing games. It is not subject to sports facilities, time, space, and climate, that gives the most important advantage to motion game—you can play it at anytime, anywhere. The player would just feel like they were at the gym with a connect on the gamebox. And also can get the same amount of exercise as real.

4.2 Why Choose Motion Games to Cure Cervical Spondylosis

- **Portability**
Daily life of the White-collars are quite busy, they do not necessarily have a lot of time for outdoors activity. Motion-sensing game provides a chance for them to do sports indoor, no restriction from space, environment and climate. Even after work or in the spare time between working, you can get enough training and exercise.
- **Entertaining**
Motion sensing games is fun to play as most of the games are, they also make it more fun with changing the interface scenes and giving different themes to the game. White-collars are a group of people with high consumption and high aesthetic, it's easy to get their attention, but also easy to lose it. Motion game has higher adaptability, with different kinds of competitive sports games like boxing, swimming, ball games and so on. It is not easy to get bored, and it can be strengthened by means of online interaction with family and friends, which meets to social needs of white-collars.
- **The same intensity of an actual workout**
During the process of the game, it provides users of a certain intensity of exercise. The game needs to be controlled by extremity movement, makes the users' body movements become inevitable in the process of the game, and due to the way the software is programed, you need to follow certain rules in the process of operation to complete the actions, which is a great interpretation of the most basic physical properties of keeping fit.
John Porcari, Ph.D. at the University of Wisconsin, United States, conducted a new study shows that "EA Sports activity" and "EA Sports vitality: six weeks to build good figure," these two Wii Sports game product can be defined as effective workout according to the standard set by the American College of Sports Medicine. This study measured the two "EA sports vitality" default fitness activities ("Afterburner" and "Legs and Lungs") about the relative motion intensity and calorie consumption, participants are energetic adults aged 16 between 25 and 45 years old. According to the results, by taking a healthy active lifestyle and regularly use the "EA sports activity", players not only can improve the activity of aerobic exercise, but also can positively affect physical condition [4].
- **Accurate motion correction.**
The motion capture technology in the game can identify player's bones and actions very accurately, by guiding their movements with the conduct on the game screen, to make the training more efficient, just like having a family fitness coach to teach you one-on-one. Kinect is a well-accepted motion capture technology globally, capture people's actions by laser camera, and identify the bone position, so as to identify the movement of the body. For activities that acquire accurate motions like dance and yoga, exercise with the games will be more effective than trying by oneself at home (Fig. 2).

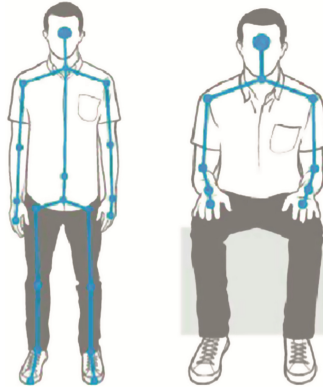


Fig. 2. Kinectbone identifying technology

4.3 Medical Field Application

The medical area already had some achievements in related fields since the import of motion games. Early in 2008, Kentucky, USA, Fort Campbell tried to use the Wii motion game to help 400 soldiers of America's 101st airborne division to recover from brain injury, and to discuss whether they would be able to return. Tests using a variety of odd Wii game (such as "quickly recognize letters game") to test the soldiers of the cognitive ability, coordinating ability and response speed, etc., and every soldier entered war in the previous year must take part in other different types of games except Wii game for brain damage detection. Southern Illinois, a herring hospital rehabilitation center has a Wii gaming platform being used in the rehabilitation training of patients, and in the west of Chicago, some rehabilitation hospitals will also use Wii rehabilitation treatment for spinal injury.

Banner Good Samaritan Medical Center in Arizona clinic uses Wii to enhance the level of surgical operation. Eight internship surgeons play Wii games for an hour before laparoscopic surgery. Results show that with the Wii warm-up, speed and accuracy of the operation have promoted by 48 %.

In the field of archaeological research, the university of California try to use Kinect more suited for archaeological working environment, replacing the expensive, complex professional equipment, such as LIDAR, in order to obtain higher accuracy of 3D scanning positioning information [5].

The above materials certificate, motions games has been used and achieved effective feedback in medical field, it has the possibility to get good curative effect in cervical spondylosis curing.

4.4 Synaesthesia Design in Motion Sensing Game

Because of the leading role body movements played in motion game, sound and visual senses are more important as a guiding media. Motion game often uses sound to guide

vision or the other way around. For example, in the boxing module of the game “Kinect Sports”, the player controls the movement by their arm movements, and the actions been used in the game is divided into the uppercut, lower hook, straight, quick thrusts, and defense, mainly uses one’s shoulder and neck. When you use quick thrusts to attack the enemy, player’s constant struck of opponents get him an extra score, then the screen shows a special effect of flame burning, prompt players to continue the hitting, accompanied by increases sound effects, indicates player to attack harder. Also, when the opponent who are going to be knocked out soon, the system will count down to remind the lose. These two phenomenon are the typical examples of how synaesthesia design been used in game interface, with the combination of vision and hearing, gamers can focus on the game instead of reading game instructions (Fig. 3).



