



# Designing Superhero Experiences

a.k.a. intrinsic motivation in movement

Prof. Perttu Hämäläinen

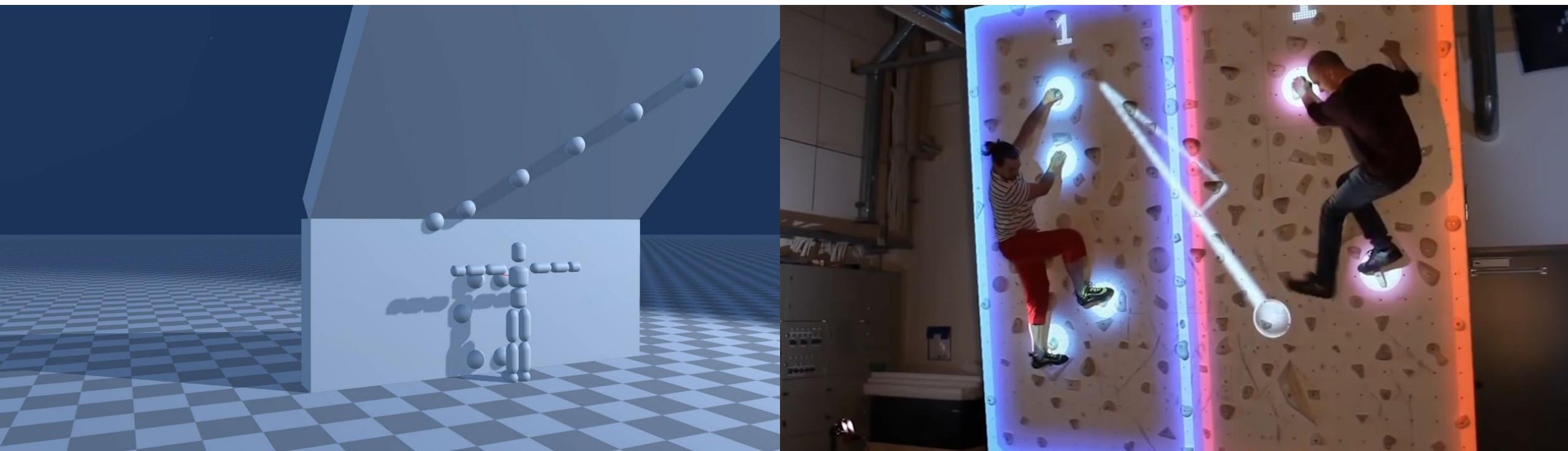
Aalto University

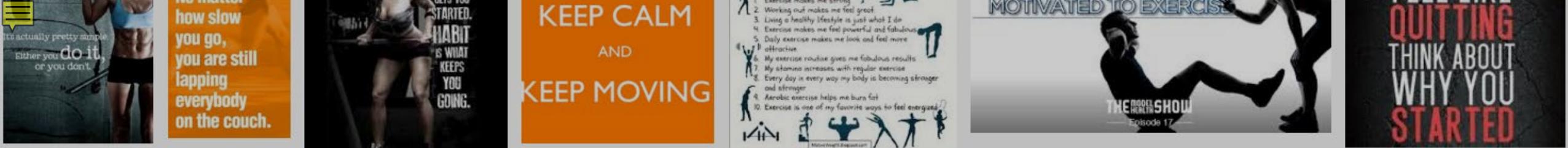
Helsinki, Finland

Homepage: <http://perttu.info>, Twitter: @perttu\_h

# My group's research: Computer Science of Movement

- Mission: Positively impact health through exergames and digitally augmented sports that motivate or otherwise promote physical activity





I EXERCISE  
BECAUSE SOMEHOW COMPLETELY  
EXHAUSTING MYSELF IS THE MOST  
**RELAXING**  
PART OF MY DAY.  
HASFIT.COM  
THE BEST FREE WORKOUTS

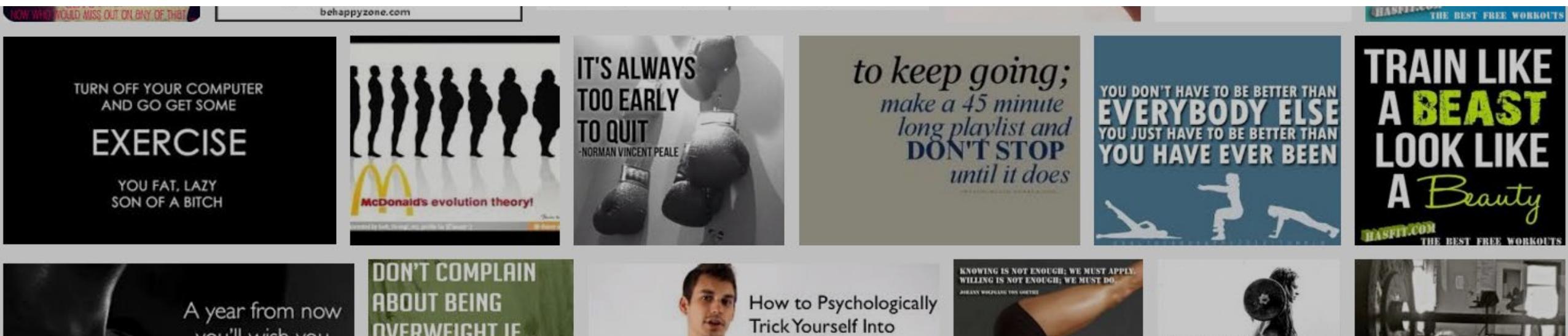


start  
today.

BEAST  
MODE  
ON  
HASFIT.COM  
THE BEST FREE WORKOUTS



# Problem: Exercise motivation



“To be motivated means *to be moved* to do something. A person who feels no impetus or inspiration to act is thus characterized as unmotivated, whereas someone who is energized or activated toward an end is considered motivated.”

Source: Ryan & Deci, 2000, Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions

# Extrinsic & intrinsic motivation





# LEGO pedometer cheating machine

[https://www.youtube.com/watch?v=MPse7\\_lsNc4](https://www.youtube.com/watch?v=MPse7_lsNc4)



# Intrinsic motivation

"Inherent tendency to seek out novelty and challenges, to extend and exercise one's capacities, to explore, and to learn."

"Children, in their healthiest states, are active, inquisitive, curious, and playful, even in the absence of specific rewards."

"Natural inclination towards assimilation, mastery, spontaneous interest, and exploration that is so essential to cognitive and social development and that represents a principal source of enjoyment and vitality throughout life."

