To be appeared in SICE Annual Conference 2008, Chofu City, Tokyo, Japan.
August 20-22, 2008.

"Hanger reflex":A Reflex Motion of a Head by Temporal Pressure for Wearable Interface

Rika MATSUE[1], Michi SATO[1], Yuki HASHIMOTO[1], Hiroyuki KAJIMOTO[1]

[1] Department of Human Communication, The University of Electro-Communications, Japan
E-mail: {r_matsue,michi,hashimoto,kajimoto}@kaji-lab.jp

Abstract: When a head is equipped with a clothes hanger made of wire sideways, and its temporal region is sandwiched by the hanger, the head rotates unexpectedly. Although this phenomenon is widely known, the mechanism that underlies this phenomenon is not well understood. This paper aims to understand the mechanism, and further show the possibility to utilize the phenomenon as a human interface.

Keywords: Interface, Navigation, Reflex, Hanger

1. INTRODUCTION

When the head is sandwiched by a wire clothes hanger, it rotates unexpectedly (Figure 1). This involuntary rotational movement is a kind of reflex triggered by pressure to the temporal region. We have thus tentatively named the phenomenon the "hanger reflex". The hanger reflex is widely known to the public, having been featured on television programs as a mysterious phenomenon that can be experienced with daily commodities. One program explained the mechanism as a kind of reflex to avoid the pain caused by the hanger [1]. If this explanation is correct, when a person equipped with a hanger feels pain on the left side, his/her head should rotate to the right. However, it was reported that the direction of rotation is different among individuals. Furthermore, if the hanger reflex is an automatic behavior or physiological reaction, it is unlikely there should be such a difference among individuals. In summary, the phenomenon has not been fully explained.

Fig. 1 Involuntary rotation of the head with a hanger.

This paper aims to clarify the mechanism of the hanger reflex by measuring the pressure distribution and verifying the relation with the direction of head rotation. We further show the possibility of applying the phenomenon in a human interface.

2. EXPERIMENTS USING A HANGAR

2.1 Pressure distribution of the head when hanger reflex occurs

We measured the pressure distribution for the head when the reflex occurred using a film type force sensor (Nitta Inc., FlexiForce). The measurement system is presented in Figures 2 and 3.

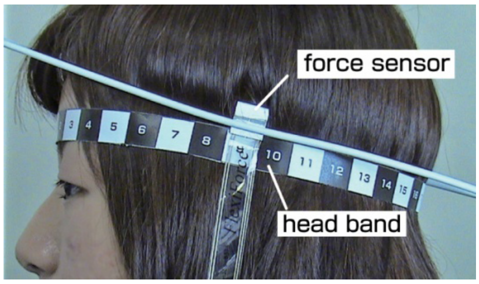

Fig. 2 Pressure distribution measurement for the hanger reflex.

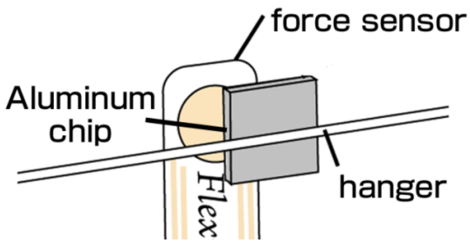

Fig. 3 Diagram of the sensor.

This preliminary experiment was conducted on one participant (one of the authors).

First, the participant was equipped with a head band with a scale having 1.5cm intervals. A hanger was then placed around the head and its position adjusted so that the hanger reflex occurred. We inserted the force sensor, and measured the pressure distribution.

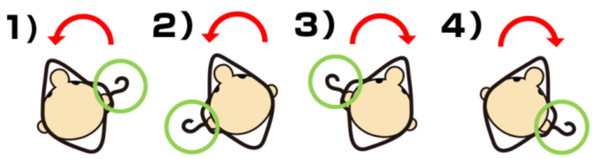

Fig. 4 Experimental cases.

We measured for four cases: 1) the hook of the hanger was on the left side, and the head rotated to the left, 2) the hook of the hanger was on the right side, and the head rotated to the left, 3) the hook of the hanger was on the left side, and the head rotated to the right, and 4) the hook of the hanger was on the right side, and the head rotated to the right (Figure 4). We measured each case five times and averaged the result.

