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Embodying the other using the sixth finger illusion

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ABSTRACT

Previous studies have robustly illustrated the phenomenon of embodying additional body parts. For example, in the sixth finger illusion, the perception of an extra finger is generated by conflicting visuo-tactile stimulation via a mirror box. However, it remains unclear to what extent we can incorporate extra body parts into our body representation, when the additional body part in question belongs to someone else. By distorting the boundary between the self and the other in the sixth finger illusion, this present study explores whether it is possible to embody an extra finger which in fact belongs to someone else. Rather than using virtual reality or a prosthetic, a real-life volunteer took part in the experiment so that their little finger acted as the participant's extra digit. We tested two illusory variations featuring the volunteer: 'the Other' condition, in which the volunteer's little finger was placed palm-down next to the participant's little finger; and 'the Other Upwards' condition, in which the volunteer's little finger was placed palm-up next to the participant's little finger. Participants experienced strong body ownership over the volunteer's finger in both conditions, demonstrating that we can perceive someone else's finger to be our own as an extra digit on our hands. Moreover, we can do so even when the finger is anatomically incongruent with our own existing body structure. This study offers insight into the startling flexibility of our mental body representations, and suggests that it is possible to embody someone else's body part without having to establish a clear first-person perspective or disembody our own existing bodies. This is a compelling paradigm to explore the self-other boundary in relation to embodiment.

1. Introduction

Although our physical selves play a significant role in our sense of identity, the perceptions of our own bodies are – surprisingly – extremely malleable (Longo & Haggard, 2012). Through various techniques such as muscle vibration, immersive virtual reality and visuo-tactile stimulation, noses are felt to be elongated (Lackner, 1988), experienced body sizes are changed (Piryankova et al., 2014) and fingers are felt to be stretched (Newport et al., 2016). It is even possible to perceive prosthetic body parts as our own, as illustrated by the rubber hand illusion (Armel & Ramachandran, 2003; Botvinick & Cohen, 1998; Ehrsson et al., 2007). These illusory effects are evoked when the brain strives to integrate contradictory information from different sensory modalities (for instance, when what we see and what we feel does not match) (Ehrsson, 2022). The result is a dynamic process in which the perception of our physical selves can be easily transformed by recent sensory stimuli, despite the life-long relationship with our own bodies.

In recent research, studies have gone further to test the constraints (or lack thereof) of bodily illusions, illustrating the astonishing flexibility of what we can effectively embody. Embodiment has been defined as what we accept as 'part of us' (Schettler et al., 2019). Body ownership – the feeling that our body belongs solely to ourselves, and that it is the only source from which we experience sensory information – is a key subcomponent of embodiment (Kilteni et al., 2012), and it remains a popular integrant of many bodily illusions. Indeed, studies have explored the embodiment of extra body parts or body ownership over objects that were never present in the body's make-up at all, rather than merely manipulating the perception of an existing body part. For example, it is possible to produce the sensation of a duplicated arm (Ehrsson, 2009), feel the presence of a tail (Steptoe et al., 2013) and even attain body ownership over a mechanical grabber (Cardinali et al., 2021) through synchronous visuo-tactile stimulation. Increasingly, research has demonstrated that healthy individuals are able to effectively embody something that is non-human.

However, variations of the rubber hand illusion have indicated that, at least with certain types of stimuli, we can feel a stronger sense of body ownership over human-like body parts; previous studies have illustrated that the illusion does not work when attempting to embody a wooden stick (Tsakiris & Haggard, 2005) or even hand-like wooden carvings (Tsakiris et al., 2010). This indicates that the closer an object aligns with our mental body representations, the stronger the sense of body ownership will be (Tsakiris, 2010). Yet, the plasticity in our bodily perception when it comes to embodying corporeal entitles is startling: it is possible to induce more complex bodily illusions that utilise more than one body part, or body parts that are arguably more connected to our own identity. For example, it is possible to evoke enfacement, the illusion of looking at your own reflection when you are in fact looking at another's face (Porciello et al., 2018), and the feeling that you have

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swapped bodies with someone else entirely (Petkova & Ehrsson, 2008). As opposed to using artificial body parts or virtual avatars, in enfacement studies, images or videos of people are used to prompt the illusory effect (Tsakiris, 2008). Similarly, in body-swapping studies, real-life volunteers are used (Petkova & Ehrsson, 2008). However, utilising real-life volunteers to take part in experimental set-ups remains underexplored in body perception studies, particularly those that study the embodiment of isolated body parts.

One such area of research includes studies concerning the sixth finger illusion, also named the 'Anne Boleyn illusion' by Newport et al. (2016): a strikingly robust phenomenon which utilises conflicting visuo-tactile stimuli to elicit the feeling of a supernumerary digit (i.e. an additional finger on our hands). This paradigm uses a mirror box, initially developed by Ramachandran and Rogers-Ramachandran (1996) to allow amputees to see their phantom limb. The participant's left and right hands are equidistantly placed palm-down on either side of the mirror box (which is positioned to the midline of the participant), so that one hand is occluded and the other can be clearly seen in the mirror's reflection. The reflection of the hand thus replicates the positioning of the occluded hand. Each finger, starting with the thumb, on both the participant's hands is stroked in synchrony as the participant focuses on the reflection in the mirror. However, while the little finger is stroked on the reflected hand, the inside surface of the little finger is stroked on the occluded hand. The empty space next to the participant's little finger on the reflected hand is then stroked – where we might expect an extra finger to grow – while the outside edge of the little finger on the occluded hand is stroked. The proximity of these two final touches on the occluded little finger, combined with the sight of the visible finger and empty space next to it being stroked, creates the sensation of a sixth finger.

It is generally agreed that the illusion is the result of both bottom-up multisensory processing and top-down influences relating to body representation in the brain, although the weighting of each, dependent on the sensory context, is yet unclear (Ambron & Medina, 2023). This, in tandem with the participant embodying empty space, acting as a 'blank canvas' from which to perceive an extra digit on their hands (Ambron & Medina, 2023), makes for a strikingly robust illusion. Unlike the rubber hand illusion (Botvinick & Cohen, 1998), the illusory effect is not minimised when subject to various postural and anatomical incongruencies (Ambron & Medina, 2023; Cadete et al., 2022, 2026; Cadete & Longo, 2022). For instance, we can feel the sixth finger not just momentarily, but for a prolonged period of time of up to 30 s (Cadete & Longo, 2020); at varying lengths, including twice as long, and half as long, as an average little finger (Cadete & Longo, 2022); and even when curved sideways, creating a semi-circle shape bending into the hand (Cadete et al., 2022). In a comprehensive study conducted by Ambron and Medina (2023), the illusion was also successful when creating the feeling of ten fingers on one hand, with the extra digit pointing horizontally out of the side of the hand (also effective, surprisingly, from 3 in. away), with the extra digit curved toward and away from the hand, and with the palm facing upwards.

