



Is this my foot? Experimentally induced disownership in individuals with body integrity dysphoria

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ARTICLE INFO

Keywords:

Disembodiment

Bodily illusions

Mixed realities

Multisensory processing

ABSTRACT

In body integrity dysphoria (BID), otherwise healthy individuals feel like a part of their physical body does not belong to them despite normal sensorimotor functioning. Theoretical and empirical evidence suggested a weakened integration of the affected body part into higher-order multisensory cortical body networks. Here, we used a multisensory stimulation paradigm in mixed reality to modulate and investigate multisensory processing underlying body (dis)ownership in individuals with BID of the lower limb. In 20 participants with BID, delay perception and body ownership were measured after introducing delays between the visual and tactile information of viewed stroking applied to affected and unaffected body parts. Unlike predicted, delay perception did not differ between the two body parts. However, specifically for the affected limb, ownership was lower and more strongly modulated by delay. These findings might be following the idea of a stronger dependency on online bottom up sensory signals in BID.

1. Introduction

Body integrity dysphoria (BID) is a disorder characterized by a mismatch of the physical and the desired body in terms of functionality or shape, resulting in a desire for disability (Brugger et al., 2016). In its most prevalent and currently most investigated variant, individuals feel like a part of their own body does not belong to themselves (sense of disownership), identify with an amputated body, and thus often desire an amputation of one or several healthy body parts (First & Fisher, 2012). While different theories concerning the underlying mechanisms are discussed (Brugger et al., 2013) and the condition is far from being understood, a prominent view is that the affected body part might not be properly integrated into higher-level neural body representations (McGeoch et al., 2011). Potentially confirmatory evidence for such hypothesis comes from both neuroimaging and behavioural studies. Structural and functional alterations were found in a distributed cortical body representation network spanning the right superior parietal lobule, primary and secondary somatosensory cortices, supplementary motor area, premotor cortex, insula, and various subcortical areas (Blom et al., 2016; Hänggi et al., 2017; Saetta et al., 2020). Furthermore, differential neural activity in the above-mentioned network was found both in response to touch to their desired as compared to their undesired body parts (van Dijk et al., 2013; McGeoch et al.,

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<https://doi.org/10.1016/j.concog.2022.103432>

Received 11 May 2022; Received in revised form 7 September 2022; Accepted 14 October 2022

Available online 10 November 2022

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2011), as well as in response to seeing their own body as amputated versus complete (Oddo-Sommerfeld et al., 2018). Along these lines, several behavioural investigations showed differential effects between the affected and unaffected limb in body-related uni-sensory and/or multisensory processing by showing, for example, altered temporo-spatial processing of tactile stimuli (Aoyama et al., 2012), or altered reactions to pain, pain anticipation (Brang et al., 2008; Romano et al., 2015), and top-down modulation of pain. On the other hand, recent empirical studies suggested normal implicit and explicit judgements about body size and shape, independent of what modality their judgement was based on, a normal peripersonal space representation (Stone et al., 2021), and no alterations in a mental rotation paradigm for body parts (Stone et al., 2019).