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist*, 55(1), 68.

Story

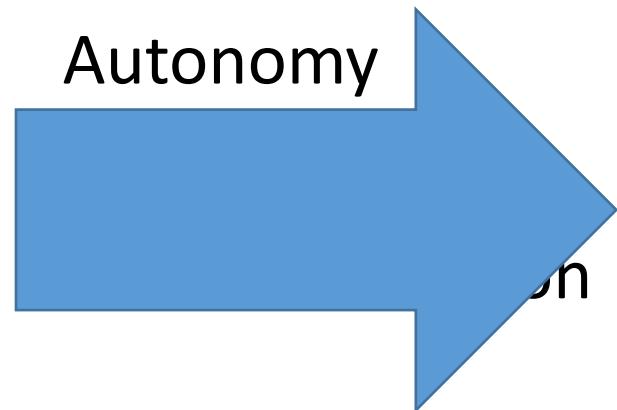
Aesthetics

Mechanics

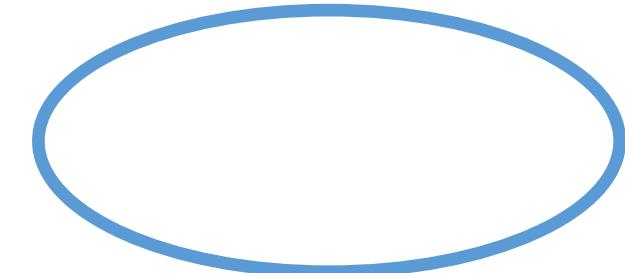
Technology

Competence

Autonomy



Curiosity/Novelty



Reminder: The classic paper on the importance of psychological need satisfaction for game enjoyment and motivation

## The Motivational Pull of Video Games: A Self-Determination Theory Approach

Richard M. Ryan · C. Scott Rigby · Andrew Przybylski

Published online: 29 November 2006  
© Springer Science+Business Media, LLC 2006

**Abstract** Four studies apply self-determination theory (SDT; Ryan & Deci, 2000) in investigating motivation for computer game play, and the effects of game play on well-being. Studies 1–3 examine individuals playing 1, 2 and 4 games, respectively and show that perceived in-game autonomy and competence are associated with game enjoyment, preferences, and changes in well-being pre- to post-play. Competence and autonomy perceptions are also related to the intuitive nature of game controls, and the sense of presence or immersion in participants' game play experiences. Study 4 surveys an on-line community with experience in multi-player games. Results show that SDT's theorized needs for autonomy, competence, and relatedness independently predict enjoyment and future game play. The SDT model is also compared with Yee's (2005) motivation taxonomy of game play motivations. Results are discussed in terms of the relatively unexplored landscape of human motivation within virtual worlds.

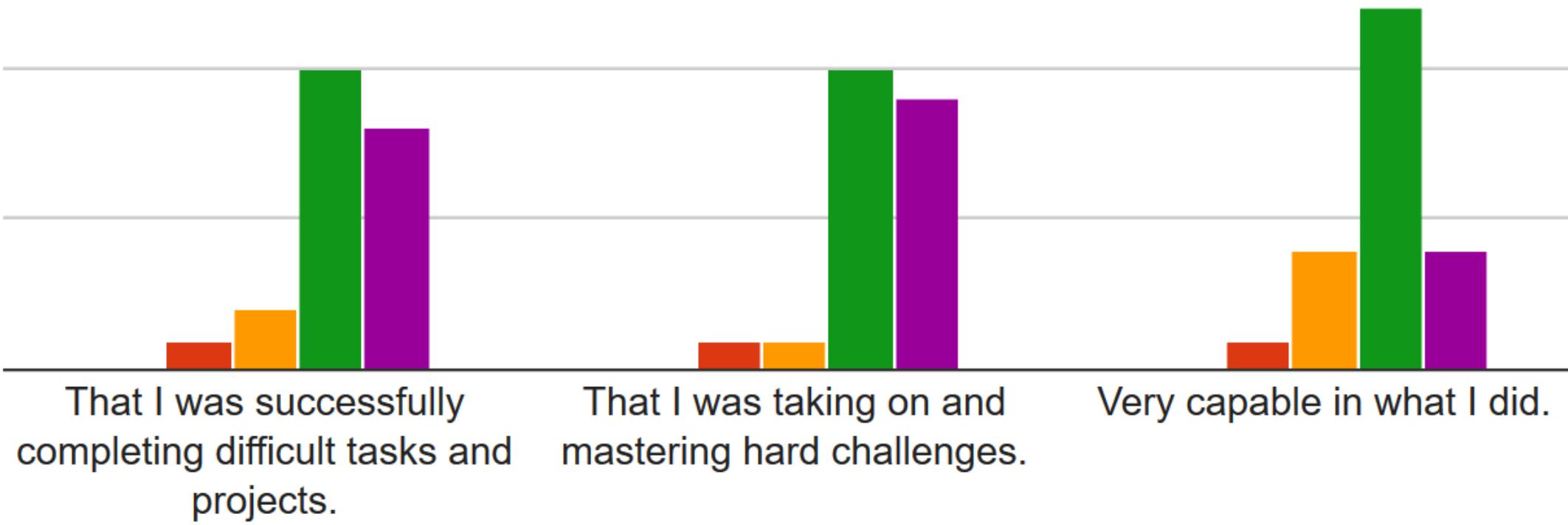
power, coupled with the integration of the Internet into mainstream society, has given birth to numerous gaming environments and “virtual worlds,” that are increasingly complex, immersive, engaging, and enabling of a wide range of activities, goals, and social behavior.

