Influence of Egocentric and Exocentric Perspectives on Virtual Avatars during Full-Body and Part-Body Mirrored and Independent Motor Learning Tasks

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Chapter 1

Abstract

- Overall aim of the Masters theses: provide insights to learning in vr, especially about the perspective on the avatar who is teaching (egocentric vs. exocentric perspective)
- thus: provide groundwork for motor learning in vr for future HCI related studies
- therefore analysis of motor learning, related work, research questions
- propose study setting

Chapter 2

Introduction

2.1 Motivation

- Overall aim of the Masters theses: provide insights to learning in vr, especially about the perspective on the avatar who is teaching (egocentric vs. exocentric perspective)
- thus: provide groundwork for motor learning in vr for future HCI related studies

Problem definition

- Motor learning tasks can be learn in MR (quellen)
- investigations in xyz but not in terms of perspective
- influence of perspective could lead to insights/ recommendations for learning in MR

2.2 Approach

How to address the Problem

- Design a Study, participants to perform movements
- two groups, ego/exo perspective, 2 movement types
- investigate the performace of the groups

Research questions and hypothesis

- RQ1: Does the perspective on a Virtual Avatar influence the learning performance (?better: outcome?)?
- RQ2: When the movement is only on a specific body part like upper body (UB), lower body (LB) or full body (FB), is there a relation between the egocentric or exocentric perspective on the avatar to the learning performance?
- H1: The perspective on the avatar has no influence on UB movements
- H2: The perspective on the avatar has no influence on LB movements
- H3: The perspective on the avatar has no influence on FB movements
- H4: The perspective on the avatar has no preferences on movement types, means the movement type has no influence on the learning performance

2.3 Outline

After this introduction, the scope of this thesis is given. The Motor Learning movements are described as well as the classification for the Mixed Reality. In the Therory section a classification of this work in relation to the Methodology and HCI Theory. The related work part will give an overview about other and MR learning systems and also work about perspectives on avatars. From this work the measures, dependent and independent variables and tasks are derived. Taking the related work into consideration a study design is proposed in the Study Setting section. Furthermore a outlook is given in the last section.

Chapter 3

Scope

3.1 Motor Learning

- discrete movements
- closed skills
- at least 2 different movement categories
- how to measure movements

How do we learn movements

facts → adoption for study

3.2 Mixed Reality

- Milgram
- AR or VR

3.3 other aspects

- synchron asynchron
- colocated/remote
- perspective
- hardware?

- feedback!
- real world, not abstract avatars
- only visuals - no audio or textual explanation
- 26: details following: how to measure movements for movements with a discrete target
- 3 types of measurements: measures of error for a single subject, measures of time and speed, measures of movement magnitude.
  - Constant Error: average Error $CE = \frac{\sum(x_i - T)}{n}$. i: all values, T: target value, n: number of values. interpretation: in average, the user missed the target by CE
  - Variable Error: inconcistency in movement error: $VE = \sqrt{\frac{\sum(x_i - M)^2}{n}}$. M: average movement, actual movement score - average movement score. interpretation: VE reflects the variability, or inconsistency in movements. moves consistently: VE small. user moves absolute consistently: VE is 0. VE does not depend on wether or not the subject was close to the target
  - total variability: the total variability around a target: $E = VE^2 + CE^2 = \sqrt{\frac{\sum(x_i - T)^2}{n}}$ interpretation: combination of VE and CE, total amount of spread about the target: overall measure how successful was the subject in achieving the target
  - absolute error: measure of overall accuracy in performance. $AE = \frac{\sum|x_i - T|}{n}$. interpretation: replace sqrt with abs
  - AE vs. E: **TODO**
  - Absolute Constant Error: $= |CE|$. if half pos and half neg could cancel each other out. when mean.
  - these measures can be applied to other movements. like pursuit motor: TOT, Mashburn task, stabilometer, two hand coordination task.
- measures of time and speed: basic to this idea: performer who can accomplish more in a given amount of time or who can accomplish a given amount of behavior is more skillfull. time measure:c $\frac{time}{unit}$. speed:$\frac{units}{time}$.

