

Reference

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Differential experiences of embodiment between body-powered and myoelectric prosthesis users

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Products

bebionic

- Major Findings
- With myoelectric (e.g. bebionic) compared to body-powered prosthetics:
- **Prosthesis embodiment (the perception of a prosthesis as a part of one's body) did not differ significantly between myoelectric and body-powered prostheses**

→ **Stronger embodiment for users with acquired limb loss compared to users with congenital limb absence, as measured by limb estimation tasks**

→ **Stronger embodiment was associated with greater daily prosthesis wear time**

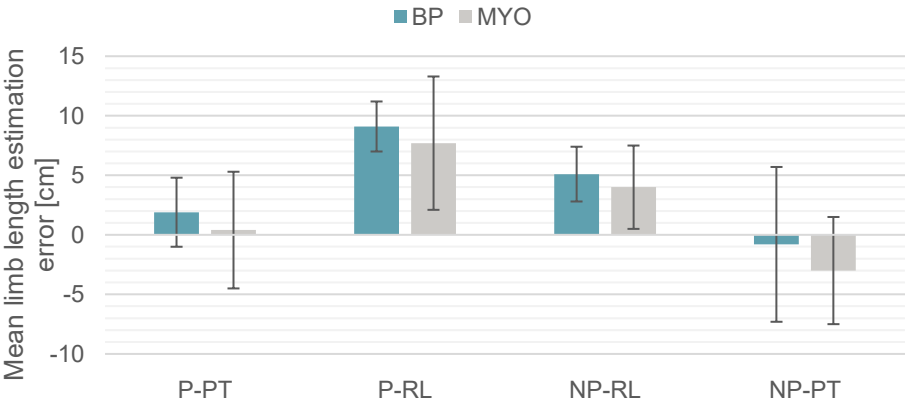
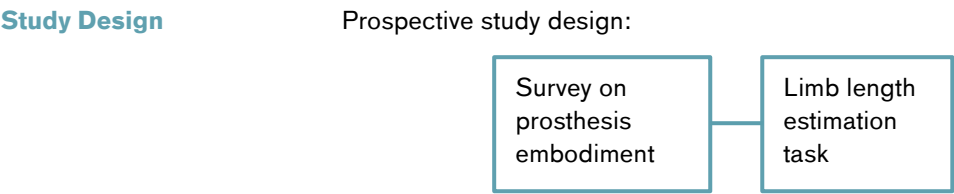


Figure 1. Mean limb length estimation error [cm] for myoelectric (MYO) and body powered prosthetics (BP) for the conditions: (P-PT) wearing prosthesis; locate prosthesis tip, (P-RL) wearing prosthesis; locate residual limb, (NP-RL) no prosthesis, locate residual limb, (NP-PT) no prosthesis, locate prosthesis tip (see details below)

Population

Subjects:	n = 9 (5 male, 4 female), healthy control (9)
Amputation / Absence level:	unilateral transradial
Previous prosthetics:	myoelectric: bebionic (2), single DoF hand (1) body-powered: voluntary-open hook (3) myoelectric and body-powered: iLimb & voluntary-open hook (2), single DoF hand & voluntary-close hook (1)
Amputation causes:	congenital (3), acquired (6)
Mean age:	48 ± 15.3 years
MFCL:	n.a.



Participants first answered a survey on the embodiment of the prosthesis (i.e., ownership of the prosthesis).

The second part of the study contained a limb length estimation. Therefore, one arm was placed in an opaque tube while blindfolded, and participants indicated the perceived position of the limb's end. Prosthesis users completed the task under following conditions: end of dominant (control) or intact (patients) limb, end of prosthesis and residual limb, respectively, while wearing prosthesis (P-PT and P-RL) and end of prosthesis and residual limb, respectively, without wearing their prostheses (NP-PT and NP-RL).

Results

Body Function		Activity			Participation	Others	
Mechanics	Pain	Grip patterns / force	Manual dexterity	Activities of daily living (ADL)	Satisfaction and Quality of life (QoL)	Training	Technical aspect