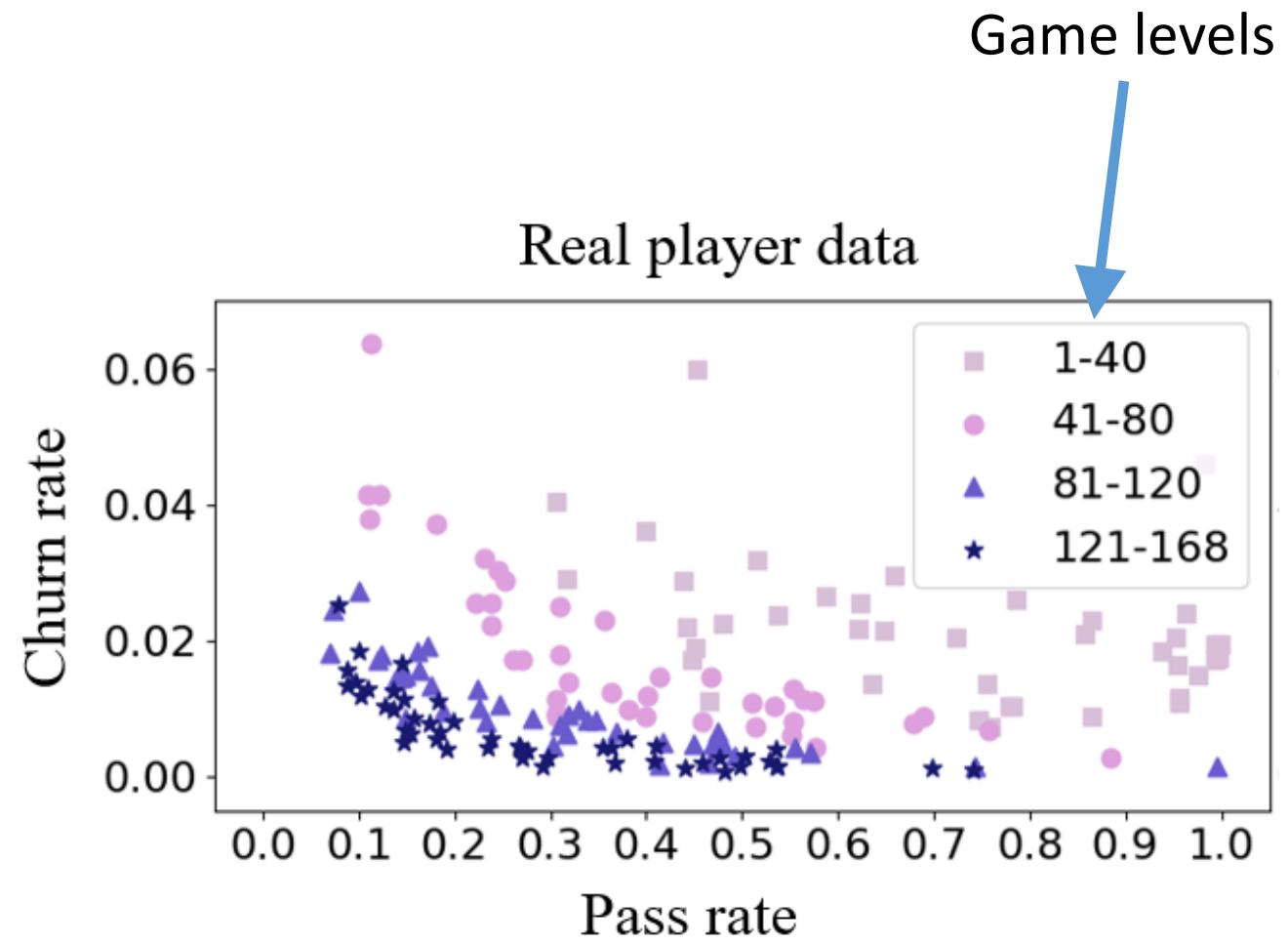
Of particular relevance to the research we present in this article are those computer environments associated with *gaming*. Participation in video games has become the fastest growing form of human recreation. Attesting to this, annual revenues from video games have surpassed those of Hollywood (Yi, 2004), making them the world's largest entertainment medium. Moreover, participation in gaming is commonplace across a variety of demographic groups, capturing an ever-increasing proportion of both youth and adult leisure time. Whether they take the form of traditional video games, online communities, or “massively multiplayer online” (MMO) adventures, computer games comprise a large and growing share of people's time and energy.

# Competence: salient to almost all favorite games

---

---





Rovio data: Lower pass rate of levels (lower difficulty, higher competence) results in less churn. Here, churn = player leaves the game for at least 7 days)



