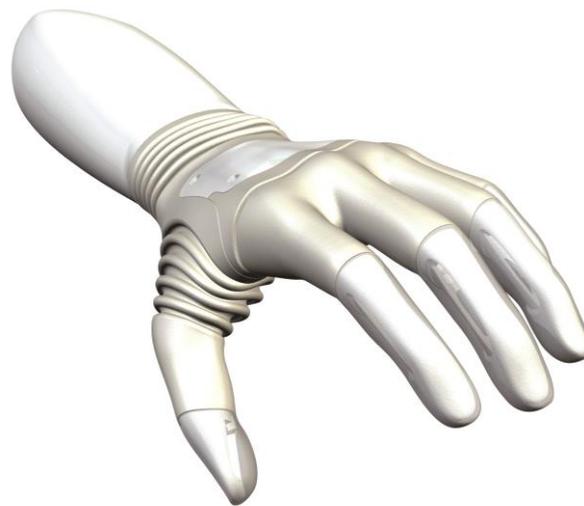


Training with upper extremity prostheses



Quality for life

Clinical Study Summaries

This document summarizes clinical studies researching the training with upper extremity prostheses. The included studies were identified by a literature search made on PubMed and within the journals Der Orthopäde, JPO Journal of Prosthetics and Orthotics, Orthopädie-Technik and Technology & Innovation.

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1 Overview table

The summaries are organized in three levels depending on the detail of information. The overview table (Level 1) lists all the relevant publications dealing with a particular product (topic) as well as researched categories (e.g. level walking, safety, activities, etc). Summaries of all the literature researching a specific question can be found in chapter 2 (Level 2).

For those interested to learn more about individual studies, a summary of the study can be obtained by clicking on the relevant reference (Level 3).

Reference		Category								Prosthesis	Target group
		Body Functions		Activity		Participa- tion	Others				
Author	Year	Mechanics	Pain	Grip pat- terns Force	Manual dexterity	ADL	Satisfac- tion QoL	Training	Technical aspects		
<u>Bouwsema</u>	2014							x		Myoelectric simulator – MyoHand VariPlus Speed	able-bodied participants
<u>Bouwsema</u>	2014							x		Myoelectric simulator – MyoHand VariPlus Speed	able-bodied participants
<u>Romkema</u>	2013							x		PAULA software connected to MyoBoy	able-bodied participants
<u>Bouwsema</u>	2012	x		x						Dynamic Mode Control hands, Digital hands, Motion control	amputees
<u>Bouwsema</u>	2010							x		Virtual hand – PAULA, Myoelectric simulator, Table-top hand	able-bodied participants
<u>Bouwsema</u>	2010	x								Mechanical elbow, Myoelectric prostheses, Digital Twin hands	amputees
<u>Bouwsema</u>	2008							x		Body-powered and Myoelectric simulator	able-bodied participants
Total number		2		1				5			

2 Summary

On the following pages you find a summary of all studies that researched the training methods with upper extremity prostheses. At the end you will find a list of reference studies contributing to the content of the summary.

Evidence-based training aspects for myoelectric prosthesis

Major Findings

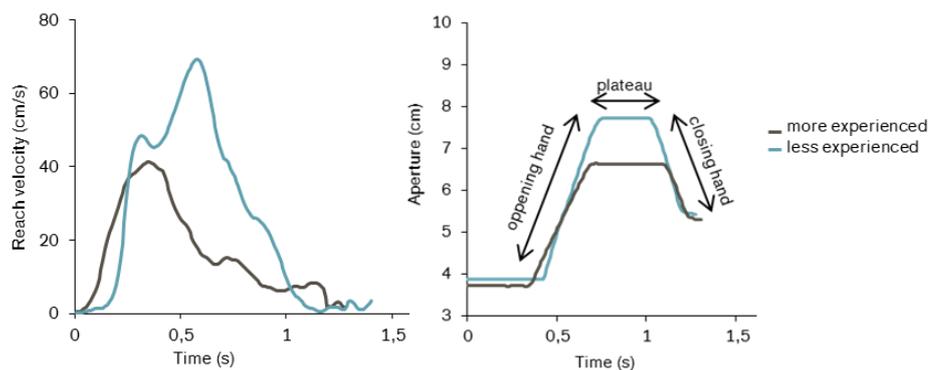
Pre-prosthetic training:

- **The pre-prosthetic training should start immediately after the amputation when the client is medically stable.**
- **Train the stump musculature.**

Prosthetic training:

- **Focus on timing between hand opening and hand closing, pay attention to simultaneously end reach and start grasp.**
- **Learn how to grasp an object first by handing it over from the unaffected hand to the prosthetic hand (indirect grasping), then proceed with tasks where an object is grasped directly with the prosthetic hand. Finally do fixing tasks (buttoning and unbuttoning, tying the shoelaces).**
- **Oral feedback should be always provided for motor learning tasks; for cognitive tasks it should be kept to the minimum.**

Reaching and grasping an object



In the following figure the reach (left) and the grasp (right) of an object performed by experienced (gray) and less experienced (blue) prosthetic users are shown. More experienced users need less time to reach the object and plateau phase (time between opening and closing the hand when grasping an object) is shorter (Bouwsema et al., 2012).