Category	Outcomes	Results for MYO vs. BP ^a	Sig.*															
Satisfaction and Quality of life (QoL)	Ownership scores	Comparable score between MYO and BP in experiencing the prosthesis as part of the body.	0															
	Agency	No significant difference between MYO and BP in feeling control over movement of the prosthesis, but the scores tended to be higher in BP users.	0															
		Agency was significantly positively correlated with residual limb length estimation error while not wearing a prosthesis.	++															
	Limb length estimation error (cm)	Estimation was similar for:	0															
		<table><tr><th></th><th>Mean ± SD</th></tr><tr><td>Dominant limb (control group)</td><td>-1.3 ± 2.0</td></tr><tr><td>Intact limb (prosthesis user)</td><td>-1.9 ± 2.1</td></tr></table>		Mean ± SD	Dominant limb (control group)	-1.3 ± 2.0	Intact limb (prosthesis user)	-1.9 ± 2.1										
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Dominant limb (control group)	-1.3 ± 2.0																	
Intact limb (prosthesis user)	-1.9 ± 2.1																	
	No significant differences observed between prosthesis types:																	
		<table><tr><th></th><th>BP (mean ± SD)</th><th>MYO (mean ± SD)</th></tr><tr><td>P-RL ^b</td><td>9.1 ± 2.1</td><td>7.7 ± 5.6</td></tr><tr><td>NP-RL ^b</td><td>5.1 ± 2.3</td><td>4.0 ± 3.5</td></tr><tr><td>P-PT ^b</td><td>1.9 ± 2.9</td><td>-0.4 ± 4.9</td></tr><tr><td>NP-PT ^b</td><td>-0.8 ± 6.5</td><td>-3.0 ± 4.5</td></tr></table>		BP (mean ± SD)	MYO (mean ± SD)	P-RL ^b	9.1 ± 2.1	7.7 ± 5.6	NP-RL ^b	5.1 ± 2.3	4.0 ± 3.5	P-PT ^b	1.9 ± 2.9	-0.4 ± 4.9	NP-PT ^b	-0.8 ± 6.5	-3.0 ± 4.5	
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	Differences between acquired and congenital limb absence were observed with large effect sizes (Hedges' g = 0.97-2.25):		n.a.															
	- residual limb length while wearing their prosthesis: participants with acquired limb loss overestimated more than the ones with congenital absence. - residual limb length when not wearing prosthesis: participants with acquired limb loss overestimated while with congenital limb absence estimated accurately. - prosthesis length when wearing the prosthesis: underestimation in congenital limb absence while tendency to overestimation in acquired limb loss.																	

Category	Outcomes	Results for MYO vs. BP ^a	Sig.*															
		- prosthesis length when not wearing the prosthesis: underestimation in both but less in congenital limb absence than in acquired limb loss.																
		<table><tr><th></th><th>Congenital (mean ± SD)</th><th>Acquired (mean ± SD)</th></tr><tr><td>P-RL ^b</td><td>4.4 ± 5.1</td><td>9.8 ± 2.8</td></tr><tr><td>NP-RL ^b</td><td>0.9 ± 0.9</td><td>5.7 ± 2.2</td></tr><tr><td>P-PT ^b</td><td>-4.4 ± 2.9</td><td>2.4 ± 2.6</td></tr><tr><td>NP-PT ^b</td><td>-6.0 ± 4.6</td><td>-0.6 ± 5.2</td></tr></table>		Congenital (mean ± SD)	Acquired (mean ± SD)	P-RL ^b	4.4 ± 5.1	9.8 ± 2.8	NP-RL ^b	0.9 ± 0.9	5.7 ± 2.2	P-PT ^b	-4.4 ± 2.9	2.4 ± 2.6	NP-PT ^b	-6.0 ± 4.6	-0.6 ± 5.2	
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Daily prosthesis wear (hours)	Significant positive correlation between hours of daily prosthesis use, and: - prosthesis length estimation error without wearing of prosthesis (NP-PT) - residual limb length estimation error without wearing of prosthesis (NP-RL) - agency	++ ++ ++																

* no difference (0), positive trend (+), negative trend (–), significant (++/–), not applicable (n.a.)
significance set at $p < 0.05$; trends set at $0.1 > p > 0.05$

^a MYO: myoelectric prosthesis, BP: body-powered prosthesis

^b P: with prosthesis, NP: without prosthesis, PT: tip of prosthesis, RL: residual limb

Author's Conclusion

"In conclusion, this study demonstrated that the experience of prosthesis embodiment is minimally affected by the type of prosthesis that is worn. Instead, it appears that the cause of limb absence and the amount of daily prosthesis wear may play a more substantial role. Future work should explore the relationship between embodiment and a wider variety of patient-specific characteristics to better understand how prosthesis users learn to perceive, or could be trained to perceive, their prosthesis as part of their body. Ultimately, this information may contribute to an improved understanding of how individuals become functionally successful with a prosthesis." (Engdahl et al. 2020)

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