As the lack of body ownership is one of the core phenomenal features of the amputation variant of BID (Brugger et al., 2016; van Dijk et al., 2013; Saetta et al., 2020), we here aimed to assess multisensory mechanisms underlying experimentally induced altered embodiment for the affected versus the unaffected limb in individuals with BID. Multisensory stimulation paradigms inducing bodily illusions have been widely used to study the fundamentals of body ownership in healthy participants as well as in patients with disorders of the bodily self (see e.g. Kilteni et al., 2015 for a review). Heightened illusory ownership during rubber hand illusion-like paradigms (Botvinick & Cohen, 1998), specifically for affected body parts, have been suggested both in neurological disorders of body ownership (i.e. somatoparaphrenia (van Stralen et al., 2013), as well as in individuals with BID (Lenggenhager et al., 2015). These findings might suggest a weaker neural body part representation and thus a stronger dependence on bottom-up multisensory signals, (i.e. visual, tactile, and proprioceptive sensory inputs), resulting in higher perceptual plasticity of the affected limb. However, while these studies investigated illusory ownership of an external body part, the core feature of BID is rather a sense of disownership for the own body, and these mechanisms have been shown to rely on different brain mechanisms (Martinaud et al., 2017). Here, we thus aimed to specifically investigate multisensory mechanisms underlying the sense of disownership (Gentile et al., 2013; Reader & Ehrsson, 2019; Tacikowski et al., 2020). For this, we used a recently established paradigm to induce a sense of disownership by breaking multisensory coherence (Kannape et al., 2019; Roel Lesur et al., 2020, 2021). In this mixed reality paradigm, visuotactile temporal delays are introduced to test their effect on (dis)ownership both in a psychophysical approach, as well as in more detailed self-reports. Using a head-mounted display (HMD), individuals with BID could see their own body from a natural first-person perspective filmed from a camera mounted on the HMD. Visuo-tactile mismatches through stroking of one of the legs were introduced using delays of the visual feedback presented in the HMD. We assessed, individually for the affected and unaffected limb, how delay perception and the sense of ownership for the own limb is modulated by the various delays. We expected generally lower ownership scores for the affected limb and a quicker drop with increasing delay due to the weakened body representation and the stronger dependence on sensory signals. In line with this, preliminary data in three BID patients using the so called limb disappearing illusion in a Mirage setup (Newport & Gilpin, 2011), showed a stronger illusion of loss of the limb as compared to healthy controls, especially for the affected limb (Stone et al., 2018). For the longer-lasting blocks, we similarly expected a stronger sense of disembodiment, decreased sense of ownership and enhanced deafference, and an enhanced difference between synchronous and asynchronous stroking when the affected limb was stroked. Furthermore, in line with previous experiments suggesting changes in temporal order judgement (Aoyama et al., 2012), we expected delay sensitivity to be decreased for the affected limb.

2. Methods

2.1. Participants

Twenty participants (mean age 46.6 years old (SD = 12.1), 16 male, 16 right handed) participated in this study. This sample size is higher than in previously published behavioural studies on BID (e.g. (Aoyama et al., 2012; Stone et al., 2019, 2020), and was constrained by the rareness of BID. Participants were recruited from several European countries through online forums, personal contacts, and word of mouth. Their participation in this study constituted part of a larger project that included a full day of testing. The



Fig. 1. Experimental Setup. *Note.* A) Experimental setup where the participant (in red) wearing the HMD sat on the recliner and the experimenter (in brown) stroked the participants' foot. B) The view of the body and the stroked feet as seen in the HMD. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

experiment reported here is independent of the research questions addressed in the larger project. BID individuals with a desire for unilateral amputation of the lower leg and who could follow the study procedures in German were included in the study. Participants' cost of travel and accommodations were covered, and they were additionally compensated with 20 Swiss Francs per hour for their participation. The protocol was approved by the Cantonal Ethics Committee of Zurich.

2.2. Experimental procedure

The experiment closely followed a previously described experimental setup (Roel Lesur et al., 2020). It consisted of two parts, firstly a part with short trials which was followed by a part with long trials. Participants were comfortably seated on a recliner (Fig. 1A), so that they could see their full body and the natural environment they were in, in the HMD (see Fig. 1B). After an introduction and explanation on how to use the HMD to answer questions, the part with short trials started. During the short trials, we assessed delay perception and body ownership. This part was divided in two blocks, where either the affected or unaffected foot was stroked, in counterbalanced order. Each block consisted of 48 trials, with 6 equidistant delays between 139 ms (intrinsic delay of the system, generally perceived as synchronous (Roel Lesur et al., 2020)) and 739 ms, where each delay was repeated 8 times in randomized order across the block. A trial lasted for 7 s, after which participants were asked to indicate whether the touch they saw and the touch they felt were synchronous, with a forced-choice question (delay perception), and how much the stroked leg felt like their own leg on a visual analogue scale (body ownership).