Clinical Relevance

Twenty to forty percent of the people with an arm amputation do not use any prosthesis in daily living. To increase the use of prosthesis it is important to have a good training, with skills learned in the clinic that can be applied at home after the rehabilitation. Rehabilitation centres often use protocols which are based on clinical experiences (best clinical practice). Up to now the most efficient way of training is still not known, and the demand for a scientifically based training is becoming larger.

The pre-prosthetic training:

The pre-prosthetic training should start immediately after the amputation when the amputee is medically stable. The goal is to prepare the patient for use of the prosthesis and ultimately to increase its acceptance.

1. Training advice - Train the stump musculature: Training can be executed in several ways, such as training with a practice hand, a prosthetic simulator, or virtual on a screen. For the overall performance it does not matter in which of these ways are used for training. An example of a commercially available virtual system is the Prosthetics Assistant of Upper Limb Architecture® (PAULA) of Otto Bock, in combination with the MyoBoy®.

Result - Training the stump musculature will result in a good independent control of the myoelectric signals and will accelerate the learning process.

The prosthetic training:

1. Training advice – Reduce the plateau phase: Focus on timing between hand opening and hand closing, pay attention to simultaneously end reach and start grasp.

Result - Movements with the prosthesis will be faster and more fluent with shorter plateau phase.

2. Training advice – Train grasping an object: It is important to start with **indirect grasping**. By handing over an object from the unaffected hand to the prosthetic hand, the client can retrieve information on the properties of the object, such as compressibility. In addition, the object can be positioned and grasped more easily with the prosthetic hand.

Proceed to **direct grasping** with the prosthetic hand. Besides the correct closing, the user needs to pay close attention to the correct positioning of the prosthetic hand with regards to the object as well.

Finally do **fixating** tasks (buttoning and unbuttoning, tying the shoelaces...).

Train with objects of different textures, compressibility and stiffness. Practice grasping objects without pressing them, and train varying degrees of compression.

Result – General positioning and gross motor control are learned quickly, but fine control such as grip force requires more time. A good control of grip force is needed in everyday life in order to handle objects correctly without breaking an object.

3. Training advice – Always provide feedback for motor learning: visual feedback on screen, auditory feedback with sounds, vibrotactile feedback, or verbal feedback.

Provide a feedback on the end result of the movement: Specify how an object is compressed rather than to indicate that the hand squeezed too hard. The emphasis is on the object (environment) rather than the body itself.

For cognitive tasks keep feedback to the minimum: In a virtual game the described training aspects can be applied easily. Here giving less feedback is more beneficial since it gives a patient opportunity to learn while performing a task.

Result – Patient will be more motivated and confident.

4. Training advice – The user should decrease gaze behaviour: Train basic control signals, reaching, and grasping with the prosthesis by looking at a fixed point in the peripheral field of view instead of directly looking at the hand. Train without visual information by letting the client look away during the exercise.

Result– The majority of sensory information such as proprioception and tactile information relevant to object manipulation is lost in prosthesis use. Only visual information is still available. Therefore prosthesis users rather look at the prosthetic hand, then in object to be grasped or manipulated, while performing actions. The less a prosthetic hand is looked at, the better the overall performance of the prosthesis user. At the start of the rehabilitation, a patient is expected to look a lot at the hand, and the amount of time will reduce when the user gains more proficient control over the prosthesis.

References of summarized studies

- Bouwsema, H., Kyberd, P. J., Hill, W., van der Sluis, C. K., & Bongers, R. M. (2012). Determining skill level in myoelectric prosthesis use with multiple outcome measures. *The Journal of Rehabilitation Research and Development*, 49(9), 1331–1348.
- Bouwsema, H., van der Sluis, C. K., & Bongers, R. M. (2008). The Role of Order of Practice in Learning to Handle an Upper-Limb Prosthesis. *Archives of physical medicine and rehabilitation*, 89(9), 1759–1764. doi:10.1016/j.apmr.2007.12.046
- Bouwsema, H., van der Sluis, C. K., & Bongers, R. M. (2010). Learning to Control Opening and Closing a Myoelectric Hand. *Archives of physical medicine and rehabilitation*, 91(9), 1442–1446. doi:10.1016/j.apmr.2010.06.025
- Bouwsema, H., van der Sluis, C. K., & Bongers, R. M. (2010). Movement characteristics of upper extremity prostheses during basic goal-directed tasks. *Clinical Biomechanics*, 25(6), 523–529. doi:10.1016/j.clinbiomech.2010.02.011
- Bouwsema, H., van der Sluis, Corry K, & Bongers, R. M. (2014). Changes in performance over time while learning to use a myoelectric prosthesis. *Journal of neuroengineering and rehabilitation*, 11, 16. doi:10.1186/1743-0003-11-16
- Bouwsema, H., van der Sluis, Corry K, & Bongers, R. M. (2014). Effect of feedback during virtual training of grip force control with a myoelectric prosthesis. *PLoS one*, 9(5), e98301. doi:10.1371/journal.pone.0098301
- Romkema, S. B. R. M., & van der Sluis, C. K. (2013). Intermanual Transfer in Training With an Upper-Limb Myoelectric Prosthesis Simulator: A Mechanistic, Randomized, Pretest-Posttest Study. *Physical therapy*, 93(1), 22–31. doi:10.2522/ptj.20120058

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3 Summaries of individual studies

On the following pages you find summaries of studies that researched training methods with myoelectric prostheses. You find detailed information about the study design, methods applied, results and major findings of the study. At the end of each summary you also can read the original study authors' conclusions.

