Reconsideration of Ouija Board Motion in Terms of Haptics Illusions

Takahiro Shitara[1], Yuriko Nakai[1], Haruya Uematsu[1], Yem Vibol[1], Hiroyuki Kajimoto[1], Satoshi Saga[2]

[1] The University of Electro-Communications
1-5-1 Chofugaoka, Chofu, Tokyo 182-8585 Japan
Email: {shitara, yuriko, uematsu, yem, kajimoto}@kaji-lab.jp
[2] University of Tsukuba
1-1-1 Tennodai, Tsukuba, Ibaraki 305-8577 Japan.
Email: saga@saga-lab.org

Abstract. Bodily movements caused involuntarily, for example while using a Ouija board, are called ideomotor actions. Our goal is to clarify the conditions under which Ouija board motion occurs, comparing visual, force, and vibrotactile cues and using a novel pseudo haptic illusion. In this study, we used a fingertip-type tactile display to find the conditions of occurrence of ideomotor action with the Ouija board. Results showed that vibrotactile cues lead to the occurrence of Ouija board motion, and that visual cues reinforce the displacement of motion.

Keywords: Ideomotor action, Pseudo haptics, 2.5-dimensional tactile display

1 Introduction

The “Ouija board” is a well-known game that can be played by multiple players, using a flat board marked with letters and numbers, and a planchette, which is a small heart-shaped piece. The players place their fingers on the planchette and ask questions, and the piece moves to point at various letters or numbers in response. Several variation cans be found worldwide, such as “Kokkuri-san” in Japan, in which a coin replaces the planchette as the game piece (**Fig. 1**). The movement of the game piece is considered a type of ideomotor action, which is a psychological phenomenon wherein a subject makes motions unconsciously [1].

From a haptics research point of view, this phenomenon can be considered a type of haptic illusion. While several haptic illusions that accompany pseudo force sensations or motions are known, the Ouija board phenomenon is characterized by the fact that multiple players are involved in the phenomenon, and each of them thinks that the movement is not due to her/himself.

The goal of our research is to clarify the occurrence conditions of Ouija board motion, comparing visual, force, and vibrotactile cues as pseudo haptic illusion.

adfa, p. 1, 2011.

Fig. 1. Ouija board: a type of ideomotor action

2 Related Work

Several studies showed that tactile cues can produce illusory force. Amemiya et al. [2] and Rekimoto [3] realized tractive force presentation by a simple device using asymmetric vibration. Skin traction has also been reported [4] [5] [6] [7] to be felt as an external force.

These haptic illusions do not explicitly accompany motion, nor do the users think that the motion is conducted by themselves by following the illusory force. On the contrary, in ideomotor actions, users assume that the motion is being produced by others. Therefore, there is a slight difference in terms of agency. Hanger reflex is similar to this latter situation [8] [9] [10]. Typical hanger reflex is an involuntary rotational movement caused by deformation of the skin at particular locations on the head, and users typically comment that their heads are being rotated by others. The potential cause of this phenomenon is assumed to be shear deformation of the skin [11], which is known to contribute to force sensations [12] [13] [14]. However, this mechanism does not explain the agency issue, because haptic illusions by shear deformation of the skin do not necessarily accompany the feeling of being "moved by others" [4] [5].

We hypothesized that there are two necessary conditions for ideomotor actions.

(1) A mechanism to generate an illusory force; and

(2) A context that can be interpreted as an existence of others.

In the case of hanger reflex, we cannot see our heads directly, which could give rise to the interpretation that our head is being rotated by someone behind us. In the case of the Ouija board, this context is achieved explicitly by the existence of the other players, or by a belief in a spiritual being.

In this paper, to achieve a Ouija board situation, we used a fingertip-type haptic device that can create the perception of pulling the users' fingers (**Fig. 2**). While Mengchen et al. [15] also used a haptic device to represent the feeling of a Ouija board, we investigate the occurrence conditions of Ouija board planchette movement by presenting force, vibrotactile, and visual stimuli.