The second part of the experiment consisted of four longer trials, where participants were stroked on their foot for a duration of 90 s. The visuotactile stimulation was either synchronous (139 ms intrinsic delay) or asynchronous (1139 ms delay), and either on the affected or unaffected leg. These conditions were presented in counterbalanced order. After each 90 s stimulation, participants were asked to complete an embodiment questionnaire that was digitally presented within the HMD and assessed full body awareness. Participants could answer the 12-item questionnaire (see Table 1) on a visual analogue scale (VAS) with their head movements. Responses to individual questions were averaged across three factors (Disownership, Deafference, Embodiment) that have been previously identified in a PCA to describe the illusion (Roel Lesur et al., 2020).

2.2.1. Zurich Xenomelia scale

As part of the larger project, participants completed the Zurich Xenomelia Scale (ZXS, (Aoyama et al., 2012)), which consisted of 12 items that could be answered on a VAS ranging from 0 to 100. The items were grouped in three subscales (Pure Amputation Desire, Erotic Attraction, and Pretending Behaviour), for which a mean score was calculated.

2.3. Statistical analyses

All data processing and statistical analyses were performed in R version 4.0.2 (R Core Team, 2018). The alpha level was set to 0.05.

2.3.1. Forced-choice delay perception

Logistic mixed models were used to analyze the forced-choice data. The intraclass correlation demonstrated non-independence of the data ($ICC(1) = 0.09$, $F(19, 1868) = 9.90$, $p < .001$). The random effect structure of the model was determined in a stepwise manner. A model including both random intercept and random slope for each individual was used for further hypothesis testing, as adding the random slope significantly improved the fit of the model ($BIC_{randomintercept} = -1493.2$ vs $BIC_{randominterceptandslope} = -1401.9$, $X^2(2) = 106.42$, $p < .001$). Therefore, the model including both a random slope and random intercept was used for further hypothesis testing.

Table 1
Embodiment Questionnaire.

<i>Factor 1: Disownership</i>	
Strangeness	Sometimes my body felt strange
Not belonging	Sometimes it felt as if my body did not belong to me
Looking at image	Sometimes my body felt more as an image than my actual body
<i>Factor 2: Deafference</i>	
Numbness	Sometimes my body felt numb
Reduced Vividness	Sometimes my body felt less vivid than usual
Disappearing	Sometimes it felt as if my body disappeared
<i>Factor 3: Embodiment</i>	
Ownership	Sometimes it felt as if the seen body was my own
Agency	Sometimes it felt that I could move the seen body when I wanted to
Looking at someone else	Sometimes it felt as if I was looking at someone else's body
<i>Additional items</i>	
Delay perception	Sometimes it felt as if the felt touch was caused by the seen touch
Control: shape and form	Sometimes the seen body resembled mine in terms of shape and structure
Belonging affected leg	It feels as if the affected leg does not belong to me

Note. The questionnaire was translated from German.

2.3.2. VAS ownership responses

Linear mixed models were used to analyze the responses to the ownership statement in the short trials. The intraclass correlation demonstrated that observations within individuals were non-independent ($ICC(1) = 0.40$, $F(19, 1868) = 65.16$, $p < .001$). Visual inspection of diagnostic plots of the residuals showed that these were normally distributed. The model that included both a random intercept and slope for individuals, where VAS ratings were explained as a function of delay, fitted the data better than the model that included only the random intercept and no random slope ($BIC_{randomintercept} = -724.23$ vs $BIC_{randominterceptandslope} = -998.57$, $X^2(2) = 289.43$, $p < .001$). Therefore, we used the random intercept and slope model for further hypothesis testing. To determine the fixed effect structure, the interaction of leg with delay, and the second and third polynomial of delay were added in a stepwise manner. While adding the third polynomial of delay yielded a significantly better fit (see Table S1), the BIC which penalizes for added model complexity did not improve. Therefore, the first model, including the linear fixed effects of leg and delay and their interaction was used for hypothesis testing.