Reference

Bouwsema H, van der Sluis C, Bongers R

University of Groningen, University Medical Center Groningen, Center for Human Movement Sciences, Groningen

Changes in performance over time while learning to use a myoelectric prosthesis

Journal of NeuroEngineering and Rehabilitation 2014, 11:16.

Products

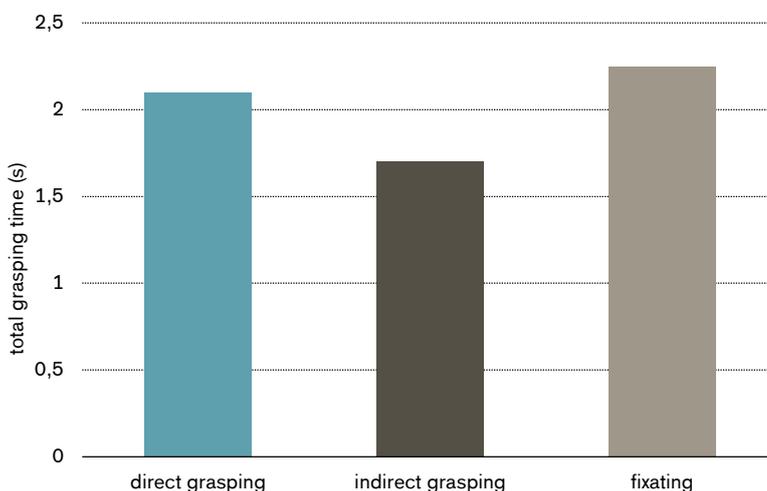
Myoelectric simulator - MyoHand VariPlus Speed

Major Findings

For different types of practice:

- **A training program should spend more time on learning fine control aspects such as grip force control**
- **Training should start with the indirect grasping tasks (handing over an object from the unaffected hand to the prosthetic hand)**
- **Patients should train in a blocked repeated fashion**

Time needed to grasp a low resistance objects



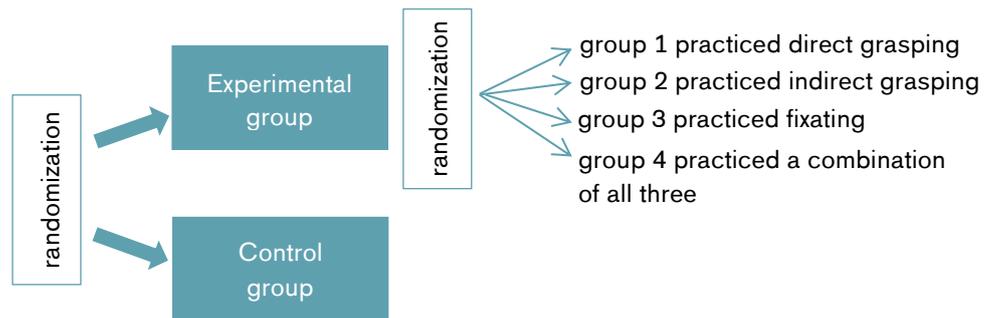
Participant needed the shortest amount of time to hand over an object from the unaffected hand to the prosthetic hand (indirect grasping) than to directly grasp an object or to fix it (e.g. unbutton and buttoning).

Population

Subjects:	62 healthy, able-bodied participants
Previous:	none
Amputation causes:	none
Mean age:	21 ± 2 years
Mean time since amputation:	none

Study Design

A randomized study:



Participants in the experimental condition, randomly assigned to one of four groups, practiced with a myoelectric simulator for five sessions in a two-week period. Group 1 practiced direct grasping, Group 2 practiced indirect grasping, Group 3 practiced fixating, and Group 4 practiced a combination of all three tasks. The Southampton Hand Assessment Procedure (SHAP) was assessed in a pretest, posttest, and two retention tests. Participants in the control condition performed SHAP two times, two weeks apart with no practice in between.

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 different types of practice	Sig.*
Training	Southampton Hand Assessment Procedure (SHAP)	The experimental groups improved more on SHAP than the control group.	++
	Compression during grasping	The indirect grasping group had the smallest object compression.	++
	Grasping time	The indirect grasping group had the smallest grasping time.	++

* no difference (0), positive trend (+), negative trend (-), significant (++/--), not applicable (n.a.)

Author's Conclusion

"Learning processes were examined in participants that learned to use a prosthetic simulator in different goal directed tasks. Results showed that grasping force control took longer to learn than positioning of the prosthesis and that indirect grasping was beneficial for controlling the grip force. Practicing different tasks improved grasping control to the same level than training just grasping while the number of grasping trials in practice were less. Improvement in performance lasted even after a period of non-use. Suggestions for clinical practice are to focus specifically on grip force control of the hand, to start to train with an indirect grasping task, and to train in a blocked-repeated fashion." (Bouwsema et al. 2014)

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Reference

Bouwsema H, van der Sluis C, Bongers R

University of Groningen, University Medical Center Groningen, Center for Human Movement Sciences, Groningen

Effect of Feedback during Virtual Training of Grip Force Control with a Myoelectric Prosthesis