# Supporting competence



<https://k62.kn3.net/taringa/A/9/2/E/7/E/doctorjav/674.gif>

# Kick Ass Kung-Fu (Hämäläinen et al., CHI 2005)



# Empowerment of movement



# Empowerment of movement



Realistic horizontal motion

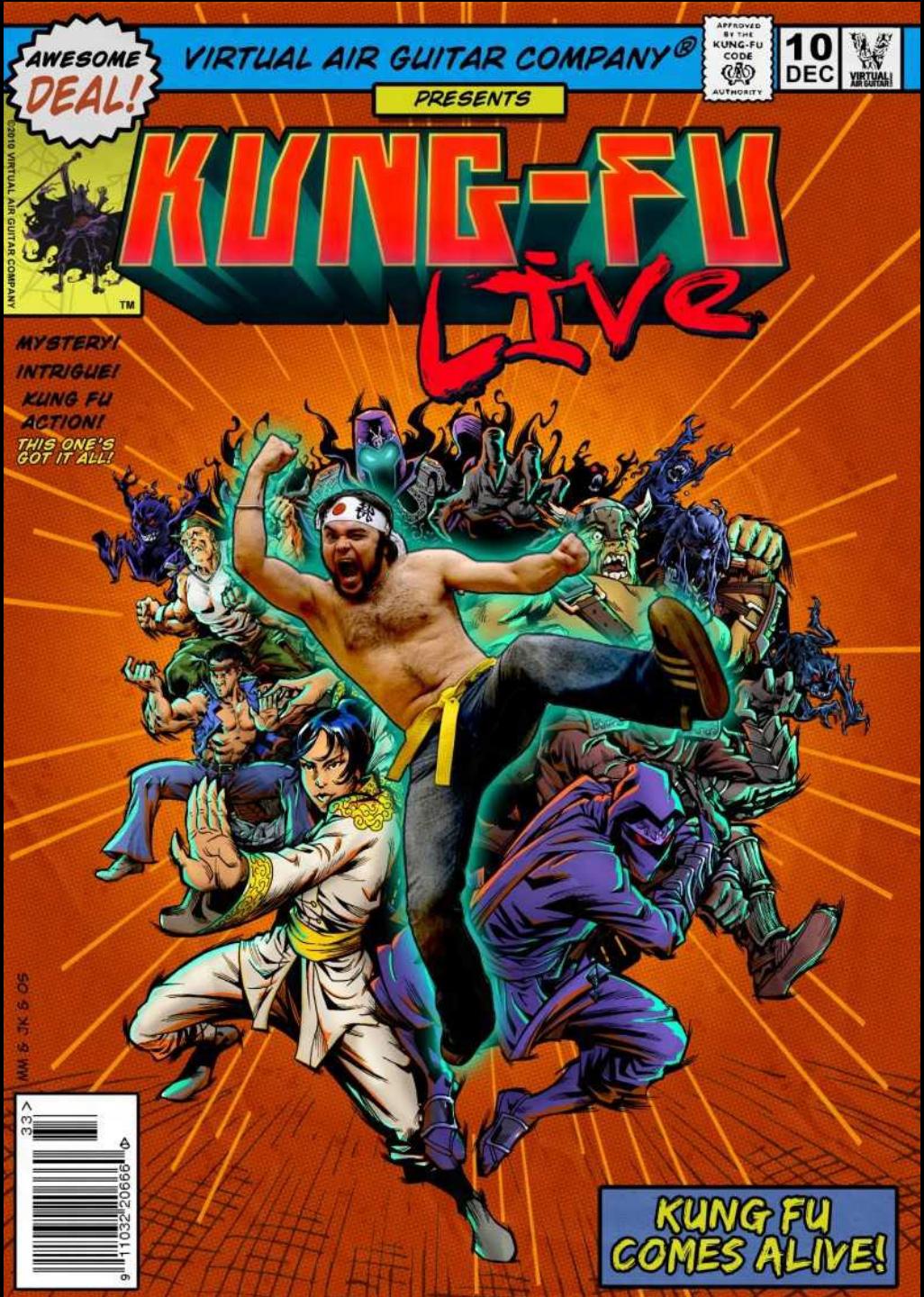


Digital vs. real?