In a second step, we assessed whether the pure amputation desire subscale of the ZXS provided additional explanation in variance of the ownership ratings. Mean amputation desire was 86.35 ($SD = 13.78$). For the analyses, the ZXS pure amputation desire subscore was mean-centered. The main effect and interaction with other predictors were added to the model. The ZXS was only available from 18 participants; therefore, we report these analyses separately and do not directly compare the model with and without the pure amputation desire score.

2.3.3. Embodiment questionnaire

Linear mixed models were used to assess effects of synchrony, leg, and their interaction. Post-hoc tests for comparisons of interest were calculated using Wilcoxon Signed-Rank tests with Bonferroni correction for multiple comparisons.

3. Results

3.1. Delay perception

To assess whether there was a difference between the affected and unaffected leg in delay perception, a logistic mixed model, which included main effects of delay, leg, and the interaction was fitted to the forced choice delay ratings. The model showed that only the main effect of delay was significant ($b = -14.41$, 95 % CI $[-18.06, -11.31]$, $z = -8.94$, $p < .001$). Thus, participants were more likely to report that there was a visual delay as the duration of the visual delay increased. There were no significant effects of leg ($b = 0.73$, 95 % CI $[-0.03, 1.50]$, $z = -1.91$, $p = .056$) or interaction of leg and delay ($b = -0.21$, 95 % CI $[-1.89, 1.48]$, $z = -0.24$, $p = .81$; see Fig. 2A).

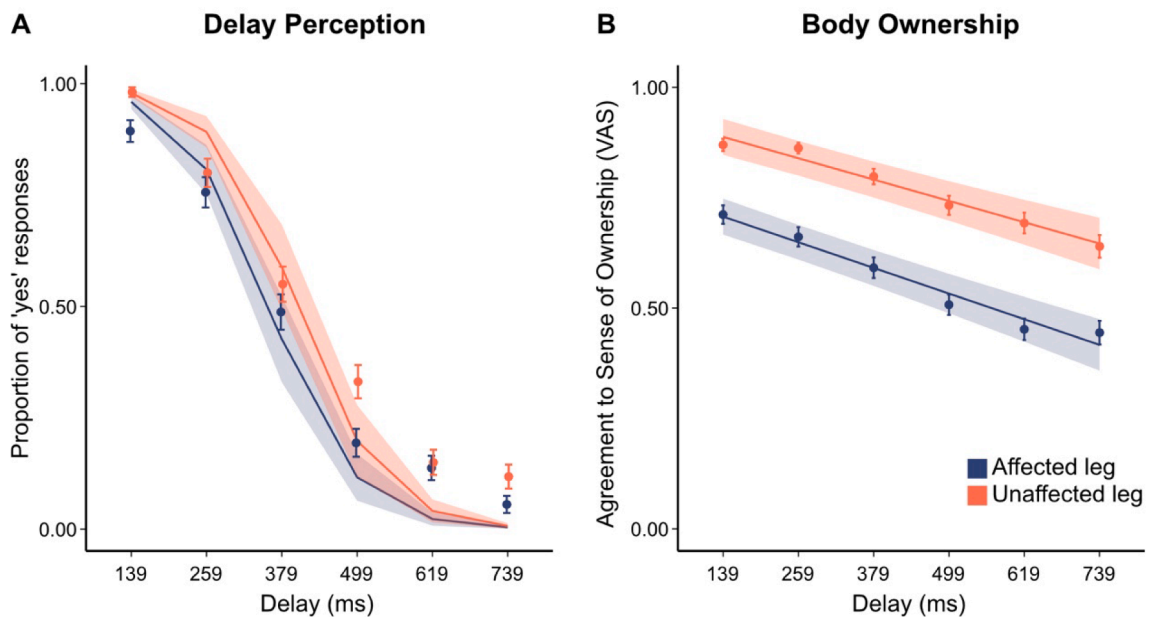


Fig. 2. Delay Perception and Body Ownership. *Note.* A) Forced choice delay ratings displayed as the proportion of 'yes' responses to the question "Were the touch you saw and the touch you felt synchronous". Points and error bars display the mean proportion of "yes" responses and the standard error. Lines and shaded areas represent the predicted value with standard error from the logistic mixed model. B) Ownership responses of the short trials. Points and error bars display the mean agreement on the VAS with the standard error. Lines and shaded areas show the predicted values with standard error from the mixed models.