PLoS ONE 9(5): e98301

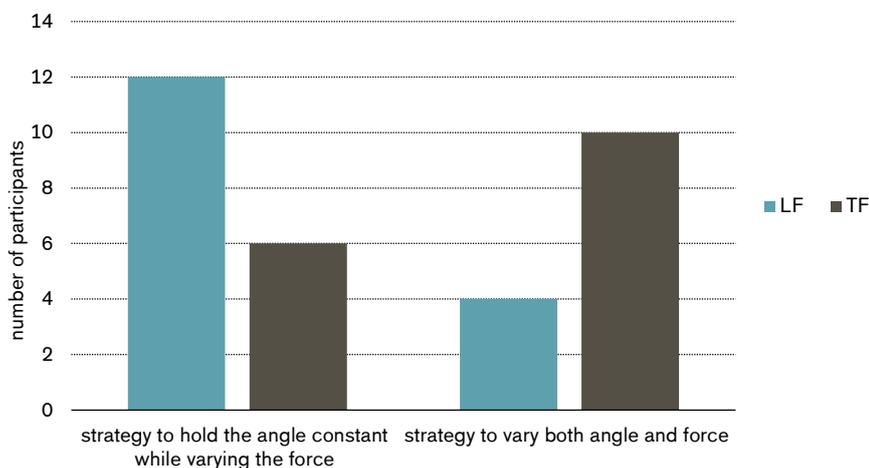
Products**Myoelectric simulator - MyoHand VariPlus Speed**

Major Findings

When different types of feedback were compared:

→ Feedback during training is important**→ When performing cognitive tasks keep oral feedback to the minimum**

Strategy while performing virtual gaming in groups receiving less (LF) and more feedback (TF)



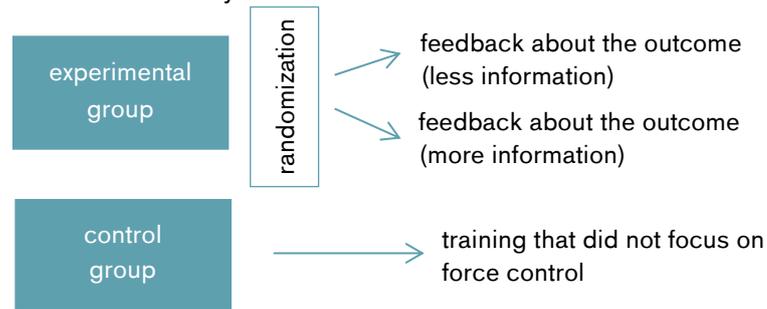
Able-bodied participants were provided with a prosthetic stimulator and asked to play a virtual ball throwing game. By grasping and controlling the handle with the prosthetic simulator, their task was to throw a ball with a certain angle and velocity into a target. One strategy was to hold the angle constant while varying the force (12 participants whom less oral feedback was given (LF) and 6 participants whom more feedback was given (TF)); the other strategy was to vary both angle and force (4 participants with LF and 10 participants with TF). Group which received fewer oral feedback had faster transfer of the learned skills into real life tasks.

Population

Subjects: 48 healthy, able-bodied participants
Previous: none
Amputation causes: none
Mean age: 21 ± 3 years
Mean time since amputation: none

Study Design

A randomized study:



32 able-bodied subjects were randomly assigned to either a group that received feedback about the outcome—the landing position of the ball (LF)—or feedback about the movement execution—the applied parameters angle and force, and the trajectory of the ball (TF). Thirty-two able-bodied participants trained grip force with a virtual ball-throwing game for five sessions in a two-week period, using a myoelectric simulator. Another sixteen able-bodied participants received training that did not focus on force control.

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 different types of feedback	Sig.*
Training	Virtual training	Number of errors decreased over time	n.a.
	Influence of feedback on performance	No main effect of feedback was seen during training.	0
		The type of feedback provided during training influenced the transfer of the learned grip force control to the tests. Movement outcome (LF) enhanced transfer of the learned skill more than feedback on movement execution (TF).	+
Grip force control	In experimental group transfer of learning occurred from this virtual training to a real life task.	+	

* no difference (0), positive trend (+), negative trend (–), significant (++/--), not applicable (n.a.)

Author's Conclusion

"Performance increased during virtual training of force control with a prosthetic simulator, reflected in a reduction in error. Using the TNC approach, variability was shown to decrease mainly as a result of the reduction of N-cost and a good covariation between the used force and angle during training. Grip force control improved only in the test-tasks that provided information on the performance. Starting the training with a task that required low force production decreased transfer of the learned grip force. Whereas feedback on movement execution was detrimental, feedback on the movement outcome enhanced transfer of the grip force to other tasks than trained." (Bouwsema et al. 2014)

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Reference

Romkema S, Bongers R, van der Sluis C

Department of Rehabilitation Medicine, University Medical Center Groningen, University of Groningen

Intermanual Transfer in Training with an Upper-Limb Myoelectric Prosthesis Simulator: A Mechanistic, Randomized, Pretest-Posttest Study