- reaction time (RT): can also be a performance measure. a measure of time from the arrival of a sudden and unanticipated signal to the beginning of the response. i will only describe it if i will use it
- movement time (MT): how long does the movement last. somtimes commbined with RT: response time= $RT + MT$
- 21 details following: discrete/closed skills
- for simplifying discussion introducing classification of movements and motor tasks.
- 2 important classification schemes:
  - based on particular movements made: discrete, continuous, serial
  - based on perceptual attributes of the task: open/closed skills
- discrete movements: movements with recognisable beginning and end. discrete tasks: kicking a ball, shifting gears. end of movement: the time on which a observer ceased examining. dm can be very rapid like blinking or longer like making the signing.
- continuous movements: dont have recognisable start and end, with behavior continuing till the movement arbitrarily stopped. Continuous tasks: swimming, running, steering a car. Continuous tasks tend to be longer than discrete tasks.
- serial movements: neither discrete nor continuous compromised of a series of individual movements tied together in time to make some "whole". center of continuum. can be rather long but are not stopped arbitrarily. serial tasks: starting a car, prepareing and lighting a wood fireplace. Serial tasks can be seen as many discrete tasks strung together and the order (and sometimes timing) is important.
- open skills: environment is constantly, unpredictably changing, so the performer cannot plan his activity effectively in advance. eg. penalty shot in ice hockey. own movement is dependet on the movement of the keeper. Driving on a freeway: depends on the other cars. Success in open skills largely determined by the extend to which a individual can adapt the planned motor behaviour to the changing environment.
- closed skills: other end of continuum, predictable environment becaus it is stable. eg archery, bowling or signing. movement can be planned in advance. since open skills seems to require rapid adaptions to a

changing environment and closed skills require a very stable performances in a predictable environment questions are raised about the method of training, do different individuals perform better in in one of these skill classes.

- to overcome these question the focus of this seminar is on discrete movement tasks and closed skills. §-¿§ see stdudy

Chapter 4

Theory

4.1 Metholodgy

sth like UX live cycle or participatory design

4.2 HCI Theory

sth like embodied cognition
Groundwork for designing VR motor learning systems

Chapter 5

Related Work

wie haben die anderen diese variablen untersucht wie wurden die variablen untersucht → studiensetting

5.1 MR learning systems

- one body:
- vr dance trainer:
- you move:
- training archived physical skills:
-
- teaching traditional dance using e-learning tools, bakogianni

5.2 Ego/exo perspective work - if exists

- training archived physical skill: seamless change from first to third person

5.3 variables

- independent/dependent variables
- measures
- task: reuse or adapt existing task

Task

- Onebody: 16 artificial postures not from but like: tai chi, matial arts
- VR Dance Trainer: dance movements, 15 min for each move
- you move: various movements to perform. using a whip, baseball, boxing, ballet, dance moves
- training archived physical skills IVE: physical skills in sport activities, especially baseball pitching

Measures

- scientific work, how to measure movements: hachimura et al, yoshimura et al, qian et al, kwon et al, all use joint angles, (mentioned in: vr dance trainer)
- onebody: skeletal tracking, how much percent do the postures match? 3d positions of limbs measured: wrist, elbow, shoulder, hip knee ankle. so angle between bones is the main measure for accuracy. additionally a subjective instructor score was recorded. And, completion time, topped by 2 min.
- VR Dance trainer: there are 3 common features for measuring hte difference between movements: joint position, velocity, angle. they tested which feature descibes movements best: joint position. base line vs post training movements are compared.
- you move: in each keyframe, score based on the joint with the maximum error, measured in euclidean distance. but only "important joints" are measured. timing errors: 0.5s error on each side of the frame for matching posture. is timing important, the window is reduced to 0.25s. max eucl. distance is linear mapped to a score. 0 error is 10 (max), 10cm is 7.5 what is the score to pass. if precision is important, 10cm needed for pass.