3.2. Body ownership

To test whether ownership of the affected and unaffected leg was differently modulated by increasing delay, a linear mixed model with main effects of leg, delay, and the interaction was fitted to the ownership ratings (see Fig. 2B, as well Fig. S1 and Table S2 in the Supplementary Material). The model showed significant main effects of leg ($F(1, 1848.11) = 78.45, p < .001$) and of delay ($F(1, 20.11) = 25.36, p < .001$). There was also a significant interaction effect of leg and delay ($F(1, 1841.11) = 4.19, p = .041$), showing that while ownership was overall lower for the affected leg, ownership also reduced more strongly with increasing delay for the affected than the unaffected leg.

In an additional model on a subset of the data of participants who completed the ZXS, we found beyond similar effects as in the model reported above, a significant interaction of amputation desire and leg ($F(1, 1660.11) = 10.544, p = .001$, see Table S3 for all model coefficients). Ownership for the affected leg was overall lower for participants with higher amputation desire, whereas this was not the case for the unaffected leg (see Fig. 3).

3.3. Embodiment questionnaire

Linear mixed models were run on the individual factors to assess the effects of leg, synchrony, and the interaction of the two. This showed that for disownership, there were significant effects of leg ($F(1, 57) = 13.49, p < .001$), of synchrony ($F(1, 57) = 85.46, p < .001$), but no significant interaction of the two ($F(1, 57) = 2.59, p = .11$). The factor disownership was significantly higher after asynchronous than synchronous stimulation both when stroking the affected and unaffected leg. Disownership was also higher when stroking the affected versus stroking the unaffected leg after both synchronous stimulation, and asynchronous stimulation (Fig. 4). For Deafference, there were significant effects of leg ($F(1, 57) = 11.04, p = .001$), and synchrony ($F(1, 57) = 74.42, p < .001$). The interaction of leg and synchrony was not significant ($F(1, 57) = 0.76, p = .39$). Deafference was overall higher after asynchronous than synchronous stimulation, and it was also higher for stroking the affected compared to unaffected leg (Fig. 4). Finally, the factor embodiment showed a significant effect of leg ($F(1, 57) = 8.91, p = .004$) and synchrony ($F(1, 57) = 42.51, p < .001$), but again no significant interaction ($F(1, 57) = 0.13, p = .72$). Embodiment was overall higher after stroking the unaffected versus affected leg, and after synchronous compared to asynchronous stimulation (Fig. 4). Full descriptive statistics of the individual questionnaire items are reported in Table S4.

Finally, the three final items of the questionnaire, (i.e. delay perception, control statement, and belong of the affected leg) were analysed individually. For delay perception, there was a significant effect of synchrony ($F(1, 76) = 9.29, p = .003$), with higher agreement to the statement whether felt touch was caused by the seen touch in the synchronous than asynchronous condition. The main effect of leg ($F(1, 76) = 0.36, p = .55$), or of the interaction of leg and synchrony ($F(1, 76) = 1.05, p = .31$) were not significant. Regarding the control item, there was a significant main effect of leg ($F(1, 57) = 16.32, p < .001$), with higher agreement for the unaffected than the affected leg. The main effect of synchrony ($F(1, 57) = 1.66, p = .20$), and the leg, synchrony interaction ($F(1, 57) = 1.00, p = .32$) were not significant. Finally, regarding the item on belonging of the affected leg, there was a significant main effect of leg ($F(1, 57) = 32.69, p < .001$), with higher agreement to the statement that it felt like the affected leg did not belong for the affected than the unaffected leg. The main effect of synchrony ($F(1, 57) = 2.79, p = .10$) and the leg, synchrony interaction ($F(1, 57) = 0.53, p = .47$) were not significant.