These results clearly indicate the flexibility of the illusion, and in turn the flexibility of our body representations – at least specifically of the hands – in the brain. It also suggests that the additional sixth finger is not merely a copy of our body as we know it, but one which has its own independent features (Cadete et al., 2022; Cadete & Longo, 2022) – and yet we still perceive it as part of ourselves. Furthermore, Ambron and Medina (2023) found that the illusion was still effective when using a pen as the sixth finger, and therefore it can be assumed that non-corporeal objects (again, with physical features distinctive to our own bodies), not solely empty space, can be embodied. Indeed, one of the most fascinating aspects of the illusion is that the boundary between our own bodies (i.e. the self) and the outside world (i.e. the other) is challenged. As Gallagher (2000) notes, self-experience is not constrained to an embedded body framework, and yet it is also imperative for a robust sense of self, both structurally and experientially – something which is altered in conditions such as schizophrenia (Jimenez & Green, 2024). However, although important, the distinction between the self and the other, and one's own bodily self-consciousness, can be manipulated through synchronous multisensory stimuli (Blanke & Metzinger, 2009). This was demonstrated successfully in Paladino et al.'s (2010) study, in which synchronous stroking of participants' cheeks with actors in a video influenced not just participants' bodily perception, but their social perception – creating a 'merging' of the self and the other.

While the constraints of the sixth finger illusion have been thoroughly researched, this self-other boundary, and how far it is disturbed during the illusion, has yet to be specifically explored; it is unclear to what extent we can incorporate an additional body part into our own body framework when the body part in question belongs to someone else. Given that other bodily illusions exploring body ownership – particularly those which feature other people's bodies – rely on the concept of replacing or swapping body parts with the participants', it remains uncertain whether the self-other boundary can be disrupted with a supernumerary body part. In addition, in these previous studies, body ownership is often induced through more immersive techniques such as virtual reality (Caola et al., 2018; Petkova & Ehrsson, 2008) and establishes a first-person perspective for the participant over the designated body or body part (Maselli & Slater, 2013). This was the case in Hoyet et al.'s (2016) study, in which virtual reality was utilised for participants to embody a six-fingered avatar. The question of whether the methods used in the sixth finger illusion are sufficient to elicit feelings of embodiment over another person, and disturb the self-other boundary, is yet to be answered.

In this current study, we used the sixth finger illusion to determine to what extent we can embody an additional body part that belongs to someone else, specifically examining levels of body ownership. Building on existing studies which investigate the constraints of the illusion (Ambron & Medina, 2023; Cadete et al., 2022, 2026; Cadete & Longo, 2020), we introduced two new conditions featuring the addition of another person's hand: 'the Other' condition, in which the volunteer's left hand is placed next to the participant's right hand; and 'the Other Upwards' condition, in which the volunteer's right hand, palm facing upwards, is placed next to the participant's right hand. 'The Other' condition was designed to test whether participants could embody someone else's finger even when it was conspicuously part of another person's hand positioned next to their own. 'The Other Upwards' condition was included to test whether this embodiment would persist when that additional finger was presented in a more anatomically incongruent posture. In both 'Other' conditions, the volunteer's left hand was used so that its mirror reflection appeared as a right hand, while the participant viewed the mirror reflection of their own right hand as a left hand. Thus, unless the additional digit was perceived simply as an isolated finger, it was already visually incongruent with the participant's own mirrored hand. In both conditions, the volunteer's little finger is stroked in synchrony with the outside edge of the participant's occluded little finger, acting as the supernumerary digit. We predicted that the participants would be able to feel a supernumerary finger using the volunteer's hand. However, given that 'the Other' condition is more in line with our standard body representation within that context, we predicted that this condition would be more effective in eliciting the illusion, and prompting stronger feelings of body ownership over the volunteer's finger, compared to 'the Other Upwards' condition.

2. Methods

2.1. Participants

Data was collected from 20 people (14 women and 6 men) after they gave written informed consent. In a previous study (Cadete & Longo, 2022), for the main questionnaire item, 'It felt like I had six fingers on my left hand', there was an effect size of $d_z = 1.26$ in the analysis comparing the condition for normal sixth finger length with the control condition. A power analysis based on this effect size using G*Power 3.1 (Faul et al., 2007), with a 2-tailed alpha of 0.05 and power of 0.95 indicated that 11 participants were required. Thus, our sample size of 20 is well powered to replicate the illusion (empty space condition) and to test the embodiment of a six finger of another's hand. Additionally, the corresponding effect in the current study for the comparison between the 'The Other' condition and the control condition was similar in magnitude ($dz = 1.316$), indicating that the observed effect size was closely aligned with that used in the power analysis.

The mean age of the participants was 33.7 years ($SD = 10.8$). Most participants were right-handed ($RH = 18$), however there were also individuals who were ambidextrous and left-handed ($AD = 1$; $LH = 1$), as was assessed by the Edinburgh Handedness Inventory (Oldfield, 1971), in which the mean score of all the participants was 65.7, and the range from −83.3 to 100. No prior screening was applied, although participants needed to be 18 years of age or above and naive to the experiment. The study was approved by the School of Psychological Sciences Ethics Committee at Birkbeck, University of London.

2.2. Materials and stimuli

The experiment set-up consisted of a table and three chairs, two placed on one side length-ways (for the volunteer, who provided the additional finger in the experiment and facilitated 'the Other' and 'the Other Upwards' conditions, and the participant), and the other placed opposite (for the experimenter). We used the same mirror box set-up as utilised in previous studies investigating the sixth finger illusion (Cadete et al., 2022; Cadete & Longo, 2020; Newport et al., 2016) to produce the conflicting visuo-tactile stimulation for the participant. A mirror (30 cm high, 40 cm wide) was put at the edge of the table in front of where the participant was due to sit. Small orange dot stickers were placed on either side of the mirror box (stuck 17 cm from the mirror horizontally and 30 cm from the edge of the table) to guide participants on correct hand placement.

A visual analogue scale (VAS) characterising the extent of body ownership, adopted from one of the measures used in a study conducted by Pyasik et al. (2022), was used in each condition in response to two different questions. The VAS was only given to participants if they experienced a sixth finger (answered 4 or above in response to questionnaire item 1: 'It felt like I had a sixth finger on my left hand'). Participants marked the VAS scale, which was provided on a sheet of paper, with a line. Lower scores indicated attribution to the other (i.e. the volunteer), and higher scores attribution to the self (i.e. the participant).

2.3. Design and procedure

The study was conducted in a quiet, well-lit room. Before the experiment began, the participant was sat to the left of the volunteer and opposite the researcher. They were asked to take off any hand jewellery (so not to interfere with the upcoming tactile stimuli), move their midline to the mirror box and place their hands, palm-down, flat on the table with their index fingers on each of the orange dots provided. The volunteer placed their hand next to the participant's, leaving just enough space for the standard sixth finger illusion to take place. In this position, the participant's left hand was occluded by the mirror, but they could clearly see the reflection of their right hand and the volunteer's hand next to theirs. The participant was asked to focus on the reflection in the mirror throughout the experiment.

