

## Methodology Appendix

### Self-Concept Clarity and the Bodily Self:

#### Malleability Across Modalities

Krol, Thériault, Olson, Raz, & Bartz

#### Self-Concept Clarity Scale (Campbell et al., 1996)

Please read each statement and use the scale below to indicate how much you agree or disagree with it.

1 = Strongly disagree; 2 = Slightly disagree; 3 = Neither agree nor disagree; 4 = Slightly agree; 5 = Strongly agree

1. My beliefs about myself often conflict with one another.
2. On one day I might have one opinion of myself and on another day I might have a different opinion.
3. I spend a lot of time wondering about what kind of person I really am.
4. Sometimes I feel that I am not really the person that I appear to be.
5. When I think about the kind of person I have been in the past, I'm not sure what I was really like.
6. I seldom experience conflict between the different aspects of my personality.
7. Sometimes I think I know other people better than I know myself.
8. My beliefs about myself seem to change very frequently.
9. If I were asked to describe my personality, my description might end up being different from one day to another day.
10. Even if I wanted to, I don't think I could tell someone what I'm really like.

11. In general, I have a clear sense of who I am and what I am.

12. It is often hard for me to make up my mind about things because I don't really know what I want.

## **Body Illusion Instructions**

### *Rubber Hand Illusion Instructions*

This task is very simple. You're going to place your right hand on the table into this box and this fake hand will be beside your hand. I am going to stroke your hand and this fake hand with 2 paintbrushes. You will simply observe this fake hand while I do so. Please focus on the fake hand for the duration of the task. It is important to not talk during this task, and to keep your attention on the task. Once I'm done stroking your hand and the fake hand, please do not move and wait for more instructions.

### *Body-Swap Instructions*

Try to keep the image you see centered in the middle of your field of view. If you see black on the borders, it probably means you have to adapt your head position. So it is very important to move slowly during this process to remain predictable. To make things easier, we will be assigning you roles: (participant's name) you will be the follower, and you will do your best to follow (confederate's name)'s movements accurately throughout the procedure.

To begin, put your hands on your thighs and your feet flat on the ground. Now, I'm going to ask you to slowly turn your head toward your right. Now, turn your head toward your left. Come back to a neutral position. Look up to the sky. Look down at the ground. Come back to neutral position.

Keep your hands on your thighs but look down at your hands. Raise your right index finger only and keep it up. Now raise your left index finger, and keep it up as well. Bring them back down. Now, come to a neutral neck position and slowly bring your palms together, with arms and fingers extended in front of you. Move them up and down. Small but quick, vigorous movements. Always try to be as synchronized as possible. Ok, gently stop moving your hands, but try interlocking your fingers, left thumb on top. Now, when I will say “squeeze” you will try squeezing your hands, and you will stop when I say “stop”. “Squeeze... Stop”, “Squeeze... Stop”, “Squeeze... Stop”. Now bring your hands back to your thighs and close your eyes until I tell you to open them again. Make sure your eyes are really closed. Are your eyes closed?

I’m now going to put an object in your right hand, so open it and make sure the object doesn’t fall (put balls in right hands). Now keep your hands where they are but open your eyes and look down at the object in your right hand. Now, when I say “squeeze” you will try squeezing the ball, and you will stop when I say “stop”. “Squeeze... Stop”, “Squeeze... Stop”, “Squeeze... Stop”. Now, very slowly, like in slow motion, try putting the ball in your left hand. Now relax your neck to a neutral position and close your eyes until I tell you to open them again. Make sure your eyes are really closed. Are your eyes closed?

I’m now going to pick up the object (Take balls and uncover mirrors). You can now open your eyes. For the next minute, look at yourself in the mirror in front of you.

Now, with your palms facing down, bring your hands in front of you, with arms and fingers extended. Now turn your palms up, back down, back up, and back down. Now, slowly bring your palms together again, arms and fingers extended in front of you. Move them up and down. Small but quick, vigorous movements. Always try to be as synchronized as possible. Ok, gently stop moving your hands and bring them to the armchairs.