Physical Therapy 2013; 93:22-31

Products

Prosthetics simulator – PAULA software connected to MyoBoy

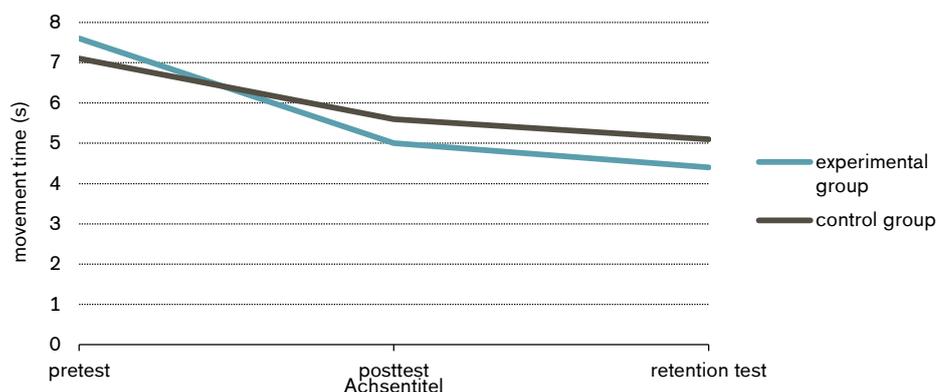
Major Findings

Prosthesis' control was compared between groups with and without previous training:

→ **Training with prosthesis simulator enables faster handling of the prosthesis**

→ **Intermanual transfer effects were present after training with a myoelectric prosthesis simulator**

Movement time for all tasks



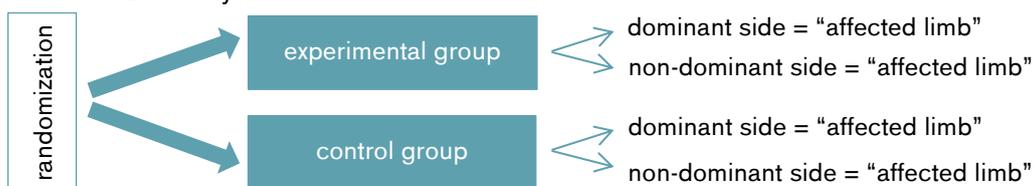
To determine the improvement in skill, a test was administered before (pretest), immediately after (posttest) and 6 days after training (retention test) for experimental group. The control group only performed the tests without training.

Population

Subjects: 48 healthy, abled bodied participants
Previous: none
Amputation causes: none
Mean age: 24.6
Mean time since amputation: none

Study Design

A randomized study:



Experimental group performed the training with the unaffected arm, and tests were performed with the affected arm (the affected arm simulating an amputated limb). Half of the participants were tested with the dominant arm and half with the non-dominant arm.

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 with and without previous training:	Sig.*
Training	Initiation time	Time from starting signal until start of the movement was not different between groups.	0
	Movement time	Time from beginning of the movement until completion of the task was shorter in experimental group.	++
	Force control	Maximal applied force on the object did not differ between groups.	0

* no difference (0), positive trend (+), negative trend (-), significant (++/--), not applicable (n.a.)

Author's Conclusion

"Intermanual transfer effects were present after training with a myoelectric prosthesis simulator in individuals who were healthy. The initiation time did not show intermanual transfer effects, presumably because of the differences in training tasks and test tasks. The movement time showed intermanual transfer effects, whereas the force control did not. Finally, no laterality effects were found. These findings suggest that intermanual transfer might be of clinical relevance for people with an upper-limb amputation because intermanual transfer training would enable them to start prosthetic training shortly after the amputation." (Romkema et al. 2013)

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Reference

Bouwsema H, Kyberd P, Hill W, van der Sluis C, Bongers R

Center for Human Movement Sciences, University of Groningen, University Medical Center Groningen, Groningen

Determining skill level in myoelectric prosthesis use with multiple outcome measures

Journal of Rehabilitation Research & Development 2012; 49(9):1331–48

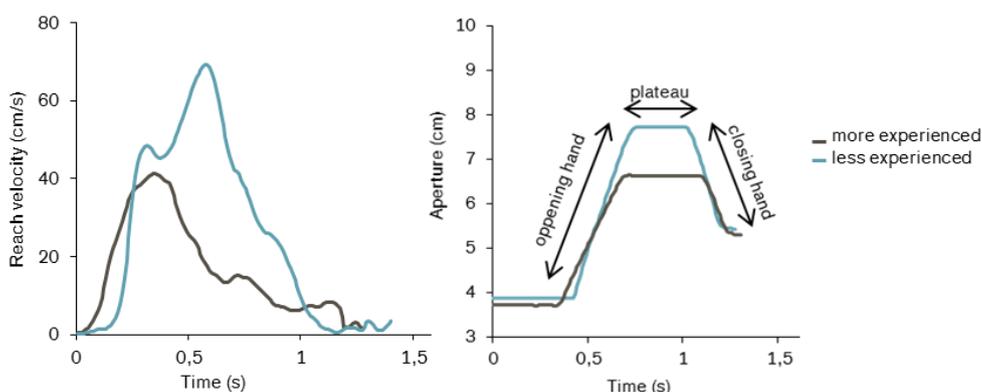
Products

Dynamic Mode Control hand, Digital hand, Motion control

Major Findings

- **Time is a key parameter when using an upper extremity prosthesis**
- **Minimizing the time needed to reach and grasp an object should be a major goal of rehabilitation**
- **More experienced prosthetic users are faster, have better grip force control and need less visual attention when using the hand**

Reaching and grasping an object



In the following figure the reach (left) and the grasp (right) of an object performed by experienced (gray) and less experienced (blue) prosthetic users are shown. More experienced users need less time to reach the object and their plateau phase (time between opening and closing the hand when grasping an object) is shorter.