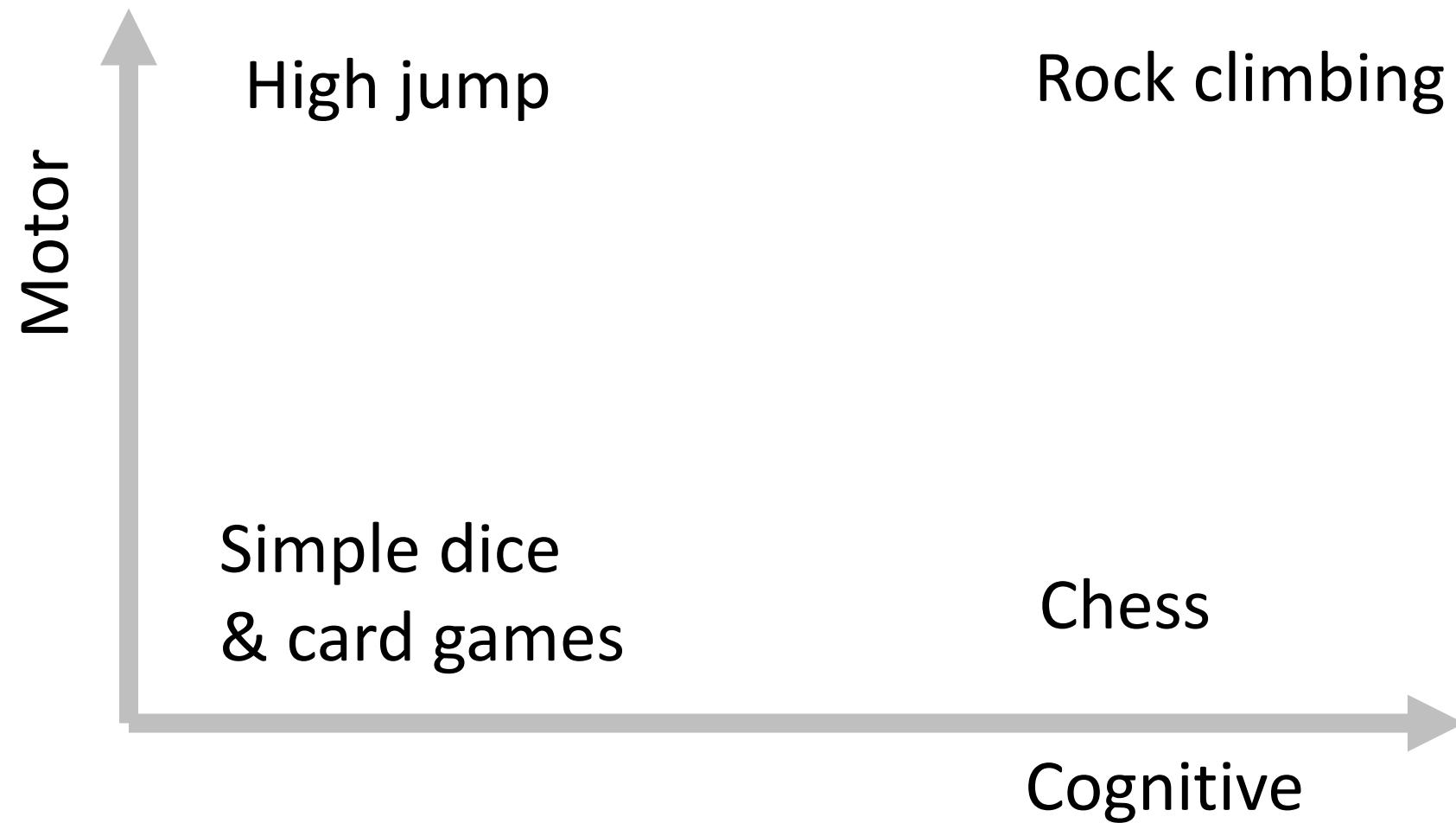
# KUNG-FU Live

Copyright 2010 Virtual Action Company

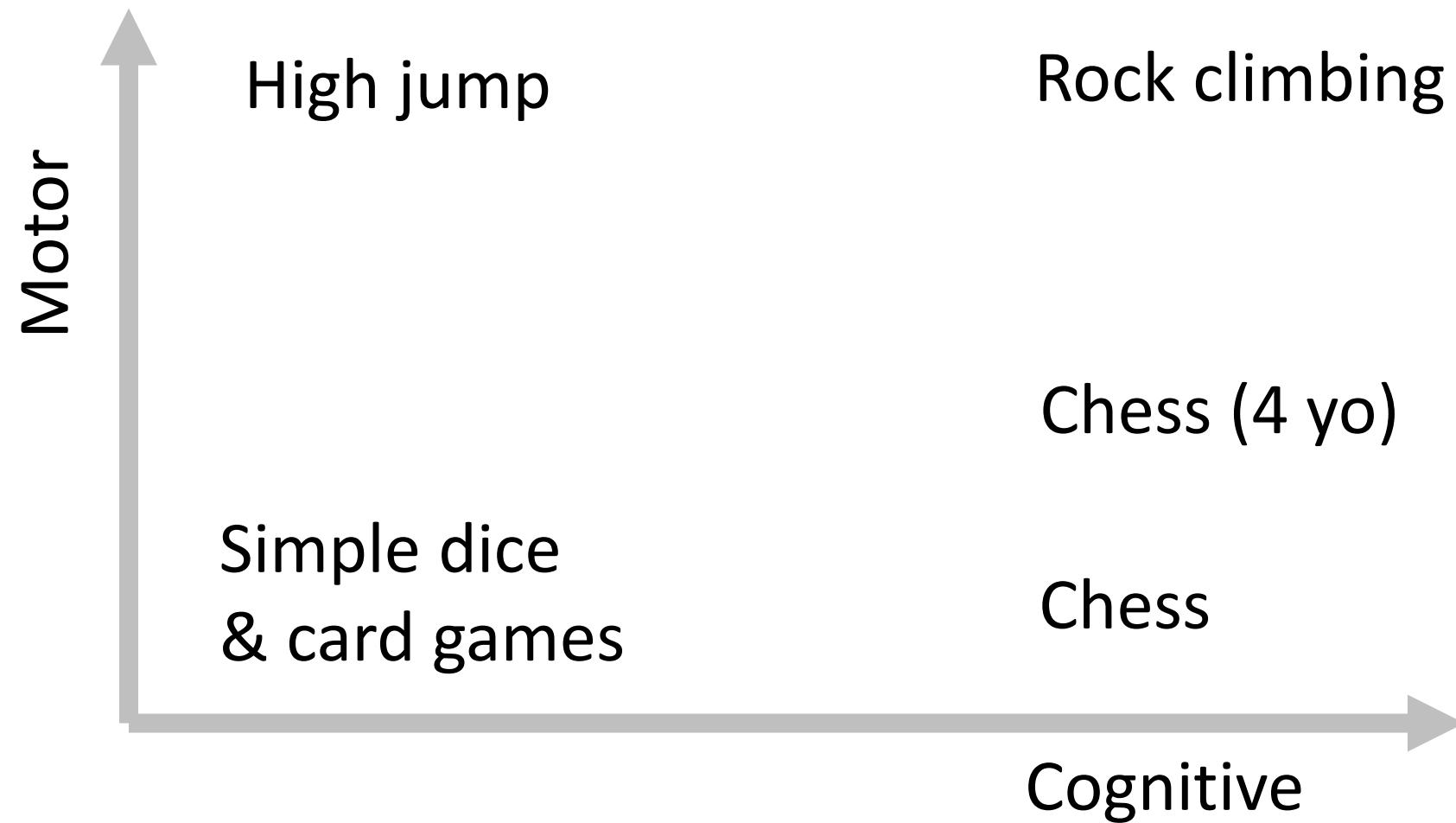


What to empower?

# The cognitive-motor challenge dimensions



# The cognitive-motor challenge dimensions



# The cognitive-motor challenge dimensions

## **Cognitive challenges:**

Sequential planning (chess)

Spatial intuition (go)

Memory

Pattern recognition

Sequential planning

Probabilistic reasoning

## **Motor challenges:**

Coordination

Reaction time

Timing



# The cognitive-motor challenge dimensions

## Cognitive challenges:

Sequential planning (chess)

Spatial intuition (go)