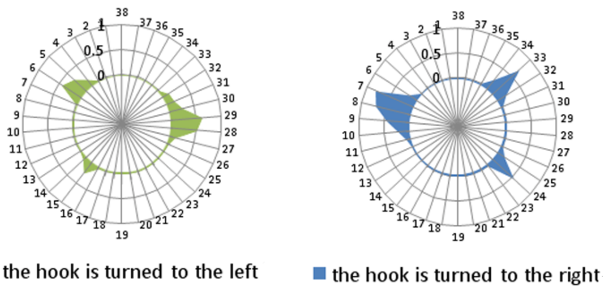

Fig. 5 Pressure distribution [N] with the head rotating to the left.

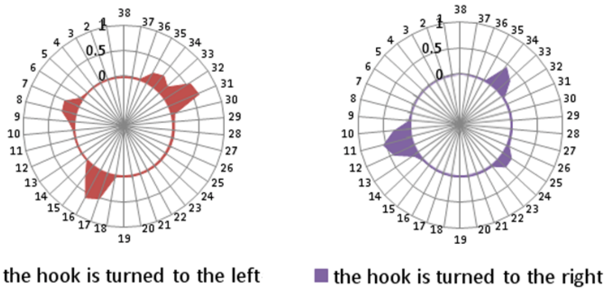

Fig. 6 Pressure distribution [N] with the head rotating to the right.

Figures 5 and 6 present the pressure distributions looking down from the top of the head. The upper side of the figure is the front of the face. Three pressure peaks around the head were observed in all cases.

Two peaks occur on the same side of the head. When the head rotates to the left, there are pressure peaks in the left frontal temporal region and on the right occipital temporal region of the head When the head rotates to the right, the reverse is true.

From the results, we speculate the direction of rotation is determined not by the direction of the hook of the hanger but by the position of the pressure peak for the head. If this is correct, the head rotation is triggered by pressure to the frontal temporal region and occipital temporal region of the head.

2.2 Two pressure peaks might play central role to the hanger reflex

The hanger used above has three points stimulating the head. However, it seems that at most two of them are related to the hanger reflex, it is sufficient to trigger the hanger reflex with only two points of contact.

To validate this speculation, we deformed the hanger into a diamond shape and named it a “rhomboid hanger”. The rhomboid hanger has only two points of contact with the head.

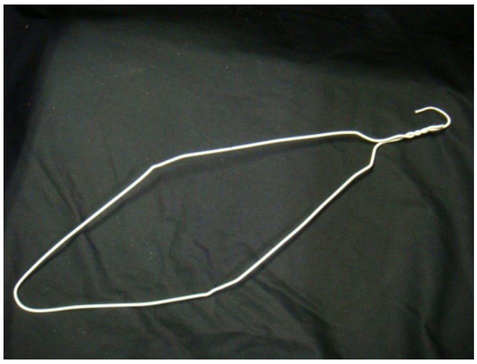

Fig. 7 Rhomboid hanger.

We tested whether the rhomboid hanger triggered the hanger reflex. It worked well in that it induced head rotation. So our hypothesis is that the hanger reflex is caused by pressure to two points of the head. Furthermore, according to this result, the hanger reflex can be induced by weak pressure.

We conducted the following experiment to confirm this hypothesis. We measured the pressure distribution when the hanger reflex occurred using the rhomboid hanger as in the previous experiment. We examined two cases: 1) the head rotating to the left and 2) the head rotating to the right. Measurements were taken for one participant (the author) and measurements for each case were taken five times and averaged.