Fig. 3. Player’s constant struck with fire effect

Similarly, in the opening interface of motion game, players can use gestures to select columns or resume the game. When move the hand to the corresponding option, with the palm suspended in the air and maintain for a few seconds, there will be a prompt system getting louder to indicate that you are about to enter the next level of the interface, using sound changes from low to high to indicates the page forwarding (Fig. 4).

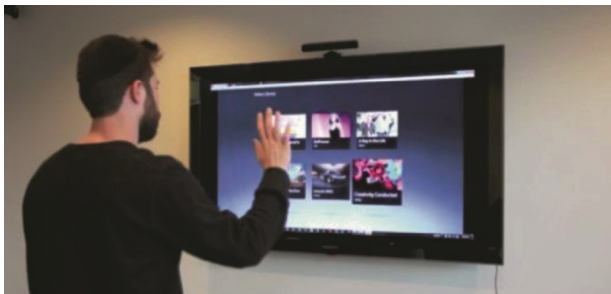


Fig. 4. The opening interface of motion game

5 Experiments

According to the research about cervical spondylosis and motion game, an experiment need to be down in order to test how the motion game effect on human’s cervical vertebra. Two motion games based on the movement of neck and shoulder, both from the game «Kinect Sports», have been chosen as the experimental materials.

Location: HUAWEI UCD Center

Target Group: Designers, Programmers, totally 20 people.

Experimental material: XBOX, Kinect, «Kinect Sports» motion games

Research Method: comparison method, observation method.

Proceeding: Choose two motion games basically using shoulder and neck—“boxing” and “Beach Volleyball” as the tester, set the timer to 5 min for each game, let the gamers play by the leading on the screen, each game for 5 min. When finished, let them compare the effects of two games to the shoulder-neck area, and which action they prefer the most (Fig. 5).



Fig. 5. Test scenario in HUAWEI UCD

Research Result: Experiment results show that 16 of 20 people prefer boxing, the angle of moving arms is suitable, compared with intense and fast action, smooth shoulder movement is more conducive to the relaxation of muscles. Arm and shoulder movements should follow definite frequency, not too hard nor to weak (Fig. 6).

Game	Shoulder			Neck	
	Movement	Angle	Lasting Time	Movement	Lasting Time
Boxing	uppercut, uppercut quick thrusts, straight punch, defense	90°~135°	0.5s~3s	dodge	0.5s~1s
Beach Volleyball	serving, smashing	90°~180°	0.5s~1s	dodge	0.5s~1s

Fig. 6. Details of movements in the two games

5.1 Designed Game Model

“Chan” is a motion-based music game designed to alleviate neck pain and provide the prevention for cervical spondylosis. The game process lasts for 5 min, according to the time and operation method of cervical vertebra gymnastics. Gamers are asked to move their head and shoulder by the leading on the screen, if speed and action are standard, the music will continue smoothly without noise, if not, the game will remind you by the changing of color and sound until you reach the standard. With all the perfect motion, you can play out a wonderful music and get the perfect trophy.

In-game actions:

- Head tilt to the left, hold for 5 s, to the right, hold for 5 s. Repeat three times.
- Head stretch to the front, hold for 5 s, tilt back, hold for 5 s. Repeat three times.
- Both hands on the shoulder, rotate forward and backward 20 times respectively.
- Rotate head both direction for three times.
- Hand over head, fingers crossed, head up, hold for 10 s. Repeat three times.
- Reorganization movements (Fig. 7).



Fig. 7. Schematic diagram of the module

5.2 Simulation Test

Location: Interaction Lab, School of design, Jiangnan University.

Target Group: Designers, in total 6 people.

Test equipment: PC, Music player, Mobile phone

Test method: Simulate the progress of “chan” by the exercise of cervical vertebra set in soothing music, lasts for five minutes in total. In order to ensure the accuracy of the action, when conductors of the experiment found out some wrong actions, they use a mobile phone to play error suggested sounds, thus to remind the subject to correct their movements.

Test Result: Subjects’ feedback showed an improvement of their necks condition. Comparing to exercise on oneself, the visual reminder and sounds of the game helps them to do the exercise correctly, and help to adjust the pace of the movements.

6 Summary Methods of the Motion Game Designed for the Treatment of Cervical Spondylosis

- Smooth limb stretching is more conducive to the relaxation of the cervical spine, one single movement should last for more than 2 s, and the total playing time is better for around 5 min.
- Using fluctuation of music to remind the accuracy of the action, can let gamers' attention focus on the exercise, instead of always staring at the screen like the other games.
- Slow type of music like piano and light music is more conducive to the user's relaxing, so does clean interface design and concise game guidance.

7 Significance

- Provide a new way for the white-collars to ease the cervical spondylosis, explore the development prospects of motion game in the field of health and its' future development prospects.
- Motion-sensing game has a high degree of motion capture recognition, it can effectively regulate the gamers' action, increase the efficiency of the curing.
- Consider the possibility of using motion game in disease curing, provide new ideas for the HCI principles in medical treatment field, explore its' future development direction.
- Explore the using of synaesthesia design in the motion game interface, discover new uses of combining action, sound and image together, explore it's function of guiding the gamers during the game progress.

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