Memory

Pattern recognition

Sequential planning

Probabilistic reasoning

## Motor challenges:

Coordination

Reaction time

Timing

**Strength**

**Flexibility**

**High-risk skills**

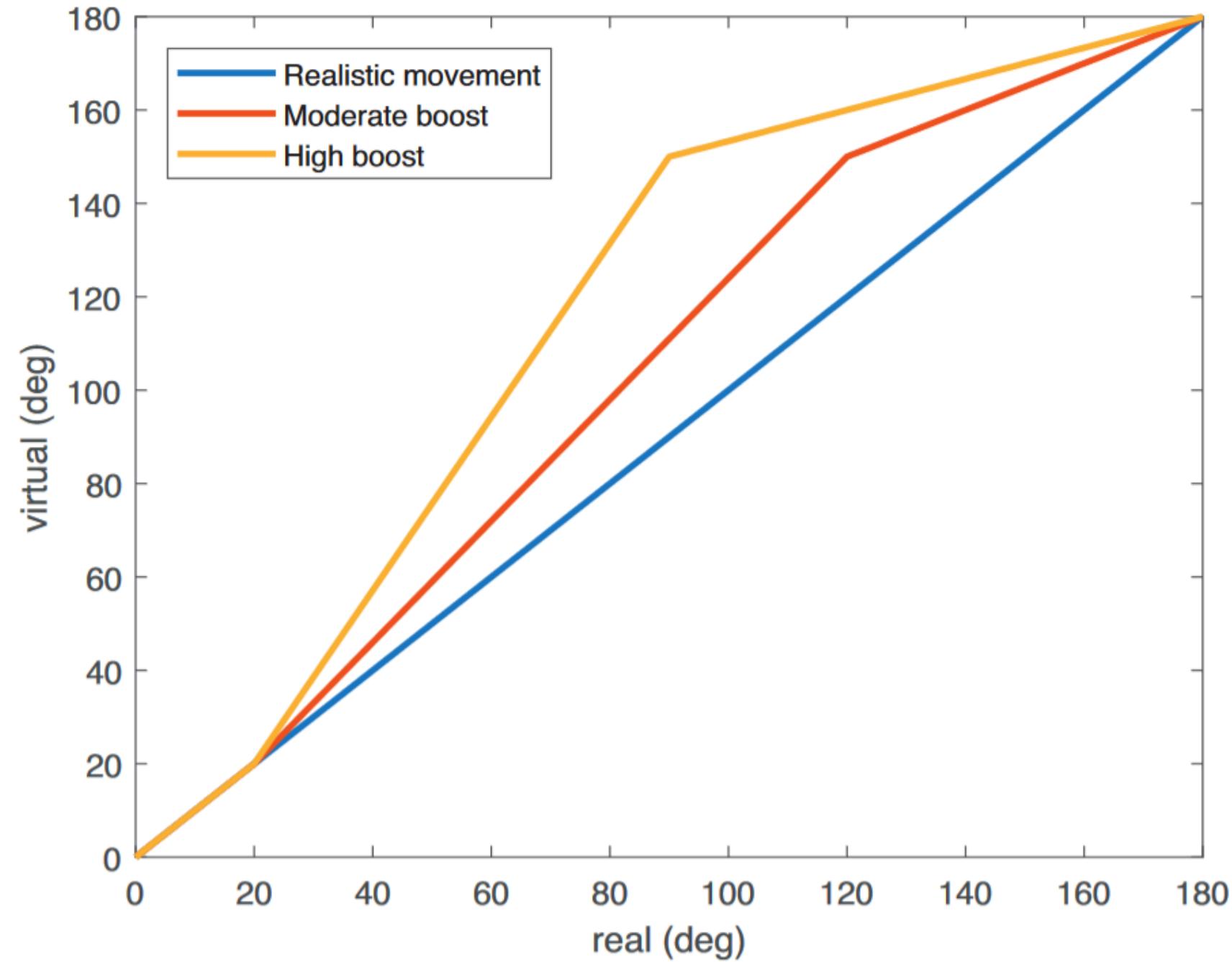


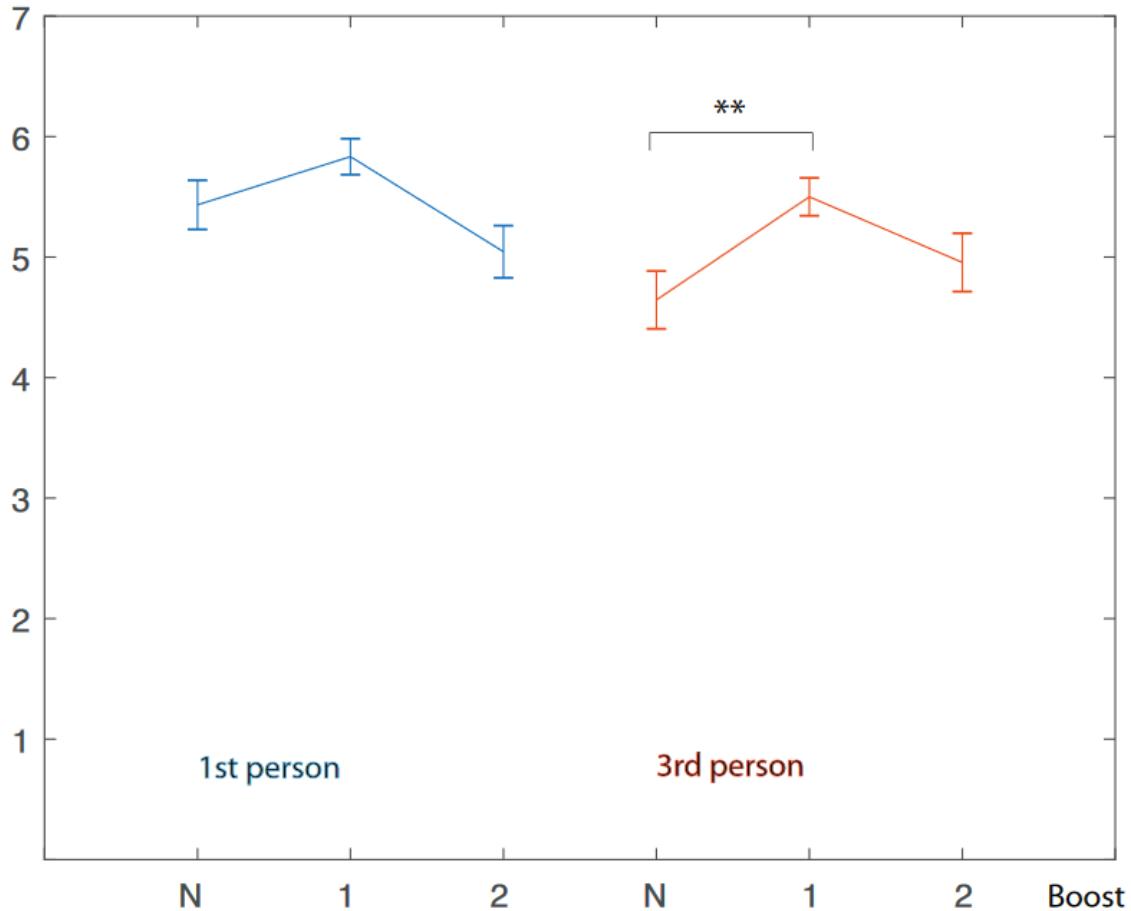
# Exaggeration of Avatar Flexibility in Virtual Reality