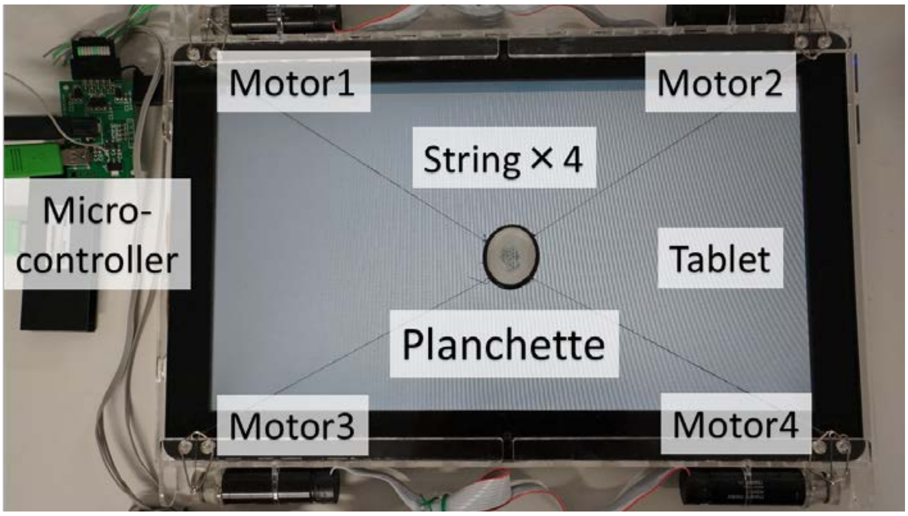

Fig. 2. The 2.5-dimensional tactile display that was used. The tablet (white area) was not part of the display, but was used for position measurement only.

3 Tactile presentation device

We used a 2.5-dimensional tactile display developed by Saga et al. [16] (**Fig. 2**).

The device comprises four DC motors (MAXON Inc., 4.5W, RE16) that pull strings connected to a round planchette that users place their fingers on. The planchette can present traction force and vibrotactile stimulation. The motor is controlled by micro-controller board (PIC24USB). We used API for Spidar-mouse developed by Sato et al. [17]. The tablet was placed under the planchette to measure finger position, but was not used for visual display. We used another display to present visual information and to conceal users' hands, as described later.

4 Experiment

4.1 Experimental conditions

The experimental device is shown in **Fig. 3**. We recruited 12 participants who were members of our laboratory. Nine were male; 11 were right-handed and one left-handed; and all were 21–45 years of age. Participants placed only the right index finger on the planchette. We prepared four haptic conditions; (1) strong traction, (2) weak traction, (3) vibration, and (4) no tactile stimuli. Each stimulation was presented for five seconds, and the direction of presentation was fixed to the right. For each condition, we measured the displacement of the right index finger on the tablet.

In conditions (1) and (2), we adjusted the intensity of the traction stimuli prior to the experiment for each participant. We increased traction stimuli gradually and measured the threshold force for each participant at which the participant's finger barely moves, and set 1.2 times that force as strong traction, and 0.6 times that force as weak traction. In other words, we expected that in condition (1), the finger should move, and in condition (2), the finger should not move passively, but it might move if the participant unconsciously exerted additional force. In condition (3), we presented a vibration (amplitude 0.1m/s^2, frequency 30Hz) that was also expected not to move the finger actively, but might cause a participant to move it unconsciously if an "external force" was felt. Condition (4) was a control condition, in which we expected the finger not to move, although it might move if visual stimulation effected the user.

For visual stimuli, we used an LCD display 9.5cm above the haptic device, as shown in **Fig. 3**. We displayed a background image of the Kokkuri-san game board, and an image of a 10-yen coin was displayed as a planchette. We prepared two conditions for visual stimuli: (1) without and (2) with additional motion. In condition (1), the image of the coin follows the motion of the participant's finger, just like a mouse cursor. In condition (2), additional motion to the right at a random speed (0 ~ 120 pixel / s) was added, and the speed was renewed with the refresh rate of 60Hz. We did not disclose the additional motion to participants until the experiment ended.