Now we're going to try to stand up. When you are ready, try standing up, slowly. Now, slowly bring your palms together again, arms and fingers extended in front of you. Move them up and down. Small but quick, vigorous movements. Always try to be as synchronized as possible. Ok, gently stop moving your hands and bring them back to your side. Now, like we did earlier, slowly turn your head toward your right... your left. Come back to neutral position. Look up to the sky. Look down. Come back to neutral position. You can now sit again. Thank you, the session is now over. You can remove your headset.

## Supplementary Materials

### Self-Concept Clarity and the Bodily Self:

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### Specificity of SCC and Embodiment Effect

#### *Study 1*

As indicated in the main text, we used the 10-item “embodiment of rubber hand” factor identified by Longo and colleagues (2008) to quantify the subjective experience of the RHI. Although these items loaded onto one factor, a secondary analysis conducted by Longo et al. (2008) showed that these items can also be broken down into three sub-components. Specifically, five items refer to ownership, the feeling that one owns the prosthetic hand (Table S1, items 1-5; e.g., “During the experiment, there were times when it seemed like the rubber hand belonged to me.”), three items refer to location, the feeling that the real hand and prosthetic hand were in the same location (Table S1, items 6-8; e.g. “During the experiment, there were times when it seemed like my hand was in the location where the rubber hand was.”), and two items refer to agency, the feeling that one can control the prosthetic hand (Table S1, items 9-10; e.g. “During the experiment, there were times when it seemed like I could have moved the rubber hand if I had wanted.)

Given that we observed that low SCC individuals were more susceptible to the RHI in the asynchronous condition, we conducted additional exploratory analyses to investigate the specificity of this effect. In other words, is SCC related to particular aspects of the embodiment experience and not others? We were particularly interested in the ownership and agency

components since a sense of body ownership, the sense that my body belong to “me”, and a sense of agency, the sense of authorship of a movement or action, are considered two fundamental characteristics of the bodily self (Gallagher, 2000; Tsakiris, Schütz-Bosbach, & Gallagher, 2007). To examine this question, we calculated the mean of items for each of the three sub-components of embodiment in the asynchronous condition and then correlated these scores with SCC.

Results are presented in Table S3. SCC was significantly negatively associated with ownership and marginally associated with location. However, SCC was not related to feelings of agency. These results suggest that the association between SCC and embodiment of the prosthetic hand in the asynchronous condition was primarily driven by feelings of ownership over the prosthetic hand.

### *Study 2*

As noted in the main text, we adapted the 10 items that loaded onto Longo et al.’s (2008) “embodiment” factor to assess the degree to which participants experienced the body-swap illusion. Consistent with Study 1, we calculated ownership (mean of items 1-5 in Table S2), location (mean of items 6-8 in Table S2), and agency (mean of items 9-10 in Table S2) scores to examine if SCC was associated with a particular aspect of embodiment in the body-swap illusion.

Of note, although the embodiment factor was the focus of the present investigation, in Study 2 participants also completed adapted versions the other questionnaire factors identified by Longo and colleagues (2008) that assess different aspects of the illusion experience. Specifically, the “loss of own body” component reflects feelings of loss of agency over one’s own body (items

11-15 in Table S2, e.g., “It seemed like my body had disappeared”), the “movement” component assesses feelings of the two bodies moving towards each other (items 16-18 in Table S2, e.g., “It seemed like the body I saw was moving towards my body”), and, finally the “affect” component measures the extent to which the experience of the body-swap illusion was enjoyable and interesting (items 19-21 in Table S2, e.g., “I found that experience interesting”). The mean of items for each component served as the index for that aspect of the illusion. We conducted additional exploratory correlation analyses to examine if, in addition to embodiment, SCC was associated with other aspects of the body-swap experience.