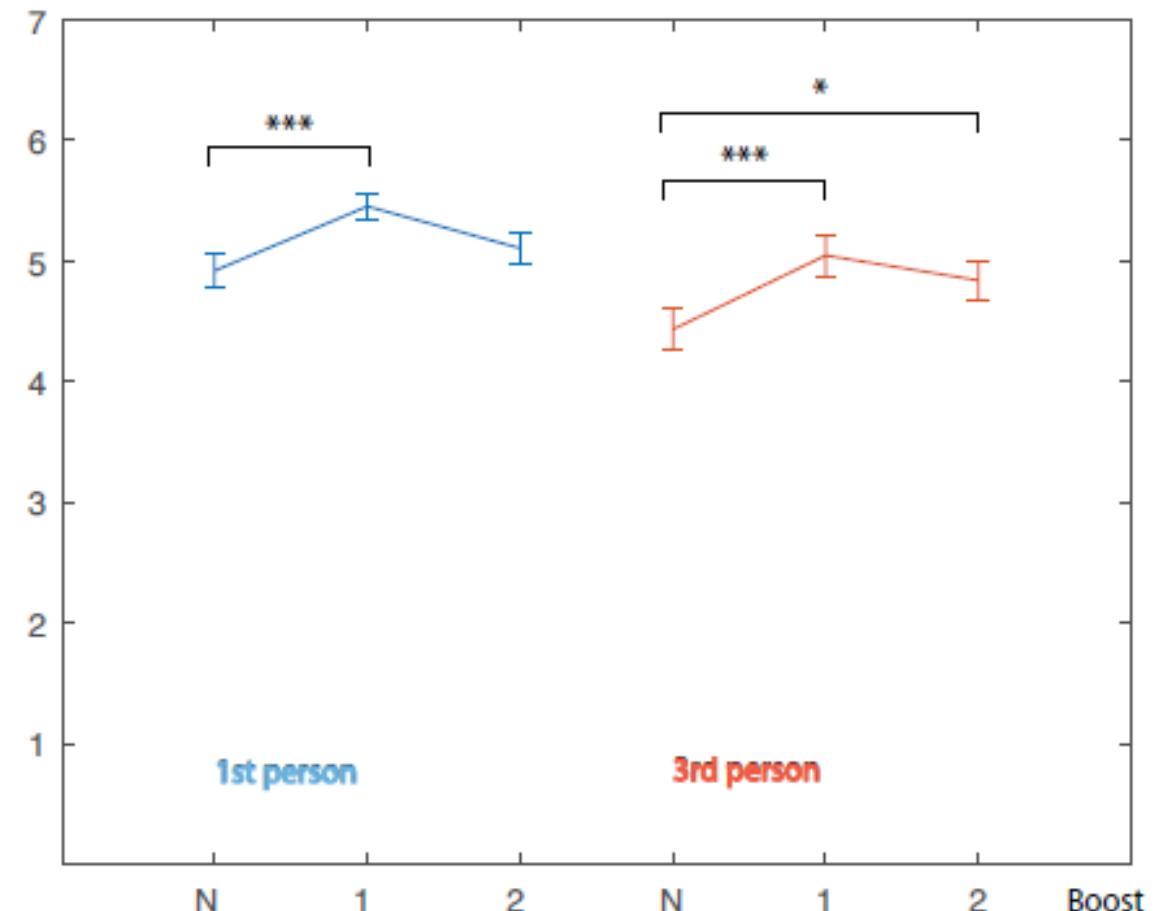
CHI PLAY 2018 paper supplemental video

Antti Granqvist, Tapio Takala, Jari Takatalo, Perttu Hämäläinen  
Aalto University, Finland





**Figure 6. Naturalness of motion.**



**Figure 8: Competence in performing the task.**

”I didn’t notice there was boosted movement, but I remember being very surprised that I was able to hit the high targets, initially it was kind of bizarre, like **’Wow am I really that good’**”



# Virtual Performance Augmentation in an Immersive Jump & Run Exergame

Christos Ioannou, Patrick Archard, Eamonn O'Neill  
University of Bath, UK

Christof Lutteroth\*  
University of Bath, UK  
University of Auckland, New Zealand

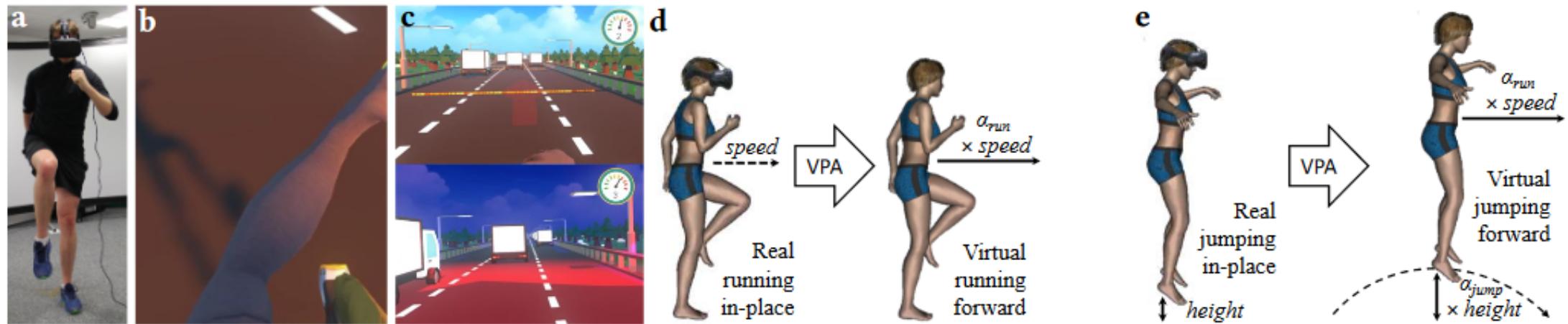


Figure 1: a) The exergame is played by running and jumping in place while wearing a head-mounted display. b) A sense of embodiment is created through visual-motor synchronicity with an avatar. c) Running, jumping over “lava gaps”, and avoiding trucks during gameplay. d) In place running with estimated speed is used to simulate forward running in VR with the speed augmented by a factor  $\alpha_{run}$ . d) In place jumping is used to simulate forward jumping in VR with the height augmented by a factor  $\alpha_{jump}$ .



If you can't empower, diversify the challenges





ACM CHI 2016  
*Best paper nomination*



CHI PLAY 2015  
*Best paper nomination*



Discovery CHANNEL™

W I R E D

New Scientist

TE





# Designing the physical environment



Game Analysis 2018  
students at Superpark



Bossaball

# Mixed Reality Empowerment



# Mixed Reality Empowerment (2013)



# Valo Jump (2018)



≡

TIME LEFT

00:23

SUPER  
**STOMP**

YOU	4 - 2	OTHER
-----	-------	-------





# Movement Empowerment in a Multiplayer Mixed-Reality Trampoline Game

**Lauri Lehtonen<sup>†</sup>**

Valo Motion

[lauri@valomotion.com](mailto:lauri@valomotion.com)

**Maximus D. Kaos<sup>†</sup>**

Aalto University

[maximus.kaos@aalto.fi](mailto:maximus.kaos@aalto.fi)

**Raine Kajastila**

Valo Motion

[raine@valomotion.com](mailto:raine@valomotion.com)

**Leo Holsti**

Valo Motion

[leo@valomotion.com](mailto:leo@valomotion.com)

**Janne Karsisto**

Valo Motion

[janne@valomotion.com](mailto:janne@valomotion.com)

**Sami Pekkola**

Valo Motion

[sami@valomotion.com](mailto:sami@valomotion.com)

**Joni Vähämäki**

Valo Motion

[joni@valomotion.com](mailto:joni@valomotion.com)

**Lassi Vapaakallio**

Valo Motion

[lassi@valomotion.com](mailto:lassi@valomotion.com)

**Perttu Hämäläinen**

Aalto University

[perttu.hamalainen@aalto.fi](mailto:perttu.hamalainen@aalto.fi)

## ABSTRACT

Insufficient physical activity motivation is a major public health problem. Exergames—games requiring physical exertion—can be designed to support motivation. For example, granting superhuman movement abilities to players has been shown to support one’s feeling of competence, an innate human need and a core intrinsic motivation factor posited by self-determination theory. In this paper, we present Super Stomp, a multiplayer mixed-reality trampoline game that empowers movement by exaggerating jump height both in the real world and in the game. We contribute a novel dual-trampoline game system and game mechanics for implementing engaging