Combinations of the four haptic conditions and the two visual conditions rendered eight total conditions. We instructed participants to look at only the display. The participants' arms were hidden by a cloth. Auditory cuing was blocked by presenting white noise from headphones.

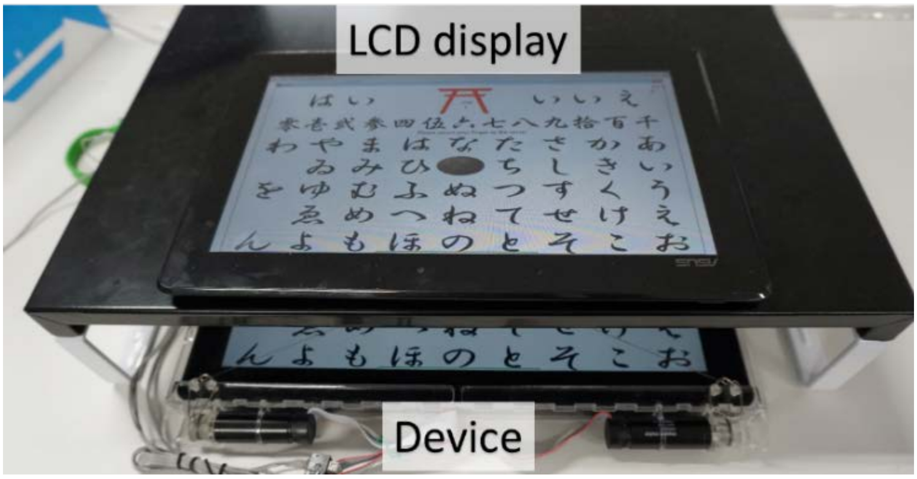

Fig. 3. Experimental device

4.2 Experimental procedure

Fig. 4 shows the experimental setup. First, participants placed their right index fingers on the planchette, and were asked to manipulate the planchette freely and see how the image of the coin moved in synchronization with their fingers, just like a mouse cursor.

Next, participants were instructed that their fingers were being pulled by a small traction force. They were asked to relax the arm and simply look at the coin in the display.

Three trials were conducted for each condition, 24 trials in total, in random order. The participants were instructed to return planchette to the center of the screen before the beginning of each trial.

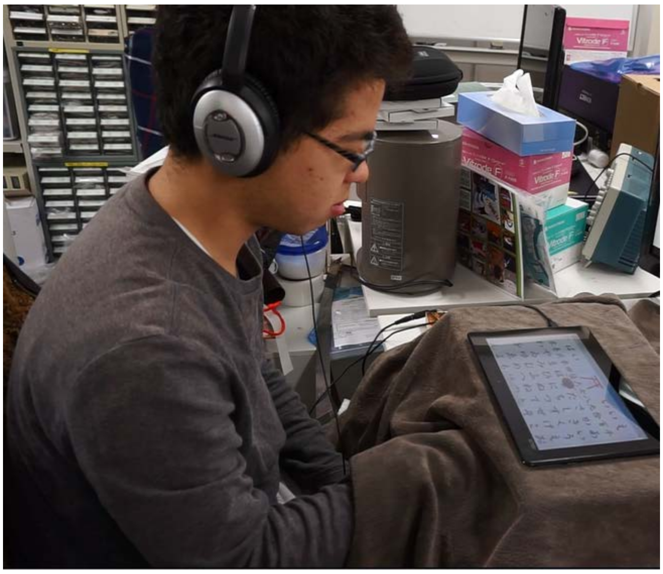

Fig. 4. Experimental setup

5 Results and discussion

Experimental results are shown in **Fig. 5**. The vertical axis is the amount of displacement of the finger, and the horizontal axis shows the haptics conditions. A 2(visual stimuli) ×4(tactile stimuli) ANOVA indicated main effects of visual stimuli ($F_{1,\ 77}$= 3.98, p<0.05) and of tactile stimuli ($F_{3,\ 77}$= 36.27, p<0.01). No significant effect was observed for the interaction of visual and tactile stimuli. Tukey HSD tests showed that effects of strong traction were significantly different from those of weak traction, vibration, and no tactile stimulus (p<0.01), and that vibration was significantly different from no tactile stimulus (p<0.05). No significant difference was found between weak traction and no tactile stimulus.