All participants took part in four different conditions in an ABCDDCBA design with Latin Square counterbalancing. The four conditions were: the standard sixth finger illusion, the control condition, 'the Other' condition and 'the Other Upwards' condition (see Fig. 1). In

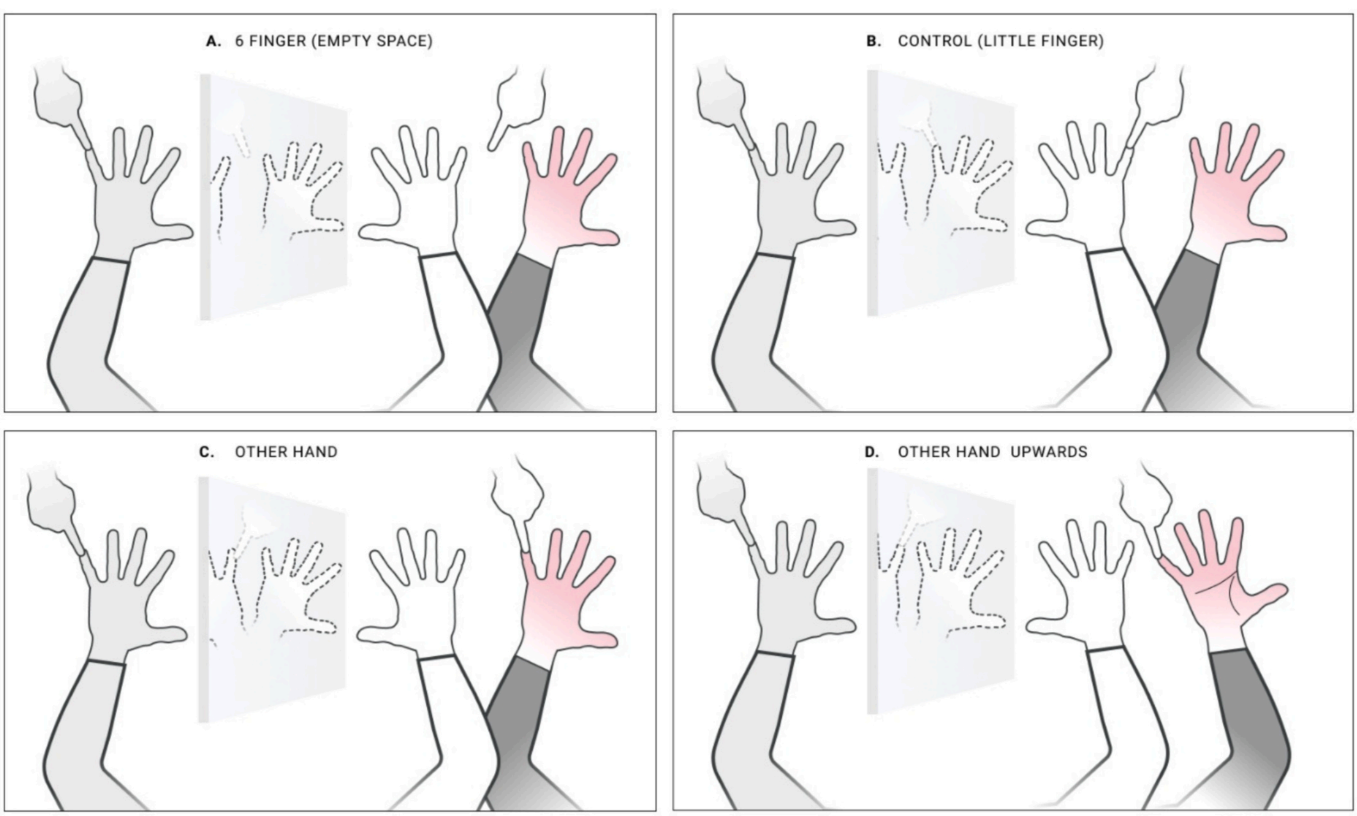

Fig. 1. **A.** Standard sixth finger illusion: the experimenter strokes the participant's hidden finger simultaneously with empty space next to the seen hand. **B.** Control condition: the experimenter strokes the little fingers of the participant's right and left hands at the same time. **C.** Other condition: the experimenter strokes the participant's hidden little finger at the same time as the fully visible hand of another person seated next to the participant. **D.** Other upwards condition: the experimenter strokes the participants hidden little finger simultaneously with the little finger of another person seated next to them, rotated palm-up.

the standard sixth finger condition, the extra finger is invisible, and the visual input consists only of the stroking of the experimenter, as if an invisible finger were there. By contrast, in the 'Other' conditions, the sixth finger involves a visible finger of another person's hand. Replicating the same procedure used in Cadete and Longo's (2020) study, in the standard sixth finger illusion condition, a trained experimenter manually stroked the participant's thumbs through to little fingers on both hands back and forth 4 times, from the knuckle to the fingertip, in a synchronised fashion. However, the little finger of the occluded hand was stroked in two locations. Firstly, it was stroked from the inside edge, while the little finger on the visible hand was stroked from the top edge. Secondly, it was stroked from the outside edge, while the space next to the participant's little finger was stroked, roughly where we would expect an additional finger to be. This final stroke was completed back and forth 20 times, again from the knuckle to the fingertip and in synchrony.

The same procedure was followed for all other conditions, up until the final set of strokes on the participant's visible hand. In the control condition, rather than stroking the space next to the participant's little finger on the visible hand, the little finger itself was again stroked from the top edge, inhibiting the illusory effect. In 'the Other' condition, the volunteer's left little finger placed palm-down next to the participant's hand was stroked. In 'the Other Upwards' condition, the volunteer's right little finger placed palm-up next to the participant's hand was stroked.

After each condition, the participants were asked to respond to a 7-item questionnaire, using a 0 to 10 response scale wherein higher scores related to a stronger agreement (10 was labelled 'strongly agree') and lower scores were representative of a stronger disagreement (0 was labelled 'strongly disagree'). The questionnaire was developed from Newport et al.'s (2016) and Cadete and Longo's (2020, 2022) studies, utilised to determine participants' experiences after each condition. Two questionnaire items bespoke to this experiment were added to gauge the effectiveness of the illusion in 'the Other' and 'the Other Upwards' conditions: 'It felt like the other person's finger was part of my left hand' and 'I could not tell the difference between a touch on my hand and a touch on the other person's hand'.

