

スライムハンド研究の展望 Prospects for the Study of Slime Hand

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概要

The wide range of illusions of proprioception produced by hiding one hand behind a mirror and performing operations visible in that mirror have been recognized for some time. We report a similar effect using a putty-like substance, in which we refer to as the Slime Hand. In this setup, a flexible putty is manipulated by pinching and stretching from the center or an edge while the same pinching and stretching motion is performed on the hand behind the mirror. This operation has a quite high rate of success in causing the mapping of the participant's skin of the hand onto the putty.

キーワード: rubber hand illusion, skin ownership, slime hand, non-proprioceptive distortion

1. Introduction

A range of approaches to the distortion of hand ownership have been reported that relate to the paradigm of the rubber hand illusion (RHI; Botvinick et al., 1998)[1], in which, the rubber hand is visibly touched at the same moment that the participant's hidden hand is physically touched. This leads to an illusory sense of ownership of the rubber hand. The illusory effect is prevented when the distance between the hands exceeds around 20 cm (Lloyd, 2007)[2]. This is essentially because the body image based on the proprioception signal refuses to be integrated into the vision-driven body image over such a large gap. As is well known, ownership distortion frequently involves proprioceptive drift to the rubber hand by around 10% to 40% of the total distance between two hands. As such, it is rare to see that a proprioceptive drift with a distance that exceeds 10 cm.

Recently, we discovered a novel ownership illusion,

namely the Slime Hand (SH; Sato, Imai, and Kodaka, 2021)[3], which seems to go partially against the RHI paradigm. See the complete version of the movie through the cited link[4]. This illusion is based on the well-known mirror-visual feedback system, in which a chunk of slime is placed before a mirror and the physical hand is placed behind it. In this layout, three types illusory ownership distortion can operate: stretching of the skin, stretching of the finger, and hollowing of the hand. To stretch the skin, the experimenter pinch-and-pulls the slime upwards by typically 5 to 20 cm while doing the same thing to the hidden hand, the elasticity of which remains within the skin's physical constraints (~ 2 cm). To stretch the finger, the experimenter pinch-and-pulls the edge of the slime away from the participant, typically by 5 to 50 cm, while the tip of the little finger is pulled in the same way while the hidden hand as a whole is kept unmoved. To give the illusion of a hollow hand, the experimenter bores a hole into the slime while a nearly identical tangible operation is performed on the hidden hand. We have frequently observed that the participant reports having the illusion of stretched skin or a stretched finger to the distance matching the visual condition. In addition, more surprisingly, nearly the same effect occurs even when the slime is not used, where the same hand operation is exhibited in midair before the mirror (the Invisible Slime Hand, ISH), similar to the invisible hand illusion (Guterstam et al., 2013)[5]. From this empirical observation, we hypothesized that the SH has four unique characteristics that differ from the conventional RHI paradigm. First is the extremely long deformation distance (more than 20 cm), second is the adaptability to an amorphously shaped hand (e.g., the hollowed hand), and the third is non-proprioceptive deforma-

tion (stretching the skin), and the fourth is extremely low individual differences.

2. Open-Laboratory Experiment

We exhibited a public experiment ($N = 95$) to test the effectiveness of the SH and the ISH, which was held in the NTT InterCommunication Center (Shinjuku, Tokyo) among the demonstrations in our open-laboratory exhibition. In this test, nearly half of the participants experienced the SH first, followed by the ISH, and the remainder experienced the opposite order vice versa. For each condition, the participants experienced the three kinds of the ownership distortion mentioned above for approximately three to five minutes. After two trials were completed, they were asked to provide their subjective rating of the strength of the illusion with a 7-point Likert scale questionnaire (-3: did not feel at all, 0: neither felt nor did not feel, +3: felt very strongly).

These results show that the slime is significantly effective for enhancing three kinds of illusory experience based on the paired t-test, although it does not necessarily mean that the invisible operation is not effective. In fact, only two participants (<2.2%) provided a rating of zero or less than zero for the illusory skin stretch in the SH and ISH. Ratings of +2 or +3 for this illusion were provided by 95.8%/89.4% in the SH and the ISH. It is especially notable that this high evaluation was obtained even though the slime is visually quite unlike the hand-shaped form (SH) or is engaged with the invisible hand situation (ISH). Nearly 50% of the participants (46/95) provided a rating of +2 or +3 for the illusory hollowed hand; so far as we know, this is the first report to yield this specific body-image distortion.