Population

Subjects: 6 unilateral transradial patients
Previous: 3 Dynamic Mode Control hands, 2 Digital hands, 1 Motion control
Amputation causes: 2 congenital deformities, 3 traumas, 1 illness
Mean age: 36 ± 18 years (range 19-59 years)
Mean time since amputation: 10 ± 8 years (range 1-19 years)

Study Design

Observational (non-interventional) study:

To obtain more insight into how the skill level of an upper-limb myoelectric prosthesis user was composed, the study aimed to portray prosthetic handling at different levels of description, relate results of the clinical level to kinematic measures, and identify specific parameters in these measures that characterize the skill level of a prosthesis user. Six experienced transradial myoelectric prosthesis users performed a clinical test (Southampton Hand Assessment Procedure [SHAP]) and two grasping tasks. Kinematic measures were end point kinematics, joint angles, grasp force control, and gaze behaviour.

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 more and less experienced prosthetic users	Sig.*
Grip patterns /force	Southampton Hand Assessment Procedure (SHAP)	The highest scores were obtained in the spherical grip, whereas the participants scored the lowest on the tip grip. Patients who had better scores on SHAP showed overall better performance on kinematic measurements.	+
Mechanics	End point kinematics	More experienced prosthetics users are reaching the object faster with shorter plateau phase between reaching and grasping an object and they need less time to execute the task.	+
	Joint angles	The movement patterns were rather similar for all participants, except for the variation in the amount of shoulder abduction (more shoulder abduction was used to compensate for the lack of wrist movement in the prosthesis).	0
	Gaze behaviour	More experienced prosthetic users focus on the object most of the time during task execution. The less experienced ones focus on the object of interest only at the beginning of a task and on the prosthesis during the task execution.	+

* no difference (0), positive trend (+), negative trend (-), significant (++/--), not applicable (n.a.)

Author's Conclusion

"In this study, we measured prosthesis use on different levels of description using clinical and kinematic measures. This study followed and extended the suggestion to combine several outcome measures, by not only measuring on a clinical, functional level, but also on more kinematic levels. The results provided a wide range of information. The clinical test (SHAP) was a good measure of skill level of the prosthesis user, whereas the fundamental measures provided deeper insight into the performance and skill level of the prosthesis users. Participants who scored higher on the SHAP showed less deviation in end point kinematic profiles from nondisabled movement patterns, with, among other factors, shorter movement times, higher peak velocities, and shorter plateau times in the aperture. Moreover, they showed better grip force control and less visual attention to the hand. The results show that time is a key parameter in prosthesis use and should be one of the main aspects of focus in rehabilitation. The insights provided by this study are useful in rehabilitation, because they allow therapists to specifically focus on certain parameters such as plateau time or visual control, which will hopefully result in the highest level of skill that can be achieved for that prosthesis user." (Bouwsema et al. 2012)

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Reference

Bouwsema H, van der Sluis C, Bongers R

Center of Human Movement Sciences, University of Groningen, Groningen

Learning to Control Opening and Closing a Myoelectric Hand

American Congress of Rehabilitation Medicine 2010; 91:1442-6

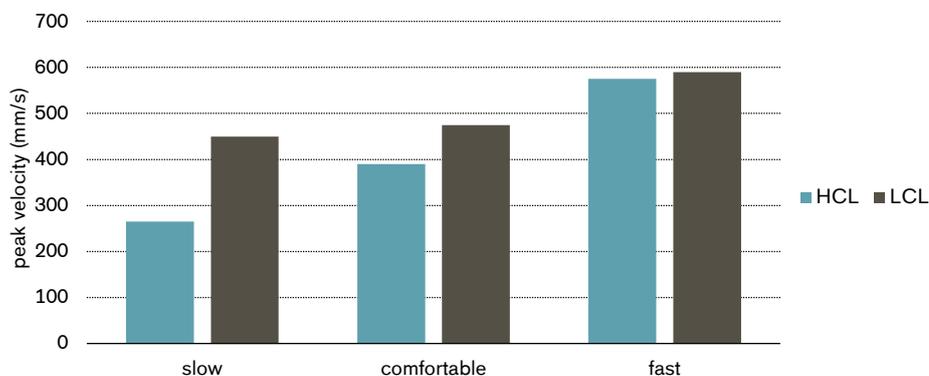
Products

Virtual hand – PAULA; Myoelectric simulator; Table-top hand (acts like Sensor Hand Speed)

Major Findings

- **Prosthetic users differ in learning capacity which determines time needed to learn how to use myoelectric prosthesis.**
- **Acquired control of a myoelectric hand is irrespective of the type of device used for training (PAULA/ simulator/ table-top hand)**
- **PAULA software is as effective as tabletop hand and prosthetic simulator.**

Peak velocity after the training period



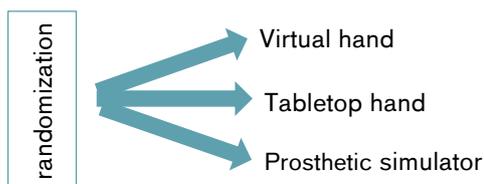
Graph shows peak velocities of opening and closing the hand reached in the post-test (after the training period) for the high capacity learners (HCL) and low capacity learners (LCL) plotted for each of the velocity conditions – slow, comfortable and fast. High-capacity learners could make a good distinction between the 3 different velocity conditions, whereas low-capacity learners could not make this distinction.