If participants successfully felt the sixth finger illusion in a condition (responding with a 4 or above on the 0 to 10 response scale to the first questionnaire item: 'It felt like I had a sixth finger on my left hand), then they were also given the other-self VAS on a sheet of paper. They were then asked to make a mark on the scale with a pen based on what felt most true to them in response to two follow-up questions: 'The sixth finger belonged to which body?' and 'This finger belonged more to which body?' For the latter question, the experimenter gestured toward the volunteer's little finger. In the 'Other' and 'Other Upwards' conditions, this was the finger used to create the illusion, whereas in the standard sixth-finger condition it was only visually available. This acted as a second measure to identify to what extent the participant felt as though they could embody the other person's finger.

2.4. Analysis

To determine the effectiveness in eliciting the sixth finger illusion, the agreement scores for each questionnaire item were compared across the four conditions via a one-way repeated measures analysis of variance (ANOVA). Paired *t*-tests were then completed for each illusory variation against the control condition to establish whether there was a stronger effect of the illusion relative to the control. For questionnaire items 1, 6 and 7, and the follow-up VAS questions, 'the Other' and 'the Other Upwards' conditions were compared with the standard sixth finger illusion as well as with each other. This was conducted firstly to determine the strength of the illusion specifically when using the volunteer's hand, and to investigate which condition was more successful in eliciting the illusion. These specific questionnaire items were selected as they were the most pertinent to whether the participant experienced a sixth finger, and whether the participant felt ownership over the volunteer's finger. Where the sphericity assumption was not met as indicated by Mauchley's test, the Greenhouse-Geisser correction was applied. Pairwise *t*-tests were corrected for multiple comparisons using the Holm-Bonferroni procedure.

In addition, the participants' marks on the VAS were measured and then converted into a percentage for analysis, with lower percentages relating more to the other and higher percentages to the self. This acted as a second measure to determine the differences in body ownership in each condition. However, as some participants did not experience the illusion, there were some missing data points across conditions – notably only 2 data points remained for the control condition for both follow-up questions. A similar issue also arose in previous studies (Cadete et al., 2022; Cadete & Longo, 2020) in which some questionnaire items were conditioned on a positive response to other items, meaning that not every participant provided data for all questionnaire items. We used a similar tactic to manage this issue as these previous studies, utilising a mixed-effects modelling approach, implemented in the lme4 package for R (Bates et al., 2015). This method addresses the issue of missing data across conditions, as it does not require complete datasets from all participants. Specifically, we modelled condition as a fixed effect and a random intercept term to account for within-subject variability. To compare conditions, we conducted paired t-tests within the mixed-effects framework, ensuring consistency with the main analysis. While similar to a one-way repeated-measures ANOVA, this approach is explicitly a mixed-effects model and is well-suited for handling unbalanced datasets. For the t-test results, degrees of freedom were calculated using the Satterthwaite approximation, which adjusts for the variance and covariance structure in the data (Kuznetsova et al., 2017). This approach is standard in mixed-effects modelling and provides more accurate hypothesis testing for unbalanced or hierarchical designs (Bates et al., 2015).

3. Results

3.1. Questionnaire item scores

Overall, the ANOVAs indicated that there was a significant difference in agreement scores between conditions for all 7 questionnaire items (see Fig. 2). For questionnaire item 1 – 'It felt like I had sixth finger on my left hand' – there was a clear difference between conditions, $F(3,57) = 31.88$, $p < .001$, $\eta_p^2 = 0.627$. The biggest disparity in agreement scores was between the standard sixth finger illusion and control condition, $t(19) = 7.988$, $p < .001$, $d_z = 1.786$, where the standard sixth finger illusion (M = 6.450) obtained a far higher agreement score on average compared to the control condition (M = 0.900). This is in alignment with the results of other studies such as Newport et al. (2016), and Cadete and Longo (2020). 'The Other' condition (M = 4.300) and 'the Other Upwards' condition (M = 3.475) were also both significantly different to the control, $t(19) = 5.886$, $p < .001$, $d_z = 1.316$, and $t(19) = 5.093$, $p < .001$, $d_z = 1.139$, respectively. 'The Other' condition had a slightly higher agreement score, indicating that the sixth finger illusion was slightly more effective in this condition when compared to 'the Other Upwards' condition, although the difference between the two was non-significant, $t(19) = 1.611$, $p = .124$, $d_z = 0.360$. It is worth noting that there was also a significant difference between 'the Other' condition and the standard sixth finger illusion, $t(19) = 3.882$, $p = .001$, $d_z = 0.868$), suggesting that, although more effective than the control, 'the Other' condition was not as successful in eliciting the feeling of a sixth digit compared to the standard sixth finger illusion.

A similar trend can be found for questionnaire items 2, 3 and 4. For example, questionnaire item 2 – 'It felt like I had two little fingers on my left hand' – also produced a significant difference in agreement scores, $F(3,57) = 21.878$, $p < .001$, $\eta_p^2 = 0.535$. Again, the biggest difference was between the standard sixth finger illusion and control condition, $t(19) = 6.193$, $p < .001$, $d_z = 1.385$, in which the former (M = 5.525) obtained