Results of the correlation analyses are presented in Table S4. Consistent with Study 1, SCC was significantly negatively related to the ownership aspect of embodiment indicating that low SCC individuals had a stronger impression that the confederate’s body belonged to them. SCC was also significantly negatively related to agency suggesting that people with low SCC were more likely to feel as though they had control over the confederate’s body. Although body ownership is necessary for feelings of agency (there can be no authorship of movement without owning a body), research also shows that feelings of agency enhance feelings of ownership (Tsakiris et al., 2007). This latter observation may account for the stronger association between SCC and body ownership in Study 2 ( $b = -0.34$ ) compared to Study 1 ( $b = -0.48$ ). Taken together, these results suggest that low SCC individuals have more malleable body ownership and agency, two fundamental aspects of the bodily self (Gallagher, 2000).

Interestingly, SCC was also related to the loss of own body component. This suggests that, in addition to being more susceptible to experiencing changes in feelings about the confederate’s body (i.e., body ownership and agency aspects), low SCC individuals were also more prone to changes in feelings about their own body. In fact, this result suggests that, for low

SCC people, the confederate's body did not simply become incorporated into their own body, but instead displaced their own body in some sense. Finally, SCC was associated with movement scores suggesting that individuals with a less clear sense of self are more likely to perceive the two bodies as moving towards each other. This is consistent with the observation that individuals that experience a stronger subjective embodiment of the prosthetic hand in the RHI also experience a "proprioceptive drift"—participants tend to misperceive the felt location of their own hand toward the prosthetic hand (Longo et al., 2008).

### *Discussion*

In sum, our results suggest that the association between SCC and embodiment is driven by body ownership and, in Study 2, agency. In Study 1, we observed that low SCC individuals were more susceptible to feelings of ownership over the prosthetic hand following asynchronous stroking. In Study 2, this effect was conceptually replicated with low SCC people being more susceptible to feelings of ownership over the confederate's body. In addition, low SCC was also associated with increased feelings of agency during the body-swap illusion. These findings imply that a more flexible sense of body ownership and sense of agency, two critical aspects structuring the bodily self (Gallagher, 2000), underpin low SCC people's more malleable bodily self.

Of note, although low SCC individuals were more likely to experience feelings of agency in the body-swap illusion in Study 2, in Study 1, there was no association between SCC and agency over the prosthetic hand in the asynchronous condition. This pattern of results makes sense given the paradigms of these two bodily illusions and the underlying processes thought to give rise to the sense of body ownership versus the sense of agency. As explained in the main text, multisensory integration processes are sufficient to induce a sense of body ownership (Ehrsson, 2012; Kilteni, Maselli, Kording, & Slater, 2015); however, the sense of agency is

dependent on a match between the expected sensory consequences of an action and the actual sensory consequences of an action (Frith, Blakemore, & Wolpert, 2000) and/or a match between the intention to act and the perception of action goals (Wegner, Sparrow, & Winerman, 2004). In other words, feelings of agency rely on action whereas feelings of body ownership do not. Thus, in Study 1, it follows that SCC was unrelated to feelings of control over the prosthetic hand given that the participant's hand and the prosthetic hand remained immobile. By contrast, in Study 2, because the body-swap illusion relies, at least in part, on the matching of movements between the participant and confederate, it is not surprising that SCC was associated with perceptions of control over the confederate's body (i.e., sense of agency). Moreover, these results are consistent with work showing that the sense of body ownership and the sense of agency are dissociable aspects of the bodily self (Kalckert & Ehrsson, 2012).

Table S1. Descriptive statistics for Rubber Hand Illusion Embodiment Questionnaire items.