Population

Subjects: 34 able-bodied participants
Previous: none
Amputation causes: none
Mean age: 21 years
Mean time since amputation: none

Study Design

A randomized study:



After entering into the study, the subjects were randomized into three groups based on type of the training they will receive. On the first day a pretest was conducted. Afterwards, the subject's control of the hand was trained on 3 consecutive days either by using virtual hand, tabletop hand or prosthetic simulator. After the last training session on the 3rd day, a posttest was administered to determine the level of

skill after the training. The pretest and the posttest test were the same and consisted of 2 parts: the participant was asked to first provide a maximum myoelectric signal for at least 2 seconds (this was repeated 5 times) and, second, to open and close the hand to the maximal aperture on 3 different velocities at command. Participants were asked to control hand opening and closing at the slowest speed possible, at a comfortable speed, and at the highest speed possible. All velocities were executed 3 times in a random order. When the hand was not fully opened or closed, the participants were corrected and instructed again.

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 training with PAULA vs simulator vs table-top hand:	Sig.*
Training	Peak and mean velocity	Both peak velocity and mean velocity showed the same main effects.	0
	Number of peaks	A large effect of the velocity conditions showed that in the slow condition the most peaks occurred, whereas in the fast condition the fewest number of peaks were shown.	0

* no difference (0), positive trend (+), negative trend (-), significant (++)/(-), not applicable (n.a.)

Author's Conclusion

"In conclusion, learned control of a myoelectric hand does not depend on the type of training (with a virtual hand, an isolated hand, or a prosthetic simulator). Prosthetic users may differ in learning capacity, and this should be taken into account when choosing the appropriate type of control for each patient." (Bouwsema et al. 2010)

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Reference

Bouwsema H, van der Sluis C, Bongers R

Center for Human Movement Sciences, University of Groningen, Groningen

Movement characteristics of upper extremity prostheses during basic goal-directed tasks

Clinical Biomechanics 2010; 25: 523–529

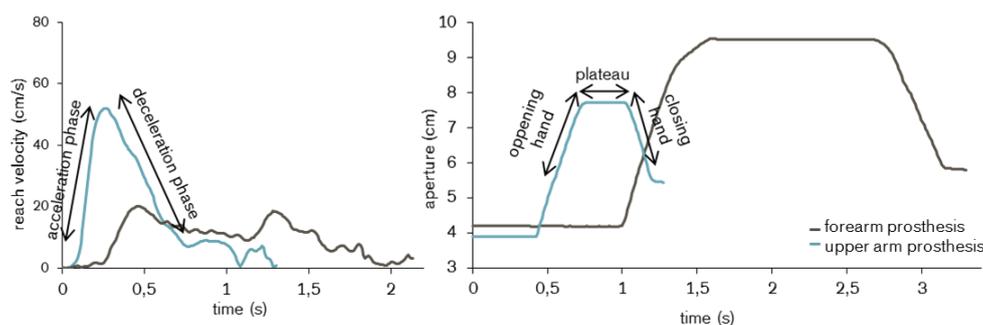
Products

Digital Twin hand

Major Findings

- **Reaching and grasping of an object with the prosthesis is slower with a plateau phase than in able bodied persons.**
- **The forearm amputees require less time to pick up an object than the upper arm amputees.**
- **Training should focus on timing between hand opening and hand closing.**
- **During training amputee should pay attention to simultaneous finish reaching and start grasping an object.**

Reaching and grasping movements for forearm and upper arm amputees:



The forearm prostheses required less time to execute the reach than the upper arm prostheses. Grasp time and plateau phase were shorter for the upper arm prostheses.

Population

Subjects: 3 forearm and 3 upper arm amputees
Previous: forearm amputees used myoelectric prostheses with Digital Twin hands
upper arm amputees used hybrid prostheses = mechanical elbow + myoelectric prostheses with Digital Twin hands
Amputation causes: n.a.
Mean age: 45 ± 11 years
Mean time since amputation: 14 ± 12 years

Study Design

Observational (non-interventional) study:

Movements from six users of upper extremity prostheses were analysed, three participants with a hybrid upper arm prosthesis, and three participants with a myoelectric forearm prosthesis. Three tasks were investigated: direct grasping task – participants reached out for and grasped an object positioned on the table in front of them with their prosthetic hand; the indirect grasping task – participants handed an object over from their sound hand to the prosthetic hand; the pointing task – participants made horizontal back and forth movements between two vertical bars, with a stylus held in their prosthetic hand.

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 movement characteristics of forearm and upper arm amputees	Sig.*
Mechanics	Grasping	The forearm prosthetic users required less time to reach an object.	++
		The forearm prosthetic user needed less time to grasp an object.	++
		The plateau phase (time between opening and closing the hand) is shorter for forearm prosthetic users.	0

* no difference (0), positive trend (+), negative trend (-), significant (++/--), not applicable (n.a.)