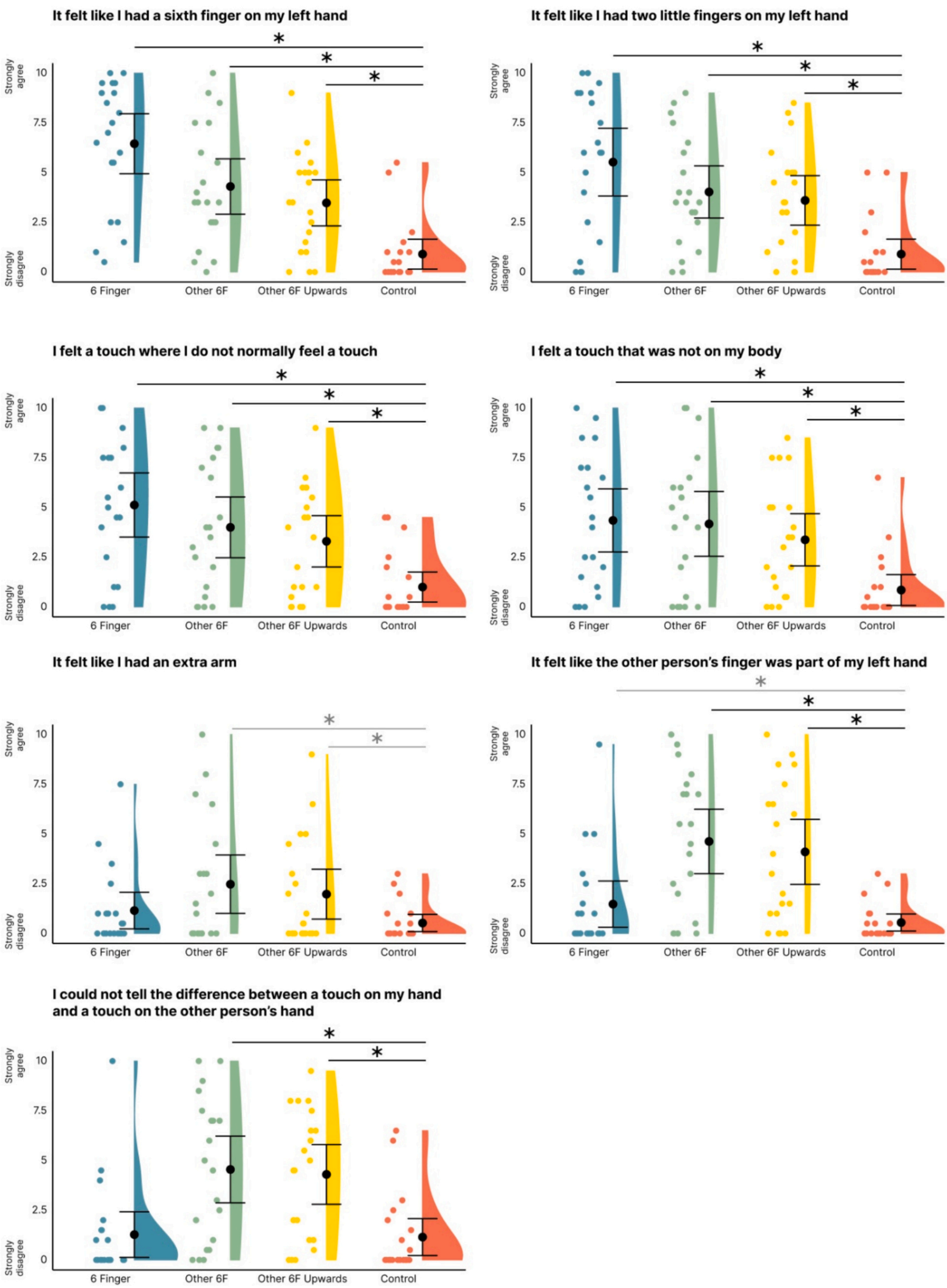

Fig. 2. Raincloud plots (Allen et al., 2021) illustrating the distribution of agreement scores for questionnaire items 1–7. Dots represent the individual data scores, and the clouds show the probability density of responses in each condition. The black bars represent the confidence intervals and the central dot marks the mean of each condition. The asterisk represents a significant difference between conditions at $p < .0001$); the grey asterisk indicates $p < .05$.

the highest agreement scores in juxtaposition to the latter (M = 0.900). There was also a significant difference between 'the Other'condition (M = 4.025) and control, $t(19) = 5.810, p < .001, d_z = 1.299$, and 'the Other Upwards' condition (M = 3.600) and the control, $t(19) = 5.394$, $p < .001$, $d_z = 1.206$).

Significant differences were also found for questionnaire item 3 – 'I felt a touch where I do not normally feel a touch', $F(1.673, 31.780) = 21.543$, $p < .001$, $\eta_p^2 = 0.531$. The standard sixth finger illusion (M = 5.125) obtained the highest agreement scores compared to the control (M = 1.000); both were significantly different from one another as indicated by the *t*-test, $t(19) = 5.687$, $p < .001$, $d_z = 1.272$). In addition 'the Other'condition (M = 4.000) and 'the Other Upwards condition (M = 3.300) were also significantly different from the control, $t(19) = 4.519$, $p < .001$, $d_z = 1.010$, and $t(19) = 4.721$, $p < .001$, $d_z = 1.056$, respectively, with 'the Other'condition obtaining slightly higher agreement scores compared to 'the Other Upwards' condition.

Questionnaire item 4 – 'I felt a touch that was not on my body' – demonstrated clear differences in agreement scores across conditions, $F(1.707, 32.438) = 15.54$, $p < .001$, $\eta_p^2 = 0.45$. Similar to the previous questionnaire items, the greatest difference was between the standard sixth finger illusion (M = 4.350) and the control (M = 0.850), $t(19) = 4.686$, $p < .001$, $d_z = 1.048$. 'The Other' condition (M = 4.175) and 'the Other Upwards' condition (M = 3.375) were also significantly different from the control, $t(19) = 4.240$, $p < .001$, $d_z = 0.948$ and $t(19) = 4.595$, $p < .001$, $d_z = 1.028$, respectively. However, unlike the previous questionnaire items, the standard sixth finger illusion and 'the Other' conditions were closer in average agreement scores compared to 'the Other' and 'the Other Upwards' conditions.

For questionnaire item 5, there was a significant difference in agreement scores across conditions, $F(3,57) = 6.372$, $p < .001$, $\eta_p^2 = 0.251$), however they remained low overall (see Fig. 2). 'The Other' condition produced the highest agreement score (M = 2.475), followed by 'The Other Upwards' condition (M = 1.975), standard sixth finger illusion (M = 1.150), and then finally, control (M = 0.525). This is in line with the results of other control questionnaire items used in studies such as Newport et al.'s (2016) and Cadete and Longo's (2020), in which participants' responses produces a lower agreement score. The most significant differences were between 'the Other'condition and the control, $t(19) = 3.020$, $p = .007$, $d_z = 0.675$), as well as 'the Other Upwards' condition and control, $t(19) = 2.948$, $p = .008$, $d_z = 0.659$).

Questionnaire items 6 and 7 – 'It felt like the other person's finger was part of my left hand' and 'I could not tell the difference between a touch on my hand and a touch on the other person's hand' respectively – were chosen specifically to test the extent to which participants were able to effectively embody the volunteer's finger in the experiment. The analysis revealed significant differences in agreement scores for both Q6, $F(1.747, 33.191) = 20.01$, $p < .001$, $\eta_p^2 = 0.513$, and Q7, $F(1.422, 27.009) = 15.691$, $p < .001$, $\eta_p^2 = 0.452$).

For questionnaire item 6, the greatest difference was between 'the Other' condition (M = 4.625) and the control (M = 0.550), $t(19) = 5.519$, $p < .001$, $d_z = 1.234$. The former acquired the highest agreement score. This was closely followed by 'the Other Upwards' condition (M = 4.100), which also significantly differed from the control, $t(19) = 4.776$, $p < .001$, $d_z = 1.068$. The standard sixth finger illusion score (M = 1.475) was closer to the control's, but still significantly differed from it, $t(19) = 2.153$, $p = .044$, $d_z = 0.481$. The standard sixth finger illusion score was also significantly different to 'the Other' condition, $t(19) = -4.551$, $p < .001$, $d_z = -1.018$) and 'the Other 'Upwards' condition, $t(19) = -3.874$, $p = .001$, $d_z = -0.866$). This indicated that both conditions were more effective in allowing the participant to feel as though the volunteer's finger belonged to them when compared to the standard sixth finger condition. Although 'the Other' condition obtained slightly higher agreement scores compared to 'the Other Upwards' condition, the difference between them was non-significant, $t(19) = 1.423$, $p = .171$, $d_z = 0.318$.