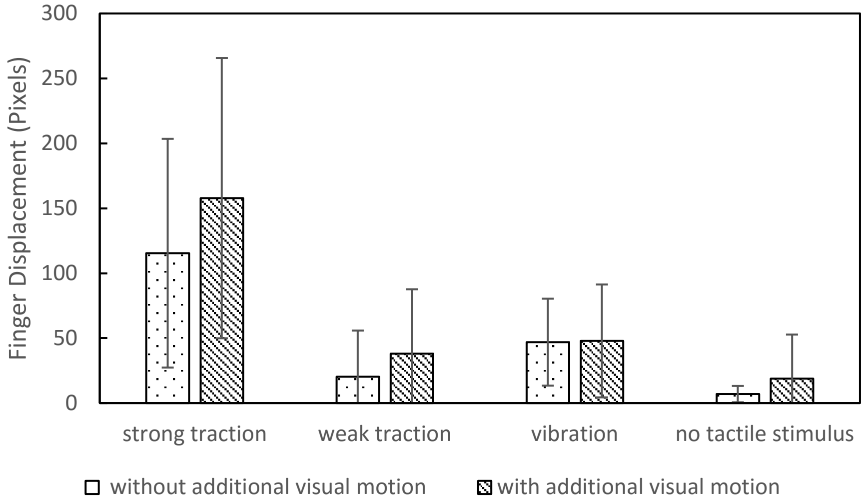

Fig. 5. Comparisons of mean finger displacement (50pixels = about 1cm). The bar indicates standard deviation.

Strong traction induced significantly larger finger displacement, which is natural. The vibration condition induced significantly larger finger displacement than did the no tactile stimulus condition. Interestingly, it was observed even when there was no additional visual motion. In the case of “vibration + without additional visual motion,” there should be no clue to the direction, but the finger moved rightward. We suggest that this is because trials occurred in random order, and participants unconsciously assumed that if there was a motion, it would be rightward. This relationship between a mental bias and resultant motion might be a key to the effect of the Ouija board.

In contrast, the weak traction condition did not induce significantly larger finger displacement than did the no tactile stimulus condition, suggesting that tiny fingertip skin displacement alone does not induce motion, or at least it is less effective than vibration in the current setup.

In terms of visual conditions, the addition of visual movement was effective for induced motion. Currently we could not conclude that it is a sufficient condition for the motion.

In summary, visual motion and vibration were both effective, and weak traction was less effective than vibration in our experimental setup. The result for vibration without visual motion suggests that directional pseudo force is not a necessary condition for induced motion, but the context of instances in which the finger moved in a certain direction is important. The visual motion might have reinforced this context.

In this experiment, we did not investigate whether these movements are truly "unconscious ". Furthermore, we showed the contribution of vibrotactile and visual cues to this ideomotor action, but the real “Ouija board” might have other cues, such as atmosphere and existence of other person. As our next step we need to setup experimental environment to consider these factors.

6 Conclusion

In this paper, we used a fingertip-type tactile display to clarify the conditions under which Ouija board motion occurs, comparing visual, force, and vibrotactile cues. Vibrotactile cues led to the Ouija board motion, and visual cues reinforced the displacement of motion. This experiment was conducted with motion occurring only in the rightward direction. Due to this problem, finger motion was rightward even when no cues to direction were present in the vibration condition. When visual stimuli were used, we did not synchronize them with vibration, which might weaken the visual effect.