Author's Conclusion

"By characterizing movements with upper extremity prostheses, specific deviations have been pinpointed between two types of prostheses and between prostheses and existing knowledge of able-bodied behaviour. Developments in technology and rehabilitation should focus on these issues to increase the use of prostheses, in particular on improving motor characteristics and the control of the elbow, and learning to coordinate the reach and the grasp component in prehension." (Bouwsema et al. 2010)

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Reference

Bouwsema H, van der Sluis C, Bongers R

Center of Human Movement Sciences, University of Groningen, Groningen

The Role of Order of Practice in Learning to Handle an Upper-Limb Prosthesis

Archives of Physical Medicine and Rehabilitation 2008; 89:1759-64

Products

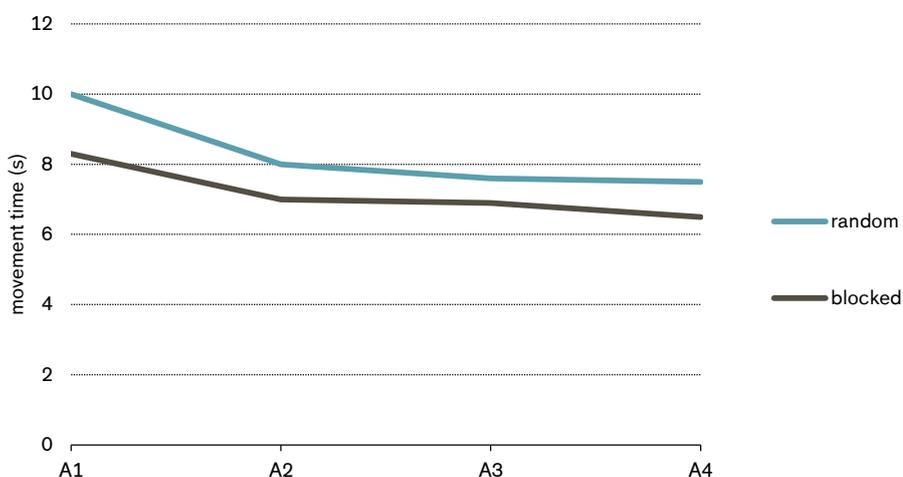
Body-powered and myoelectric simulator

Major Findings

Different orders of presentation of practice tasks:

→ **Practicing in a blocked fashion leads to faster performance**

Movement time in task performance

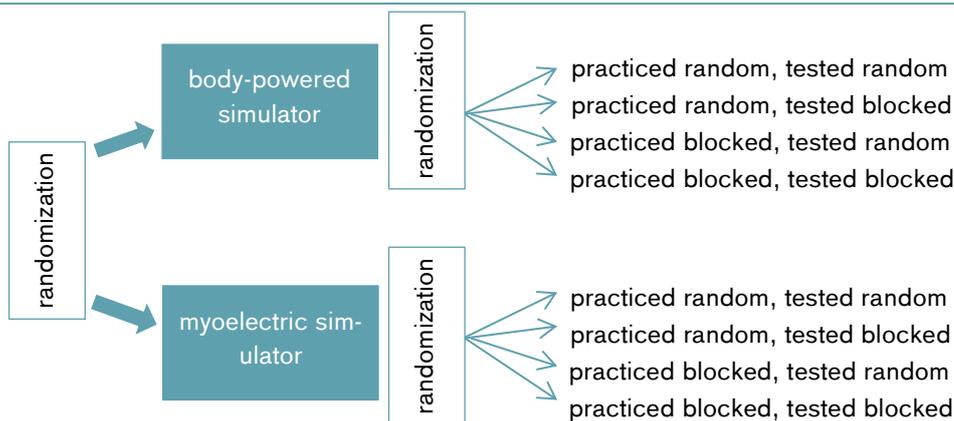


Movement time in seconds for each of the 2 groups (random – blue, blocked – grey) in the four blocks of acquisition phase (A1, A2, A3, A4). Blocked practicing involves trainings of all trials of 1 task before the next task is introduced. In the acquisition phase participants performed 3 tasks: direct grasping, indirect grasping, and fixating, each consisting of 20 trials.

Population

Subjects: 72 healthy, able-bodied participants
Previous: none
Amputation causes: none
Mean age: 21 ± 2 years
Mean time since amputation: none

Study Design



On day 1, participants performed 3 tasks (direct grasping, indirect grasping, and fixating, each consisting of 20 trials) in the acquisition phase. The order of practice was either random or blocked. On the second day, a retention test and a transfer test were conducted to determine the effect of learning from the previous day. In 2 groups, the order was changed, from random to blocked and from blocked to random. The retention test consisted of 5 trials of each acquisition task, while in the transfer test, 5 trials of 3 new tasks had to be executed.

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 different orders of presentation of practice tasks:	Sig.*
Training	Initiation time	No difference between groups, between simulators, or among tasks.	0
	Movement time	Blocked groups performed faster than random groups.	+

* no difference (0), positive trend (+), negative trend (-), significant (++/--), not applicable (n.a.)

Author's Conclusion

"Performance in daily life with a prosthetic device is indifferent to the structure in which the training is set up. However, because practicing in a blocked fashion leads to faster performance, it might be suggested that patients practice at least a part of the training tasks in blocks." (Bouwsema et al. 2008)

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