The same pattern can be identified for questionnaire item 7. Again, the greatest difference was between 'the Other' condition (M = 1.275) and the control (M = 1.150), $t(19) = 4.353$, $p < .001$, $d_z = 0.973$. Similarly, 'the Other Upwards' condition (M = 4.300) and control were also significantly different to one another, $t(19) = 4.460$, $p < .001$, $d_z = 0.997$. The standard sixth finger illusion (M = 1.275) was closer to the control condition in average agreement score, with both producing lower agreement scores compared to the other two conditions. Again, the standard sixth finger illusion was significantly different to 'the Other' condition, $t(19) = -4.012$, $p < .001$, $d_z = -0.897$, and 'the Other Upwards' condition, $t(19) = -3.808$, $p = .001$, $d_z = -0.852$, suggesting that both conditions were more successful in confusing the boundaries between the participant and the volunteer compared to the standard sixth finger illusion condition. Again, while 'the Other' condition obtained slightly higher agreement scores compared to 'the Other Upwards' condition, the difference between the two was non-significant, $t(19) = 0.893$, $p = .383$, $d_z = 0.200$.

3.2. VAS scores

It is important to consider the missing data points for the two follow up questions utilising the VAS, particularly for the control condition, which only produced 2 data points across all participants, compared to the other conditions which produced 11 or above. (Although, the strength of the illusion for the control condition was anticipated to be lower and generate lower agreement scores, and so missing data points were to be expected.) Because of this, the focus of analysis for the VAS scores was on the standard sixth finger illusion, 'the Other' condition and 'the Other Upwards' condition (results can be seen in Fig. 3).

For the VAS question 1 – 'The sixth finger belonged to which body?' – the ANOVA was non-significant, $F(3, 30.069) = 2.344$, $p = .093$, $\eta_p^2 = 0.19$), indicating there was not a significant difference in body ownership between conditions. The standard sixth finger illusion obtained the highest percentage of body ownership (M = 81.161%), followed by 'the Other' condition (M = 71.767%) and finally 'the Other Upwards' condition (M = 67.825%). The paired *t*-tests also indicated non-significance, even between the standard sixth finger illusion and 'the Other Upwards' condition, which were the highest and lowest percentages respectively, $t(28.3) = 2.47$, $p = .118$, $d_z = 3.480$.

However, this is in contrast to the VAS question 2 – 'This finger belonged more to which body?' – in which there was a clear difference between conditions, $F(3, 23.773) = 15.30$, $p < .001$, $\eta_p^2 = 0.66$. The paired t-tests indicated a significant difference in body ownership between the standard sixth finger illusion (M = 16.070%) and 'the Other' condition (M = 39.744%), $t(25.1) = -4.83$, $p < .001$, $d_z = 4.800$. Similarly, there was a significant difference between the standard sixth finger illusion and 'the Other Upwards' condition (M = 43.669%), $t(24.9) = -4.61$, $p < .001$, $d_z = 4.710$. This suggests that 'the Other' and 'the Other Upwards' conditions more successfully confused the boundaries between the *other* and the *self*, in that the volunteer's little finger felt more like the participant's own. Interestingly, 'the Other Upwards' condition produced a higher percentage of body ownership compared to 'the Other' condition, although the difference was ultimately non-significant, $t(24.9) = -0.12$, $p = .91$, $d_z = 0.120$.

4. Discussion

In summary, the findings of the present study suggest that not only is it possible to embody an additional body part, but it is possible to do so when this additional body part belongs to someone else; the self-other boundary can indeed be successfully disrupted in the sixth finger illusion. The results indicate that participants experienced a sixth finger across all the illusory conditions, having produced significantly higher agreement scores when compared to the control condition. The strength of the illusion was greater in the standard sixth finger condition compared to other conditions – replicating the results from previous studies (Ambron & Medina, 2023; Cadete and Longo, 2020; Newport