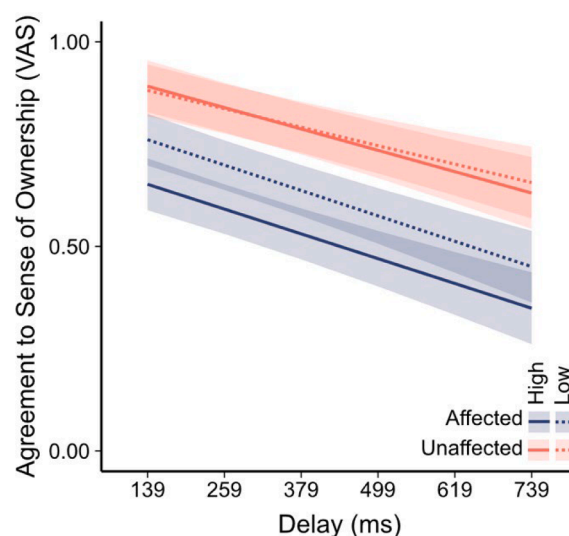


Fig. 3. Body Ownership as Predicted by Delay and Amputation Desire. *Note.* Predicted values for ownership are displayed as lines with standard errors as the shaded area. High and low amputation desire are used for visualization purposes only (Mean \pm 1 SD). Amputation desire was entered as a continuous variable in the model.

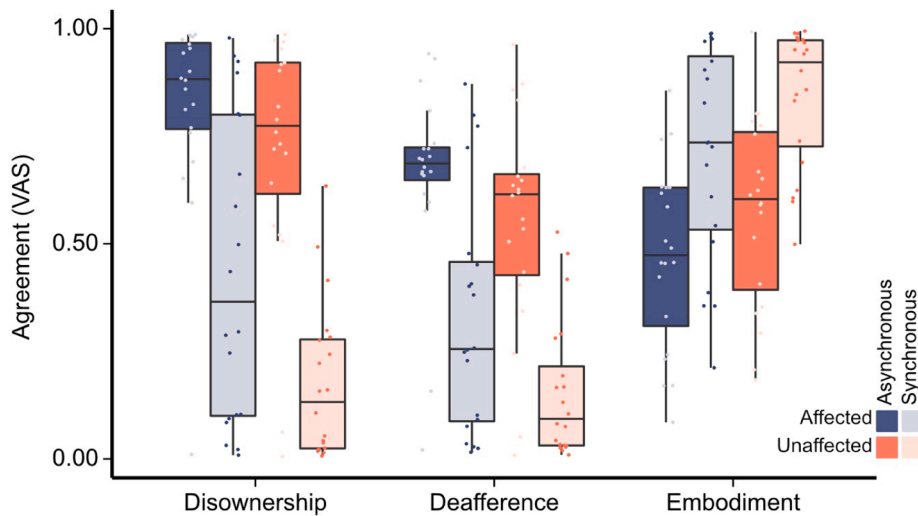


Fig. 4. Responses to the Embodiment Questionnaire. *Note.* Questionnaire responses by condition in the second part of the experiment. Points represent individual responses on a VAS from 0 to 1. The boxes show the interquartile range with the median as a horizontal line. Whiskers show the upper and lower extremes.

