

Imagery and observation research
in virtual reality environments

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BACKGROUND

- Observational practice has been suggested to promote motor learning in early skill acquisition (e.g., Anderson, Rymal, & Ste-Marie, 2014; McCullagh, Law, & Ste-Marie, 2012)
- Feedback is known to be essential for promoting learning and various types of augmented feedback have been investigated in real world settings (e.g., Magill & Anderson, 2012)
- However, the optimal type of augmented feedback during observational practice that best promotes learning is currently unknown
- Virtual reality provides an ideal environment to augment the learning process; as a highly controllable environment it allows to systematically manipulate variables and to create new types of interactions as compared to a real-world setting

The main objective of this line of research is to examine the impact of different non-/verbal feedback strategies during observation (with and without imagery) on coachee's cognitive representation and motor performance of a complex motor action in early skill acquisition

VR SET UP

Technical environment

Graphics environment

- Two-sided CAVE
- 2100 x 1600 pixels/ side
- Passive stereo



Motion capture

- OptiTrack System
- Prime 13W/ 10 cameras
- Customized motion capture suit
- 44 markers to reconstruct 21 joints

End-to-end latency:

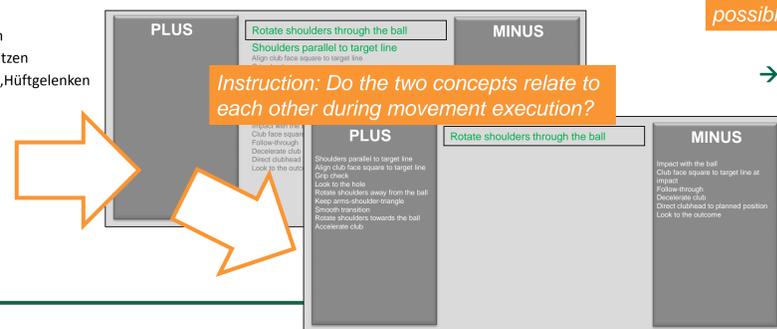
- Around 60 ms (Waltemate et al. 2015)

Basic Action Concepts (BACs) of the squat

- Schulterbreiter Stand
- Fußspitzen leicht nach außen gedreht
- Aufrechte Haltung
- Beine beugen
- Gesäß nach hinten schieben
- Aufrechte Haltung beibehalten
- Knie bleiben hinter den Fußspitzen
- Knie bleiben in Achse mit Fuß-, Hüftgelenken
- Fersen bleiben am Boden
- Kniewinkel 100°
- Hüfte vorschieben
- Beine strecken
- Knie nach vorne schieben
- Knie zeigen nach innen
- Fersen vom Boden abheben
- Oberen Rücken rund machen

Cognitive representation

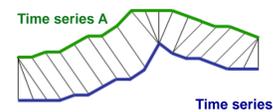
Structural dimensional analysis of mental representation (SDA-M; Schack, 2012)



Motor performance

Instruction: Try to perform a squat as similar as possible to the squat of the skilled person

Motion capture (see VR Set Up) → Dynamic time warping (DTW; Müller, 2007)



Performance error calculated as deviation between actual and target performance

PILOT STUDY

- In a first step, we investigated the influence of different types of augmented feedback during observational practice in a virtual reality environment
- Specifically, we were interested in the impact of various types of real-time visual feedback on participants' motor performance and cognitive representation structure of the squat
- In a pilot study, we compared an 'own avatar' condition (i.e., mirrored action) to an 'own avatar plus ghost' condition (i.e., mirrored action plus ghost action)

DESIGN

Design of the pilot study (N = 15)

	Pre-test	Acquisition	Post-test	Retention-test
	Day 1	Day 1	Day 1	Day 2
Own avatar condition	SDA-M	Squat practice with mirrored action	DTW	SDA-M
	DTW			DTW
Own avatar plus ghost condition	SDA-M	Squat practice with mirrored + ghost action	DTW	SDA-M
	DTW			DTW

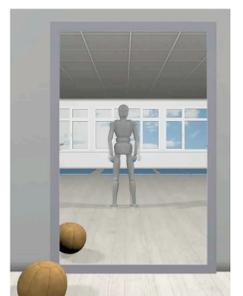
Note: SDA-M: structural dimensional analysis of mental representation; DTW: dynamic time warping; number of squats during test sessions: 2 x 5 squats; number of squats during acquisition: 6 x 5 squats..

REAL-TIME FEEDBACK

- Novices were assigned to one of two conditions
- Own avatar** condition: Whilst executing the squat, participants observed their own avatar performing their own movement in a virtual mirror
- Own avatar plus ghost** condition: Whilst executing the squat, participants observed their own avatar performing their own movement plus an avatar of a skilled person performing a correct squat, superimposed on their own avatar, in a virtual mirror



Own avatar

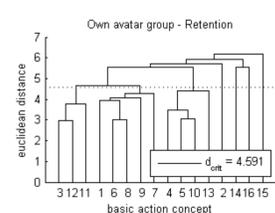


Own avatar plus ghost

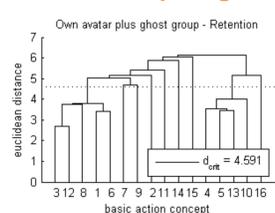
PRELIMINARY RESULTS

Cognitive representation

Own avatar

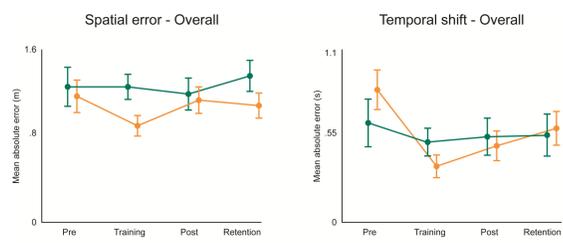


Own avatar plus ghost

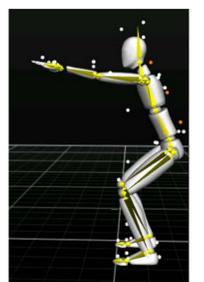


Preliminary results showed a trend for the 'own avatar plus ghost' group to outperform the 'own avatar only' group in both motor performance and cognitive representation structure of the squat

Motor performance



Own avatar
Own avatar plus ghost



NEXT STEPS

- Add (no mirror) control condition to determine baseline
- Add change in perspective to provide side view
- Add error/ achievement highlighting to guide attention
- Add error/ achievement exaggeration to guide attention
- Add other modalities (e.g., audition) to provide multimodal nonverbal feedback
- Add verbal feedback (e.g., instructions, explanations) by adding the virtual coach to the mirror



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