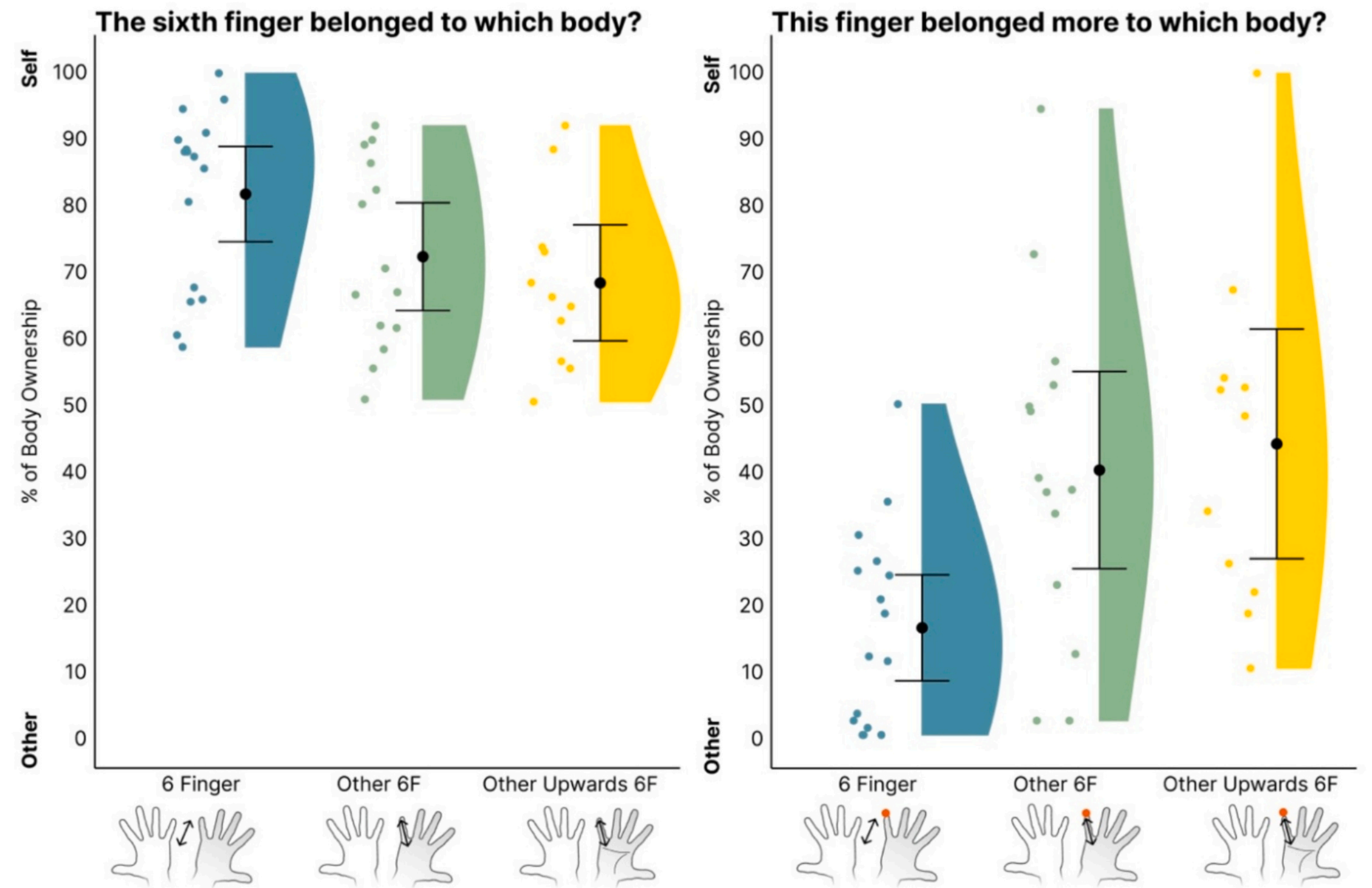

Fig. 3. Mean VAS scores indicating levels of body ownership for the follow-up questions. A higher percentage is equivalent to the *self*, while a lower percentage is equivalent to the *other*. The orange dots for the second question represent which fingers the experimenter pointed to.

et al., 2016) – but the illusory effect was also evoked in both 'the Other' and 'the Other Upwards' conditions. There was not a significant difference in agreement scores between 'the Other ' and 'the Other Upwards' conditions, meaning that participants were able to embody the volunteer's finger both when the volunteer's hand was facing palm-down and palm-up. Interestingly, the VAS scores demonstrated that the experienced sixth finger felt as though it belonged more to the participant themselves, regardless of condition. However, they also suggested that the volunteer's little finger felt significantly more like it belonged to the participant in 'the Other' and 'the Other Upwards' conditions when compared to the standard sixth finger illusion condition. 'The Other Upwards' condition even obtained higher body ownership scores when compared to 'the Other' condition (although the difference was ultimately non-significant).

Firstly, from this study, 'the Other' and 'the Other Upwards' conditions can now be added to the growing body of variations which are successful in eliciting the sixth finger illusion. This further illustrates the flexibility present in the mental representations of our own body: not only can we incorporate additional body parts to our body schema (Ambron & Medina, 2023; Cadete & Longo, 2020; Newport et al., 2016), but we can also incorporate other people's body parts. This aligns with past research (Ambron & Medina, 2023; Cadete & Longo, 2022), which suggests that the perceived sixth finger has its own independent properties from our existing body. Another relevant aspect is that the standard sixth finger involves an invisible finger, in contrast with the 'Other' conditions, which involve a real and visible finger of another person's hand. This could explain the higher embodiment scores in the sixth finger condition than in the 'Other' conditions. Ambron and Medina (Ambron & Medina, 2023) first introduced the potential role of invisibility in the flexibility of this illusion. Yet, Wang et al. (2025) successfully induced the sixth finger illusion using a rubber finger, which is visible. Also, invisibility does not confer this enhanced flexibility in replacement illusions, with the invisible hand illusion vanishing at 90° (Guterstam et al., 2013), unlike the supernumerary finger (Cadete et al., 2026).

The fact that there was not a significant difference between 'the Other' and 'the Other Upwards' conditions in experiencing a sixth finger and body ownership levels over the volunteer's finger, illustrates, in line with previous studies (Ambron & Medina, 2023; Cadete & Longo, 2022), that the illusion is robust to anatomical incongruencies with our own day-to-day bodies. This is consistent with recent findings that supernumerary fingers can be embodied across all tested angles of rotation, in both abduction and extension, up to 180° from the actual fingers, even when these positions are anatomically implausible (Brusa et al., 2025; Cadete et al., 2026). This suggests that the sixth finger illusion is indeed – at least partially – the result of bottom-up visuo-tactile sensory information. Of course, this contrasts with another body of research (Tsakiris, 2010; Tsakiris et al., 2010; Tsakiris & Haggard, 2005) which argues that we are more likely to feel a stronger sense of body ownership over objects that closely match our internal body representations. (Although, it is worth noting that these studies utilised the rubber hand illusion, which is distinctly not as robust as the sixth finger illusion – the illusory effect disintegrates when using a foreign object which has a different skin texture (Tsakiris et al., 2010), for example.) A key difference, however, is that the rubber hand illusion involves replacing the real hand with a fake one, whereas the sixth finger illusion involves adding a supernumerary finger alongside the real hand. This may allow greater flexibility, because the extra finger does not need to match the proprioceptive position of the existing fingers. As proposed by Cadete et al. (2026), one possible explanation is that there is greater flexibility for supernumerary body parts because the proprioceptive signals from our real limbs do not need to match the extra ones. That is, it is acceptable for the real hand to remain in one position while the extra finger is perceived in another. This differs from the rubber hand illusion, which is constrained by posture and typically breaks down at 90°, likely because the rubber hand replaces the real hand rather than being added to it. That being said, we cannot exclude the possibility that some of this flexibility also arises from the type of body part involved. Because fingers are already represented as multiple distinct digits on each hand, there may be greater tolerance for adding an extra finger than for adding an extra hand. As this present study shows, these top-down influences are not strong enough to disrupt the illusion when using the volunteer's hand both palm facing up, and palm facing down, illustrating the startling malleability specifically of the mental representations of our own hands. This is particularly remarkable because more than one type of incongruence was present: participants saw touch applied to someone else's finger, while that finger was also rotated palm-up, in contrast to the touch applied to their actual little finger, which remained palm-down. Adding further sources of mismatch did not extinguish the illusion, underscoring the robustness of the illusion to anatomical incongruence.

Strikingly, 'the Other' and 'the Other Upwards' conditions proved effective still even with the volunteer sat next to the participant. Other studies which feature real-life volunteers (Petkova & Ehrsson, 2008) or live videos of people (Tsakiris, 2008) often also include the deceit that the participant replaces their body part with the other's, or the other person's body is mirrored with the participant's to elicit the experience of a first-person perspective – something which is considered integral when measuring embodiment (Blanke & Metzinger, 2009). This creates an environment in which the other's body part can feel more like the participants' own. However, in the present study, the volunteer's finger is *added* to the participant's hand representation while the volunteer is sat next to the participant, inhibiting a first-person perspective. Schettler et al. (2019) note that in order to produce a stable body image in illusory contexts, the participant's real body must be disembodied to some extent to be replaced by something else. Furthermore, there is evidence to suggest these deceits are necessary for some illusions to function successfully: in Armel and Ramachandran's (2003) study using the rubber hand illusion, the effect was dampened when the participant's own hand was also visible. Yet, in this present study, the participant easily added the other's finger to their own body representation and the self-other boundary was disrupted. This, in line with the findings from studies such as Cadete and Longo's (2020), and Ambron and Medina's (2023), firstly demonstrates that even if we are perfectly cognisant of the fact that we do not have a sixth finger, we are still able to incorporate it into the mental representation of our own bodies. But secondly – and crucially – it shows that we can still embody an extra body part when the body part in question does not in reality belong to us. The self-other boundary can be defied even when there is not a first-person perspective, and despite our lifelong practice of distinguishing between the self and the other (Gallagher, 2000).