4. Discussion

The current study used a mixed reality setting to investigate to what extent temporal visuo-tactile mismatches affect delay perception and the sense of (dis)ownership of the stroked affected and the unaffected leg in individuals with BID with a long-standing desire for leg amputation. The study revealed two main findings. *First*, while there was a trend towards enhanced delay perception for the affected limb, this effect did, unlike predicted, not reach significance. *Second*, in line with our hypothesis, body ownership was reduced and the senses of disembodiment and deafference were enhanced when the affected leg was stimulated. This was evident both in the single item rating assessing leg ownership specifically for the stimulated leg after the repeatedly presented short trials with various delays, as well as in the more extensive questionnaire asking about full body disembodiment after the longer stimulation periods. Furthermore, such reduction was stronger in individuals who report a stronger amputation desire according to the ZXS (Aoyama et al., 2012). *Third*, and as expected, we found a stronger modulation of ownership by the specific delays for the affected leg (i.e., an even stronger decrease in sense of ownership with increasing delays for the affected limb). Together these findings might be in line with a body representation that is more dependent on modulations of bottom-up signals, which is associated to a more malleable bodily self.

4.1. Comparable delay perception between the affected and unaffected limb

Various theories assume the aetiology of BID, at least partly, in disturbed multisensory higher-level representation of the bodily self (e.g. Brang et al., 2008; Saetta et al., 2020). Confirming such deficits, a behavioural study in individuals with BID used a temporal order judgement task to assess differences between limbs in temporal order judgements (TOJ) of tactile stimuli applied desired and undesired body sites, a task that is known to depend on higher-level, multisensory, rather than primary body representations (Aoyama et al., 2012). While no difference between the affected and unaffected leg was reported when stimulation sites were across limbs (i.e., one on the affected and one on the unaffected limb) a significant difference in TOJ was found when the stimulation sites were on the same limb, but one above and one below the line separating the accepted and rejected part of the limb. In contrast to the desired leg, for the undesired, a bias in TOJ towards the distal, rejected, site was observed (more likely to respond the stimuli were simultaneous when the proximal site was stimulated first), which the authors suggested might be due to a hyperattention towards the undesired limb (Aoyama et al., 2012).

Unlike predicted on the basis of the previous study using the TOJ task, our results suggest no significant difference in delay perception between the affected and the unaffected leg. This finding is in line with findings in healthy participants, showing that visuo-tactile delay perception did not differ between conditions of altered bodily self cues (e.g., hand orientation or synchronous stroking), despite the fact that previous studies using temporal order judgement did suggest such interaction (Ide & Hidaka, 2013).

Even though the discussion of non-significant trends has been disputed (Schumm et al., 2013), we think it is important to note that while there was no significant effect of the leg on the delay detection, there was a trend suggesting that, if there was an effect, it would point towards enhanced delay detection in the affected limb. This could be in line with either an enhanced attention to the affected limb (cp. e.g., Aoyama et al., 2012), or the previously suggested relaxed constraints for temporal sensorimotor coherence in self-related conditions (Ide & Hidaka, 2013; Maselli et al., 2016). Studies in a larger sample, or by using more fine-grained measures such as staircase procedures or balanced visuotactile mismatches (where vision also precedes touch) would be desirable (Roel Lesur et al.,

2020, 2021). In our study, we only stimulated the foot, which always belonged to the rejected part of the limb. To further understand the role of either attention or influence of self-relatedness, a similar comparison (i.e., comparing stroking above and below the demarcation line of the affected leg), as done by [Aoyama et al. \(2012\)](#) or [McGeoch et al. \(2011\)](#) could be informative.

4.2. Decreased and more strongly modulated sense of body ownership

Our data, both for the affected and the unaffected limb, were in line with previously published data showing decreasing sense of ownership with increasing delay in healthy participants ([Roel Lesur et al., 2020, 2021](#)). Rather unsurprisingly, the participants reported a generally lower sense of ownership for the affected compared to the unaffected limb, a finding that is in line with the core symptom of BID, (i.e., a sense of estrangement of the affected limb, to the point of an amputation desire ([First & Fisher, 2012](#))). Such link was also evidenced by the fact that individuals with BID who indicated a stronger desire for amputation according to the ZXS, reported generally lower body ownership for the affected but not for the unaffected body part in our task. More interestingly however, for the affected limb there was a stronger decay of ownership with increasing delay, suggesting the limb is more readily and more strongly disowned in conditions of visuo-tactile mismatch. Similar to previously reported findings using the rubber foot illusion ([Lenggenhager et al., 2015](#)) and the limb disappearing illusion ([Stone et al., 2018](#)), our data are in line with the idea of a stronger malleability of the undesired leg. In our case, the presumably weaker representation of the undesired leg as compared to the desired leg, and thus increased plasticity of the representation of the limb, may have led to an increased reliance on the momentary visuotactile input, and thus led to a more rapid increase in disownership for the own body part.