As our future work, we hope to improve the current device to conduct experiments in the left and right direction so as to verify the relationship between the mental bias and resultant motion that was obtained in this experiment. Also, we would like to verify the effect of Ouija board motion by synchronizing vibration and visual stimuli, and investigate the subjective evaluation on whether the movements are truly "unconscious ". We will also investigate other factors associated with Ouija board such as atmosphere and existence of other person.

Acknowledgment

This work was supported by JSPS KAKENHI Grant Number 15H05923 (Grant-in-Aid for Scientific Research on Innovative Areas, “Innovative SHITSUKSAN Science and Technology”).

References

1. Stock, A., Stock, C.: A short history of ideo-motor action. Psychological Research68, 2-3, 176-188 (2004)
2. Amemiya, T., Gomi, H.: Distinct pseudo-attraction force sensation by a thumb-sized vibrator that oscillates asymmetrically. Haptics: Neuroscience, Devices, Modeling, and Applications Lecture Notes in Computer Science 8619, 88-95 (2014)
3. Rekimoto, J.: Traxion: a tactile interaction device with virtual force sensation. Proceedings of the ACM Symposium of User Interface Software and Technology, 427–432 (2013)
4. Yem, V., Kuzuoka, H., Yamashita, N., Ohta, S., Takeuchi, Y.: Hand-skill learning using outer-covering haptic display. Proceedings of EuroHaptics , Lecture Notes in Computer Science, 8618, 201–207 (2014)
5. Kuniyasu, Y., Sato, M., Fukushima, S., Kajimoto, H.: Transmission of forearm motion by tangential deformation of the skin. Proceedings of Augmented Human International Conference (2012)
6. Shull, P., Bark, K., Cutosky, M.: Skin nonlinearities and their effect on user perception for rotational skin stretch. Proceedings of the IEEE Haptics Symposium, 77–82 (2010)
7. Kojima, Y., Hashimoto, Y., Kajimoto, H.: Pull-Navi. Proceedings of the ACM SIGGRAPH Emerging Technologies Session (2009)
8. Sato, M., Matsue, R., Hashimoto, Y., Kajimoto, H.: Development of a head rotation interface by using hanger reflex. Proceedings of the IEEE International Symposium on Robot and Human Interactive Communication, 534–538 (2009)

9. Nakamura, T., Nishimura, N., Sato, M., Kajimoto, H.: Development of a wrist-twisting haptic display using the hanger reflex. Proceedings of Advances in Computer Entertainment Technology Conference (2014)
10. Shikata, K., Makino, Y., and Shinoda, H.: Inducing elbow joint flexion by shear deformation of arm skin, Proceedings of World Haptics Conference (2015)
11. Sato, M., Nakamura, T., Kajimoto, H.: Movement and pseudo haptics induced by skin lateral deformation in hanger reflex. Proceedings of Special Interest Group on Telexistence (in Japanese) (2014)
12. Edin, B.B., Johansson, N.: Skin strain patterns provide kinaesthetic information to the human central nervous system. Journal of Physiology, 487(1), 243–251 (1995)
13. Collins, D.F., Prochazka, A.: Movement illusions evoked by ensemble cutaneous input from the dorsum of the human hand. Journal of Physiology, 496(3), 857–871 (1996)
14. Ebied, A.M., Kemp, G.J., Frostick, S.P.: The role of cutaneous sensation in the motor function of the hand. Journal of Orthopaedic Research, 22(4), 862–866 (2004)
15. Mengchen, Z. Farheen, T.: OuijaPlus: A force feedback Ouija board. Proceedings of Human Interface Technologies (2008)
16. Saga, S., Deguchi, K.: Lateral-force-based 2.5-dimensional tactile display for touch screen. Proceedings of Haptics Symposium, 15 - 22 (2012)
17. Sato, M., Isshiki, M., Liping, L., Akahane, K.: Spidar-mouse: A Design of Open Source Interface for SPIDAR. Proceedings of Human Communication Group Symposium (in Japanese) (2009)