The difference in VAS scores across the two questions, 'The sixth finger belonged more to which body?' and 'This finger belonged more to which body?' prove interesting. Participants felt as though their experienced sixth digit belonged more to themselves than the volunteer, regardless of whether the volunteer's hand was used in the illusion or not. Yet, for 'the Other' and 'the Other Upwards' conditions, the volunteer's finger felt like it belonged more to the participant when compared to the standard sixth finger illusion. This is not surprising, given that the other person's finger was used to create the illusion in the 'Other' conditions, whereas in the standard sixth-finger illusion, it was only visually present. What is notable, however, is that it clearly illustrates the self-other boundary was successfully altered for participants when embodying an additional digit on the hands: the volunteer's finger felt more like their own. Although it may only be partial ownership (Blanke & Metzinger, 2009), the ease with which participants were able to attribute ownership over the volunteer's finger – to accept an additional body part which clearly does not belong to the self, yet perceiving it as one's own – is startling.

This is not the first time that synchronous stroking of body parts of two different people shifts the self-other boundary. In the enfacement illusion (Apps et al., 2015; Sforza et al., 2010; Tsakiris, 2008), synchronous stroking of one's face simultaneously to another person's face, makes it seem like that face is more similar to one's own. In a psychophysical task using a morphing image of one's face with another person's face, the interpersonal multisensory stimulation shifts the ability to discriminate one's own face from the other (Sforza et al., 2010; Tajadura-Jiménez et al., 2012), so that the other's facial features were more easily accepted as one's own. The other sixth finger illusion of this study may therefore involve similar mechanisms to the enfacement illusion, where another person's finger is perceived as belonging to one's body, blurring the distinction between the self and the other. In the enfacement illusion, there is a blurring of the self-other boundaries, where one's face and another's face overlap, and they are perceived as more similar (Tajadura-Jiménez, Grehl, et al., 2012; Tsakiris, 2008). In the present illusion, however, the finger of another person is perceived to belong to one's body, as an additional finger, not as a mesh of both little fingers. Rather than an overlap of representations of the self and the other, the other's finger is accepted as an extra body part of one's hand.

Further work could explore whether this illusion also affects social cognition. The enfacement illusion not only made participants feel more similar and closer to a stranger after synchronous stimulation of their face with the stranger's face, but also increased conformity, shifting closer to the estimates attributed to the other, and made the stranger seem more attractive (Paladino et al., 2010) and trustworthy (Tajadura-Jiménez et al., 2012). However, faces play a particularly strong role in self-identification, so the social effects found in the enfacement illusion may not be present for hands or fingers in the same way. The main components identified in the experience of enfacement are self-identification, similarity and affect, with no further subcomponents emerging for self-identification (Tajadura-Jiménez et al., 2012). This contrasts with the embodiment of the rubber hand, which includes the subcomponents of ownership, location and agency (Longo et al., 2008). Adding a set of measures of social implications of the 'Other' sixth finger illusion would help identify the role of fingers (and potentially other body parts) in social cognition. It is also unclear from the present study whether this illusion requires the 'Other' hand to be in the participant's peripersonal space. The rubber hand decays as the hand is placed farther from the participant's real hand (Lloyd, 2007), and synchronous visual and tactile events seem to only bind if both hands are in the near space (Makin et al., 2008). However, supernumerary body parts may be less constrained by distance than replacement illusions, because they are added to the body rather than needing to match the position of an existing body part.

At the same time, this illusion may not generalise equally across body parts, as the hand may be especially suited to this kind of self-other blending because of its distinctive role in social interaction. Indeed, the hand is known to have important social (*for a review, see* Longo, 2025, Chapter 15). For instance, infants as young as 12 months old point to create joint attention (Liszkowski et al., 2004), an ability shared with chimpanzees (Leavens & Hopkins, 1998). We also use our hands to convey (McIntyre et al., 2022) and identify emotions (Blythe et al., 2023). A particularly striking example of the social role of the hand comes from sign languages, in which the hand is the primary articulator of linguistic communication. Even among hearing people, gestures remain highly relevant to communication, and they share key developmental milestones with spoken language (Bates & Dick, 2002). The prominent social role of the hand, as shown in these studies might suggest that the hand might be more flexible to this type of illusion than other body parts. The illusion of embodying someone else's body part may be more easily induced in fingers and hands, due to this specific social component, which may blur the boundary between the self and the other in a way that the foot or leg may not.

Body ownership is just one subcomponent of embodiment (Kilteni et al., 2012; Longo et al., 2008) – there is also self-location (the sense of locational alignment we feel between the body and the self (Lenggenhager et al., 2009)) and agency (of the subjective feeling of being in control of our actions (Blanke & Metzinger, 2009)). Research in the last decade has begun to examine these three subcomponents of embodiment in isolation, arguing that they may be weighted differently in various contexts, and that different perceptual mechanisms underpin each one (Kilteni et al., 2012). Indeed, if body ownership is not a necessary measure of embodiment, and difficult to define, testing for agency and self-location in this present study could prove a useful tool to gain a greater understanding of the quality of embodiment of the other person's finger. Future work could include an 'Other-control' or visual-only control condition to separate the contribution of seen touch on another person's finger from the visuo-tactile mismatch with the hidden finger, and to test whether some degree of embodiment may arise at an earlier visual stage when it is a real finger and belongs to another person. Additionally, future work could integrate complementary measures, such as skin conductance responses, to capture autonomic threat responses to supernumerary embodiment.

Nevertheless, this present study found that not only is it possible to embody someone else's finger using the sixth finger illusion – successfully disrupting the boundary between the other and the self – but it is also possible even when the posture of the other person's finger is anatomically incongruent to one's own. This illustrates the startling flexibility of our internal body representations, specifically around the hands. Unlike other studies, in which the act of embodying a foreign object results in replacing it with our own body part, this experiment reveals that it is possible to feel body ownership over additional body parts belonging to someone else – even when we are clearly aware of that additional presence and a first-person perspective has not been established. This further demonstrates the lack of constraints around eliciting feelings of partial body ownership, and is promising for future studies wishing to utilise real-life volunteers in their research. It would be beneficial for future studies to continue to examine the constraints of the sixth finger illusion when using a real-life volunteer, as well as whether high levels of body ownership have any direct consequences on our own existing bodies.

CRediT authorship contribution statement

Holly Blood: Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization. **Denise Cadete:** Writing – review & editing, Supervision, Formal analysis, Conceptualization. **Matthew R. Longo:** Writing – review & editing, Supervision, Formal analysis, Conceptualization.

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Data availability

Raw data and analysis code are available in the OSF link: https://osf.io/t4paf/.

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