3. Discussion

Even taking into consideration that the experiment was not performed in an ideally controlled manner, the results strongly suggest that the SH involves non-proprioceptive deformation, adaptability to an amorphous shaped hand and the extremely low individual differences. Our hypothesis is that these unfamiliar effects essentially originate from the functioning of the illusion on the body image specific to the region of the skin, which is free from the proprioceptive signal.

This is supported by the fact that no one commented (orally or written) that they experienced an upward or horizontal proprioceptive drift of the whole hidden hand triggered by the pinch-and-pulled operation. It is urgent to examine these peculiar characteristics under well-designed laboratory experimental conditions.

文献

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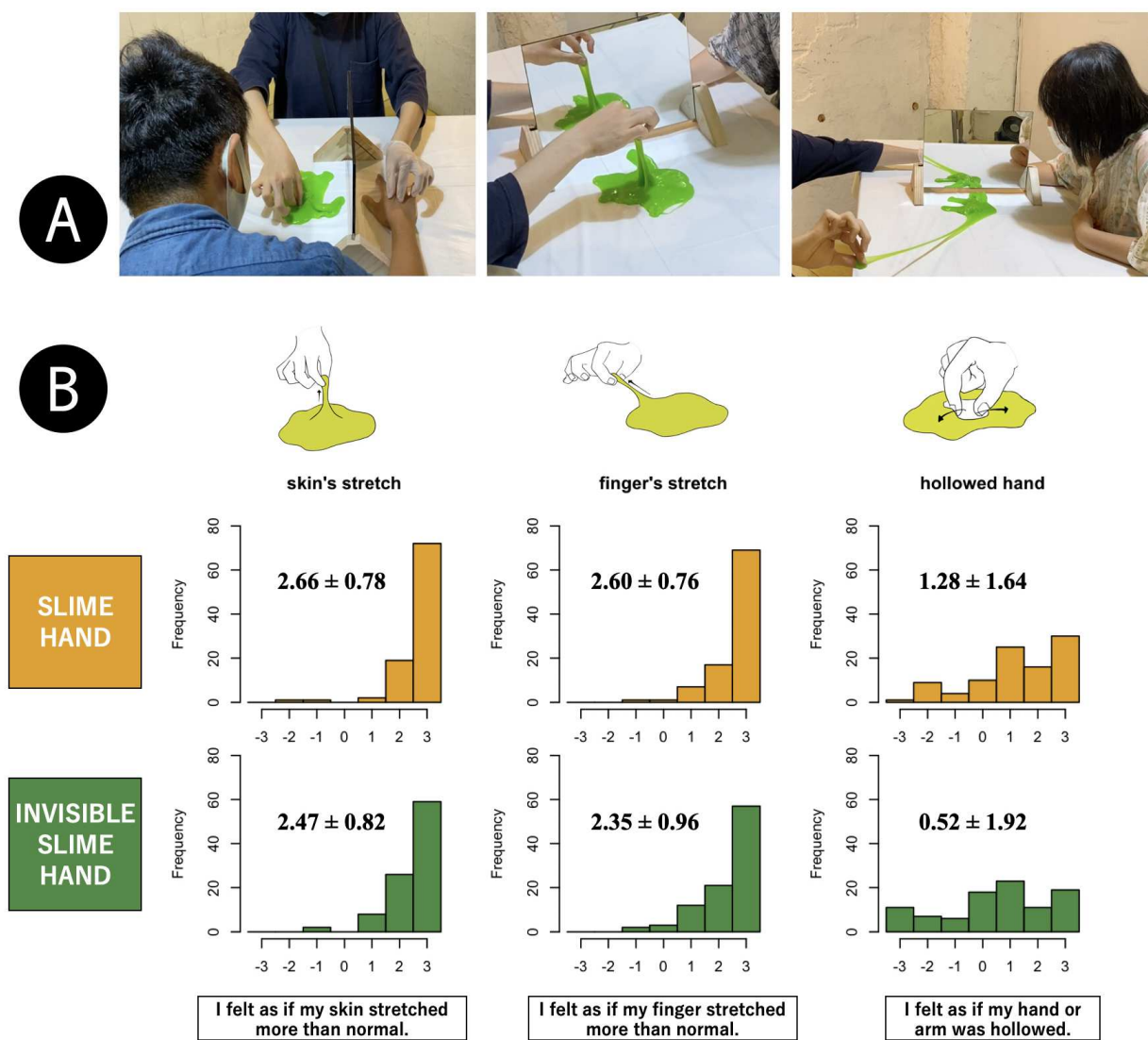


図1 スライムハンドのデモの様子 (A) とオープンラボでのアンケート結果 (B)