Multisensory Research

The Redundant Signals Effect and the Full Body Illusion: Not Multisensory, But Unisensory Tactile Stimuli are Affected by the Illusion

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Supplementary material

Table S1.

Counterbalancing order that was used in the experiment. Rec. indicates the order in which the videos for the control condition were recorded. S stands for shoulder, U stands for underarm. To be able to present the opposite stimulation in the control condition, the underarm was always stimulated in the order tapping–stroking and the shoulder was always stimulated in the order stroking–tapping. *Seen* indicates where the stimulation was visible to participants. *Felt* indicates where the stroking could be felt by participants. In orders 1–4 the tactile stimulation presented to participants was kept constant across conditions. In orders 5–8 the visual stimulation was kept constant across conditions.

Order	Rec.	Cond.	Induction		Block 1		Block 2		Block 3		Block 4		Participant
			Seen	Felt	Seen	Felt	Seen	Felt	Seen	Felt	Seen	Felt	
1	1: S–U 2: U–S	Sync Async	U–S S–U	U–S U–S	S–U U–S	S–U S–U	U–S S–U	U–S U–S	S–U U–S	S–U U–S	U–S S–U	U–S U–S	1, 9, 17
2	1: U–S 2: S–U	Sync Async	S–U U–S	S–U S–U	U–S S–U	U–S U–S	S–U U–S	S–U U–S	U–S U–S	U–S U–S	S–U U–S	S–U U–S	2, 10, 18
3	1: S–U 2: U–S	Async Sync	S–U U–S	U–S U–S	U–S S–U	S–U U–S	S–U U–S	U–S U–S	U–S S–U	S–U S–U	S–U U–S	U–S U–S	3, 11, 19
4	1: U–S 2: S–U	Async Sync	U–S S–U	S–U S–U	S–U U–S	U–S U–S	U–S S–U	S–U S–U	S–U U–S	U–S U–S	U–S S–U	S–U S–U	4, 12, 20
5	1: S–U	Sync Async	S–U	S–U	U–S	U–S	S–U	S–U	U–S	U–S	S–U	S–U	5, 13, 21

	2: U–S		S–U	U–S	U–S	S–U	S–U	U–S	U–S	S–U	S–U	U–S	
6	1: U–S	Sync	U–S	U–S	S–U	S–U	U–S	U–S	S–U	S–U	U–S	U–S	6, 14, 22
		Async	U–S	S–U	S–U	U–S	U–S	S–U	S–U	U–S	U–S	S–U	
	2: S–U												
7	1: S–U	Async	S–U	U–S	U–S	S–U	S–U	U–S	U–S	S–U	S–U	U–S	7, 15, 23
		Sync	S–U	S–U	U–S	U–S	S–U	S–U	U–S	U–S	S–U	S–U	
	2: U–S												
8	1: U–S	Asyn c	U–S	S–U	S–U	U–S	U–S	S–U	S–U	U–S	U–S	S–U	8, 16, 24
		Sync	U–S	U–S	S–U	S–U	U–S	U–S	S–U	S–U	U–S	U–S	
	2: S–U												

Measuring race model violation relative to unisensory responses

Following Couth *et al.* (2018), we investigated whether the unexpected race model violation in the asynchronous condition could be ascribed to a relative larger ‘room for improvement’ due to the unisensory processing speed. That is, if participants respond more slowly to the unisensory stimuli the threshold (bound) against which the multisensory stimuli are compared is artificially reduced. For each participant we selected the fastest unisensory response (visual or tactile) in each condition and used those to calculate group means for each condition. Paired-sample *t*-tests were conducted to compare the fastest unisensory response between conditions. In addition, we conducted a correlation analysis between the fastest mean unisensory response and the amount of race model violation in the asynchronous condition.

The results indicate that the fastest unisensory response did not differ significantly between the synchronous (M = 265.13, SD = 57.66) and the asynchronous condition (M = 258.67, SD = 59.12), $t_{23} = -0.81$, $p = 0.427$. We also did not obtain a significant correlation between the fastest unisensory response and the amount of race model violation in the asynchronous condition, $r = 0.06$, $p = 0.791$. These findings suggest that the slower responses to unisensory stimuli in the asynchronous condition (driven by slow responses to the tactile stimuli in our experiment) do not provide a likely explanation for the unexpected race model violation in that condition.

RT variance on unisensory tactile stimuli

In the general discussion we speculate that the relative slowing of reaction times to unisensory tactile stimuli in the asynchronous condition may be attributed to attention having to switch from the virtual body to the real body in the asynchronous condition. We assumed that participants' attention in both conditions was primarily directed at the virtual body because they were instructed to pay attention to the visual stroking and tapping during the RSE task. A logical consequence of this is that RTs may be expected to vary more for the unisensory tactile stimuli in the asynchronous condition than in the synchronous condition. On the group level, the variance of the RTs was indeed larger in the asynchronous (17,547) compared to the synchronous condition (13,971) for unisensory tactile stimuli. A paired-samples t-test to compare the individual variances for each condition showed a trend towards significance, $t_{23} = -1.93$, $p = 0.066$. For unisensory visual stimuli the variances were somewhat larger in the synchronous (12,246) than in the asynchronous condition (10,813). This difference was not significant, $t_{23} = 1.44$, $p = 0.164$. Taken together, this demonstrates that participants are attending the virtual body but show a delay for the tactile stimuli that are

presented to the real body in the asynchronous condition, resulting in larger variances for these stimuli.

Correlating illusion strength with the unisensory tactile effect

To investigate whether the unisensory tactile effect was directly associated with the subjective experience of having the illusion, we correlated various subjective indices of the illusion with the reaction time difference score between the two conditions on the unisensory tactile effect. The indices that we used were: the difference score between the two conditions on the mean illusion score (S1–S3), the mean illusion score (S1–S3) in the synchronous and asynchronous condition, the difference score between the two conditions on S1, the score on S1 in the synchronous and asynchronous condition, the score on S6 in the synchronous and asynchronous condition and the score on S8 in the synchronous and asynchronous condition. S1, S6 and S8 were chosen as indices of the illusion as they all tap into the amount of transfer of touch that was experienced to the virtual body, which we consider to be relevant for the unisensory tactile effect as it may determine the amount of switching between the virtual and the real body. S7 was not used because the scores on this statement are complementary to scores on S8. As can be seen in Table S2, we did not find any significant correlations between the subjective indices of the illusion and the unisensory tactile effect.

Table S2.

Correlations between subjective indices of the illusion and the unisensory tactile effect obtained on the speeded detection task.

	S1–S3_diff	S1–S3_s	S1–S3_a	S1_diff	S1_s	S1_a	S6_s	S6_a	S8_s	S8_a
Unitac_diff	−0.25	−.024	0.01	−0.25	−0.27	0.07	−0.17	0.19	−0.18	0.16
p	0.234	0.258	0.970	0.234	0.195	0.743	0.425	0.371	0.410	0.470

S1–S3 reflects the average score of illusion statements S1, S2 and S3. S1, S6 and S8 reflect the respective illusion statements. The addition ‘diff’ indicates that a differences score was calculated between the synchronous and asynchronous condition for a certain item. The addition ‘s’ stands for the synchronous condition and the addition ‘a’ stands for the asynchronous condition.

Reference

Couth, S., Gowen, E., and Poliakoff, E. (2018). Using race model violation to explore multisensory responses in older adults: enhanced multisensory integration or slower unisensory processing? *Multisens. Res.*, **31**, 151–174. https://doi.org/https://doi.org/10.1163/22134808-00002588