5.4 Body parts included

- onebody
- vr dance trainer
- you move: full body

- training archived physical skill: full body

training method

- one body:
- vr dance trainer:
- you move:
- training archived physical skill: key frame method

tracking technology

-
-
-
- training archived physical skills: kinect

display technology

-
-
-
- training archived physical skills: low res HMD (oculus rift dk1/dk2)

Independent and Dependent Variables

Dependent Variables

- VR
- bilateral movements
- Movement types: synchronous / asynchronous

Independent Variables

- Body parts: upper body (UB), lower body (LB), full body (FB)
- Perspective: Ego, Exo, Ego/Exo combined
- Movement types: synchronous / asynchronous

5.5 How do we learn movements

5.6 how to quantify movements

Judging motions and their matching to a given motion is not a trivial task. One approach follows Rudolph von Laban who was a professional dancer. Von Laban developed a broadly used dance notation. His work lead to the *Laban Movement Analysis* with which a human movements could be quantized.[1] There are four main components to systematically describe movements in the *Laban Movement Analysis*: body, effort, shape and space. Each component can describe movements independently or combined. Hachimura et al. **TODO**used the methodology of *Laban Movement Analysis* and adopted it to for digital movements.
Yoshimura et al. **TODO**followed a similar approach from another dance movement description theory called *furi*. *Furi* is also described by four so called *indices*: *kamae*, *jyu-shin*, *koshi*, *uchiwa*. Yoshimura at all could map these indices to concrete markers on the body of a performer. They showed that there was a significant difference between movements by an expert and a beginner. Qian et al. **TODO**developed a gesture recognition system for performing arts. To match the motions ten body parts were defined: head, torso, upper arms, forearms, upper legs and lower legs. For each body part the Mahalanobis distance is calculated to an ideal point. The Mahalonobis distance describes the distance between a point p and a distribution D. Kwon et al. **TODO**

- K. Hachimura, K. Takashina, and M. Yoshimura, "Analysis and Evaluation of Dancing Movement Based on LMA," Proc. IEEE Int'l Workshop Robots and Human Interactive Comm., pp. 294-299, 2005.
- M. Yoshimura, N. Mine, T. Kai, and L. Yoshimura, "Quantification of Characteristic Features of Japanese Dance for Individuality Recog-

[1] Brockhaus, Rudolf Laban. http://www.brockhaus.de/ecs/enzy/article/laban-rudolf (accessed 2018-10-25)

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- G. Qian, F. Guo, T. Ingalls, L. Olson, J. James, and T. Rikakis, "A Gesture-Driven Multimodal Interactive Dance System," Proc. IEEE Int'l Conf. Multimedia and Expo (ICME '04), pp. 1579-1582, June 2004.
- D.Y. Kwon and M. Cross, "Combining Body Sensors and Visual Sensors for Motion Training," Proc. ACM SIGCHI, pp. 94-101, 2005.
- vr dance trainer

5.7 Conclusion

- task is xyz because of abc
- measures are xyz because of abc
- variables are...

Chapter 6

Study Setting/ concept

6.1 Preliminary Study design

Aim of the Study

The aim of the study is to investigate the influence of egocentric and exocentric perspectives on a virtual avatar during motor learning tasks.

process

There are two groups: one learn only with the egocentric perspective, the other one with the exocentric perspective on the virtual avatar.
To derive conclusions on body regions, every participant learns movements for three different body parts. The body parts are:

- *upper body*(UB)
- *lower body*(LB)
- *full body*(FB)

To derive conclusion on movement types, two different movements per body part is learned. The two movement types are:

- mirrored movements
- independent movements

	UB	LB	FB
Ego	1 mirrored and 1 asynchronous movement	1 mirrored and 1 independent movement	1 mirrored and 1 independent movement
Exo	1 mirrored and 1 independent movement	1 mirrored and 1 independent movement	1 mirrored and 1 independent movement
Ego/Exo	1 mirrored and 1 independent movement	1 mirrored and 1 independent movement	1 mirrored and 1 independent movement

Independent variables

- perspective on the avatar (Ego/Exo centric)
- body parts (*upper body*, *lower body*, *full body*)
- movement types (mirrored/independent movements)

measures

TBA

comments

um Influence of Egocentric and Exocentric perspectives on Virtual Avatars during full-body
zu zeigen, muss ich dann nicht auch verschiedene lern systeme heranziehen?
sonst zeige ich das ja nur für dieses eine lern system.

Chapter 7

Outlook

- timetable, what to do...