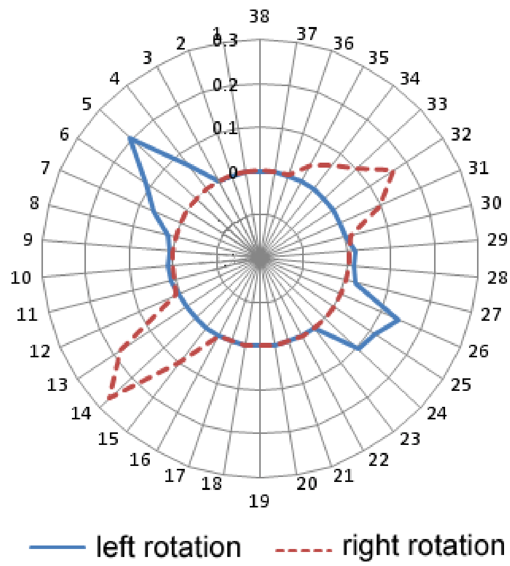

Fig. 8 Pressure distribution [N] for the head equipped with the rhomboid hanger.

Figure 8 shows the results of the experiment. Two dominant pressure peaks around the head were observed in both cases. The graph shows the maximum pressure to the head is 0.27N. It is significantly weaker than the maximum pressure to the head due to the common hanger (Figures 5 and 6). As a result, it is suggested the hanger reflex requires only slight pressure to the head.

2.3 One pressure peak might be enough for the hanger reflex

The measurements suggest the head certainly rotates iby two pressures, one is frontal temporal region, and the other is occipital temporal region. These two pressures naturally have the same value due to the law of action and reaction. Nonetheless, it is not clear which one has a greater influence on the hanger reflex—the frontal stimulation or the rear stimulation. In the next experiment, we tried to provide evidence for which stimulation point determines the direction of rotation.

We inserted a plastic board between the hook of a hanger and the head, so that two contact points were hindered, and the head is stimulated by a single point, as in Figure 9.

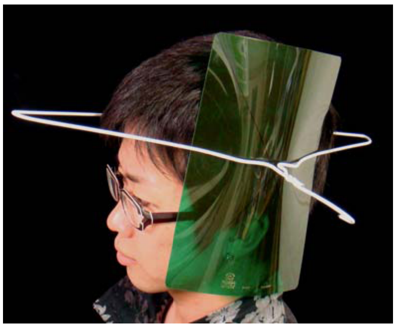

Fig. 9 Hanger producing only one stimulation.

Six participants (three men, three women, 21–23 years old) participated in the experiment. The hanger with a plastic board was placed around the head and whether the hanger reflex occurred and the direction of head rotation were investigated. There were four experimental conditions: 1) the stimulus point of the hanger was in the left frontal temporal region, and the plastic board was inserted on the right side of the hanger, 2) the stimulus point of the hanger was in the right occipital temporal region, and the plastic board was inserted on the left side of the hanger, 3) the stimulus point of the hanger was in the right frontal temporal region, and the plastic board was inserted on the left side of the hanger, and 4) the stimulus point of the hanger was in the left occipital temporal region, and the plastic board was inserted on the right side of the hanger.

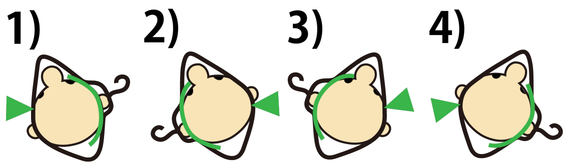

Fig. 10 Hanger with plastic board experimental conditions.

A hanger reflex was observed for all participants, even though the stimulation point was limited to one point. All participants turned their head to the direction of the stimulus, which agrees with our previous observations. Two participants did not turn when stimulated from the rear, but they did turn after we readjusted the hanger.

Table 1 The rotation direction of the head.

	the rotational direction of a head			
	1)left/front	2)right/back	3)right/front	4)left/back
1st participant	L	L	R	R
2nd participant	L	L*	R	R*
3rd participant	L	L	R	R
4th participant	L	L	R	R
5th participant	L	L*	R	R*
6th participant	L	L	R	R

*… it has readjusted the contact position of a hanger

From these results, we speculate the hanger reflex is caused by a single stimulus from either the frontal temporal region or the occipital temporal region, but the frontal temporal region is slightly more sensitive.

3. WEARABLE INTERFACE USING HANGER REFLEX

We have experimentally investigated and hypothesized the trigger for the hanger reflex due to a hanger. The hypothesis is illustrated in Figure 11. When the left frontal temporal region is stimulated, the head turns left. When the right frontal temporal region is stimulated, it turns right. Based on this result, we determined a better stimulation method to induce the hanger reflex without using a hanger, and then made and evaluated a prototype.