Another interesting observation is that while the ownership scores were clearly lower for the affected than unaffected limb, and this effect was related to the pure amputation desire according to the ZXS, they were still rather high (i.e., a median of 0.81 (range 0–1) in the lowest delay). A previous study found that while the ownership for the own foot is disturbed, illusory ownership for a rubber foot is enhanced ([Lenggenhager et al., 2015](#)). It could thus be speculated that the digitalization of the own foot in mixed reality could have resulted in alienation of the seen foot. Even though the current setup intended to prevent this by portraying a realistic view of the participant's own body, which might paradoxically enable higher ownership. Further systematic research on different malleability of body perception in physical, augmented and virtual environments ([Ho, Krummenacher, Lesur, Saetta, & Lenggenhager, 2022](#)) would be desirable and might inform future therapeutic approaches.

4.3. Limitations and outlook

Even if the results of the control question suggest low suggestibility, it is important to note that the current findings are purely based on explicit measures, and previous literature has suggested an important contribution of suggestibility to experimentally induced bodily illusions ([Marotta et al., 2016](#); [Stone et al., 2018](#)). Noteworthy is that some studies using similar paradigms have also shown changes in implicit physiological measures ([Gentile et al., 2013](#); [Tacikowski et al., 2020](#)), but see [Roel Lesur et al. \(2020\)](#) for a non-replication. In view of the fact that a previous study in BID found an effect of multisensory stimulation in a rubber foot illusion paradigm exclusively on explicit and not on implicit measures ([Lenggenhager et al., 2015](#)), it would be interesting to investigate in future studies the effects of multisensory mismatch on more implicit measures of body ownership ([Roel Lesur et al., 2020](#)). Furthermore, while the presented paradigm is interesting to investigate potential altered multisensory integration mechanisms in BID, another interesting avenue would also be to investigate how such an experimentally induced body ownership illusion could alter the desire for amputation or the sense of estrangement from the leg. Multisensory stimulation and bodily illusion paradigms have previously been argued to bear therapeutic potential ([Lenggenhager et al., 2015](#); [Stone et al., 2018](#); [Turbyne et al., 2021](#)), and developing non-invasive tools to reduce suffering is of utmost importance ([Chakraborty et al., 2021](#)). While it was not the main aim of the current study, we added one question after the long blocks on how the body ownership of the actual undesired body part was affected by the experiment. Yet, this item was not affected by synchrony of stimulation. Furthermore, the observation that the scores varied depending on which leg was stimulated, suggests that there may have been confusion between affected by stroking and affected by BID. Future studies should look more specifically at the effects of longer-term experimentally modulated body ownership on subjective well-being and the desire of amputation.

CRedit authorship contribution statement

Marieke L. Weijs: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing. **Jasmine T. Ho:** Conceptualization, Investigation, Project administration, Resources, Visualization, Writing – review & editing. **Marte Roel Lesur:** Conceptualization, Methodology, Software, Writing – review & editing. **Bigna Lenggenhager:** Conceptualization, Funding acquisition, Methodology, Project administration, Resources, Supervision, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

We would like to thank the participants of this study. We would also like to thank Martina Scattolin and Lorena Stäger for assistance with data collection.

This research was funded by the Swiss National Science Foundation (grant number: PP00P1_170511 and PP00P1_202674).

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.concog.2022.103432>.

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