Item (“It seemed like...”)	Synchronous			Asynchronous		
	Median	Mean	SD	Median	Mean	SD
1. I was looking directly at my own hand, rather than at a rubber hand. (O)	5	3.79	2.28	2	2.73	1.89
2. The rubber hand was part of my body. (O)	5	4.04	2.07	2	2.61	1.58
3. the rubber hand belonged to me. (O)	5	3.99	1.99	2	2.49	1.58
4. the rubber hand was my hand. (O)	5	4.10	2.14	2	2.43	1.68
5. the rubber hand began to resemble my real hand. (O)	5	4.68	1.84	3	3.25	1.75
6. my hand was in the location where the rubber hand was. (L)	4	3.81	1.96	2	2.85	1.67
7. the rubber hand was in the location where my hand was. (L)	3	3.39	1.98	2	2.50	1.53
8. the touch I felt was caused by the paintbrush touching the rubber hand (L).	5	4.15	2.08	2	2.64	1.79
9. I could have moved the rubber hand if I had wanted. (A)	3	3.19	1.93	2	2.28	1.53
10. I was in control of the rubber hand. (A)	3	2.93	1.84	2	1.98	1.21

Note: O = Ownership item; L = Location item; A = Agency item

Table S2. Descriptive statistics for Body-Swap Embodiment Questionnaire items.

Item (“It seemed like...”)	Longo et al. (2008) Dimension	Median	Mean	SD
1. I was looking directly at my own body, rather than at someone else’s body.	Embodiment (Ownership)	5	4.09	1.71
2. The body I saw began to resemble my real body.	Embodiment (Ownership)	5	4.41	1.67
3. The body I saw belonged to me.	Embodiment (Ownership)	5	4.21	1.49
4. The body I saw was my body.	Embodiment (Ownership)	4	4.06	1.52
5. The body parts I saw were part of my body.	Embodiment (Ownership)	5	4.94	1.28
6. My body was in the location where the body I saw was.	Embodiment (Location)	5	4.85	1.74
7. The body I saw was in the location where my body was.	Embodiment (Location)	5	5.00	1.71
8. The touch I felt was caused by the objects touching the body I saw.	Embodiment (Location)	5	4.32	1.65
9. I could have moved the body I saw if I had wanted.	Embodiment (Agency)	4	3.77	1.62
10. I was in control of the body I saw.	Embodiment (Agency)	3	3.27	1.56
11. I was unable to move my body.	Loss of own hand	2.5	2.34	1.93
12. I could have moved my body if I had wanted.	Loss of own hand	5	4.94	1.43
13. I couldn't really tell where my body was.	Loss of own hand	4	3.65	2.12
14. My body had disappeared.	Loss of own hand	2	2.74	2.18
15. My body was out of my control.	Loss of own hand	3	2.77	1.99
16. My body was moving towards the body I saw.	Movement	3	2.85	1.79
17. The body I saw was moving towards my body.	Movement	3	2.74	1.69
18. I had two bodies.	Movement	1.5	2.32	2.21
19. I found that experience enjoyable.	Affect	6	5.41	1.31
20. I found that experience interesting.	Affect	7	6.53	0.75
21. The touch of the objects in my hands was pleasant.	Affect	5	5.12	1.27

Table S3. Scale psychometrics and correlation analyses between self-concept clarity and embodiment sub-components in the asynchronous condition of the rubber hand illusion in Study 1.

<b>Subscale</b>	<b><math>\omega</math></b>	<b><math>r</math></b>	<b><math>p</math></b>
embodiment	0.93	<b>-.24</b>	<b>0.023</b>
ownership	0.94	<b>-.28</b>	<b>0.013</b>
location	0.77	-0.22	0.055
agency	0.78	<b>-.10</b>	<b>0.401</b>

Table S4. Scale psychometrics and correlation analyses between self-concept clarity and each Body-Swap Embodiment Questionnaire subscale in Study 2.

<b>Subscale</b>	<b><math>\omega</math></b>	<b><math>r</math></b>	<b>p-value</b>
embodiment	0.91	<b>-.472</b>	<b>0.005</b>
ownership	0.96	<b>-.436</b>	<b>0.010</b>
location	0.99	-.192	0.275
agency	0.98	<b>-.460</b>	<b>0.006</b>
loss	0.95	<b>-.534</b>	<b>0.001</b>
movement	0.99	<b>-.496</b>	<b>0.003</b>
affect	0.94	-.260	0.138

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