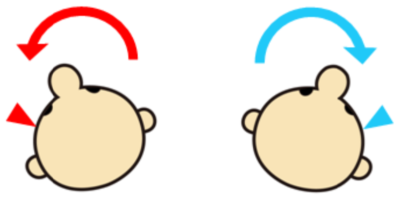

Fig. 11 Our hypothesis for a trigger of the hanger reflex.

3.1 Evolution of the stimulus method

In the previous experiments, we applied pressure to the head with a hanger, but if the hanger reflex is caused by a stimulus on the “skin” of the head, there are other methods of stimulation that can be used. First, we used electricity to stimulate the frontal temporal region of the head with the Forehead Retina System [2]. However, an electric stimulus did not trigger the hanger reflex. Second, we tested a vibration stimulus to the head with a vibrator (Audiological Engineering Corp., skin stimulator); however, the hanger reflex observed. These results suggest that the pressure, not vibration, is essentially important for the hanger reflex. Therefore, we tried to find a way to apply pressure without using hanger.

Fig. 12 Pressure stimulus without using a hanger.

A plastic bottle cap was inserted between the head and a head belt made of polyethylene, which was taken from a crash helmet, and this system was able to cause the hanger reflex (Figure 12). Thus we made a prototype using these materials.

3.2 Prototype construction

The prototype is shown in Figure 13. A gear motor was attached to the head belt. A screw head was attached to the motor so that it pushed the head vertically. The motor was controlled by a microprocessor (Renesas, H8-3048) connected to a PC. The diameter of the screw head was 2.0cm.

Fig. 13 The prototype system to generate hanger reflex.

This prototype has a motor unit only at the right frontal temporal region, because our purpose at this time is to cause the hanger reflex and control the pressure to a head.

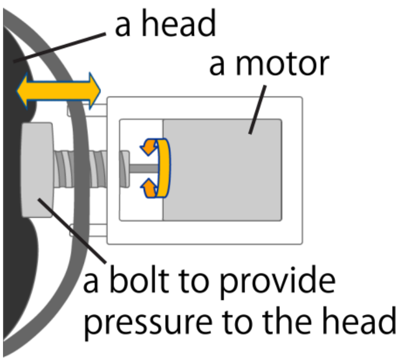

Fig. 14 Architecture of the stimulator.

3.3 Experiment

We tested the prototype with 6 participants, and confirmed that the hanger reflex was observed with 4 Participants. However, there were two problems. The first problem was that, unless the screw was in contact with a certain small region, the head did not move at all. The second problem was that, the stimulus by this machine was extremely painful. For application in an interface, the pain should be as small as possible and the position sensitivity should be as low as possible. These problems remain to be solved by future research.

Table 2 Rotation of the head

	the rotation of a head
1st participant	○
2nd participant	○
3rd participant	×
4th participant	×
5th participant	○
6th participant	○

4. CONCLUSION

In this paper, we studied the hanger reflex, which is the involuntary turning of the head when sandwiched by a clothes hanger. We suggested the possibility that the factor determining the direction of head rotation was a stimulus to the frontal temporal region of head, and confirmed this hypothesis by experiment. We also made a prototype to generate the hanger reflex by stimulating the frontal temporal region of the head locally. Although hanger reflex certainly occurred, it was not as effective as using an actual hanger. The prototype experiment raised the questions of why the hanger reflex for an actual hanger was not as painful and had less position sensitivity compared with that for our prototype. In other words, why is the actual hanger so “efficient” at rotating the head? These issues should be addressed in future research.

REFERENCES

[1] Fuji Television the TORIVIA spread committee: trivia No.004, spring of TORIVIA volume 1, pp.11-12, 2003.

[2] Kajimoto, Kawakami, Maeda, Tachi, “Tactile Feeling Display using Functional Electrical Stimulation,” *9th International Conference on Artificial Reality and Telexistence(ICAT99)*, Tokyo, Japan, 1999.