## INTRODUCTION

Lack of exercise is a major public health concern [5, 10]. One way to address the problem is to ensure people are motivated to exercise by satisfying their innate human needs. Games have potential to satisfy these needs, as they can offer a great amount of autonomy (e.g., players can choose which character abilities to enhance and freely explore the game world), can support competence by providing challenging tasks to master, and can support relatedness by including multiplayer features that provide an opportunity for social interaction and bonding. These components—autonomy, competence, and relatedness—are considered innate human needs to satisfy

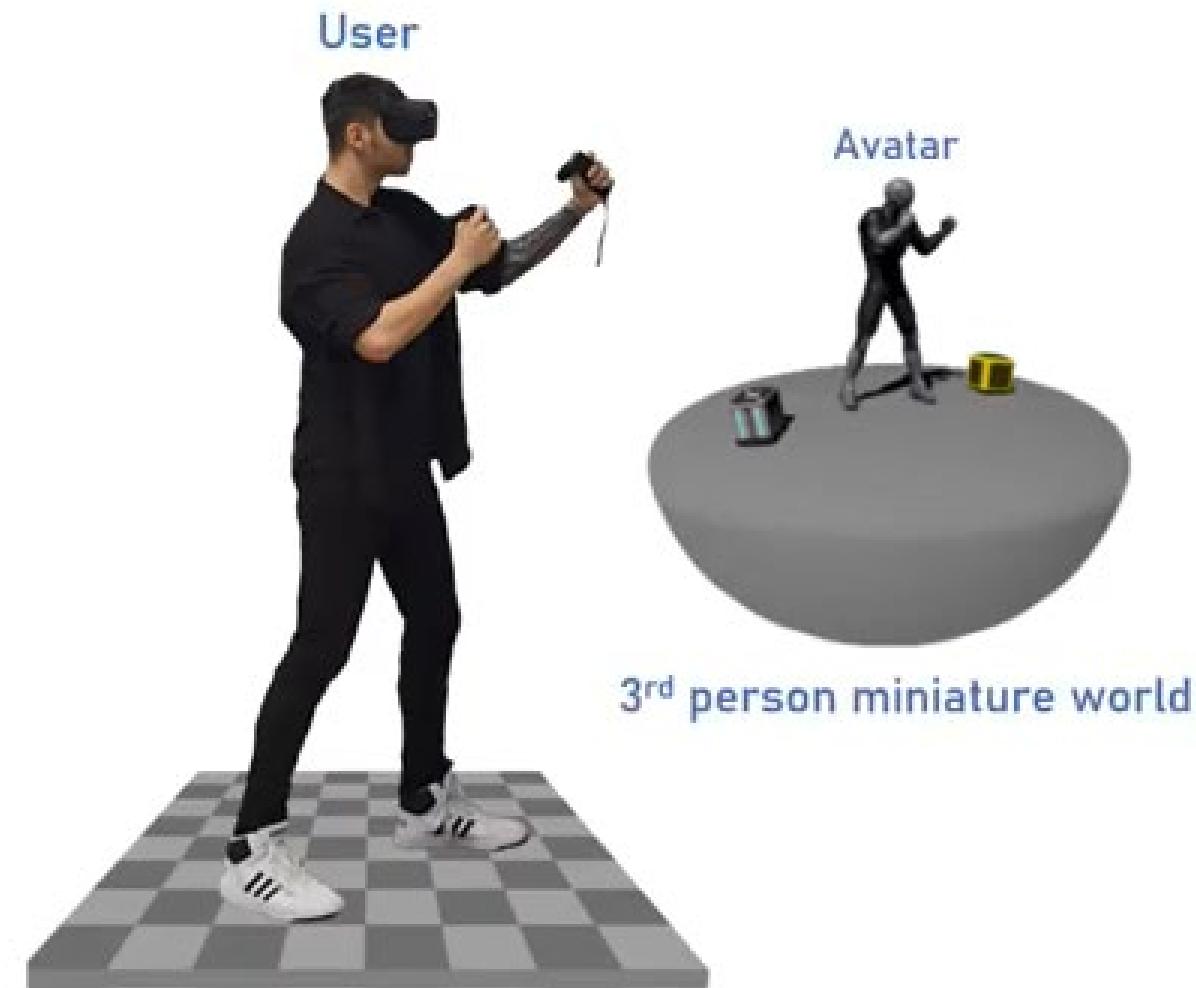


# Challenges of empowered, dynamic movement in VR

- Very hard to achieve the following at the same time:
  1. Natural full-body movement, e.g., martial arts fighting where one moves around, punches and dodges
  2. Navigating large spaces
  3. Low simulator sickness
- Natural 1st person: space limited
- Steering (joystick) locomotion: simulator sickness
- Teleport (the most common VR locomotion): interferes with movement, requires careful aiming



# Intro: A novel VR display and interaction technique



What about curiosity/novelty?



# Interest—The Curious Emotion

Paul J. Silvia

*University of North Carolina at Greensboro*

---

**ABSTRACT**—*Despite their interest in why people do what they do, psychologists typically overlook interest itself as a facet of human motivation and emotion. In recent years, however, researchers from diverse areas of psychology have turned their attention to the role of interest in learning, motivation, and development. This article reviews the emerging body of work on the psychology of interest, with an emphasis on what contemporary emotion research has learned about the subject. After considering four central questions—Is interest like other emotions? What functions does interest serve? What makes something interesting? Is interest merely another label for happiness?—the article considers unanswered questions and fruitful applications. Given interest’s central role in cultivating knowledge and expertise, psychologists should apply research on interest to practical problems of learning, education, and motivation.*

## IS INTEREST AN EMOTION?

Interest is an eccentric emotion. Many theories don’t include interest in their lists of major emotions, and a few theories reject interest as an emotion altogether. Nevertheless, interest has a proud history in emotion psychology. In his landmark book on emotional expression, Charles Darwin (1872/1998) described emotions related to learning, thinking, and exploring. Darwin’s terms—*abstracted meditation, perplexed reflection, and stupefied amazement*—seem quaint to modern readers, but his ideas remain ahead of their time. Many decades later, modern emotion psychology doesn’t know much about what I’ll call *knowledge emotions*: states such as *interest, confusion, surprise, and awe*.

A good case can be made for viewing interest as an emotion. Modern theories of emotion propose that emotions are defined by a cluster of components. Typical emotional components are physiological changes, facial and vocal expressions, patterns of







## Curious exploration of movement







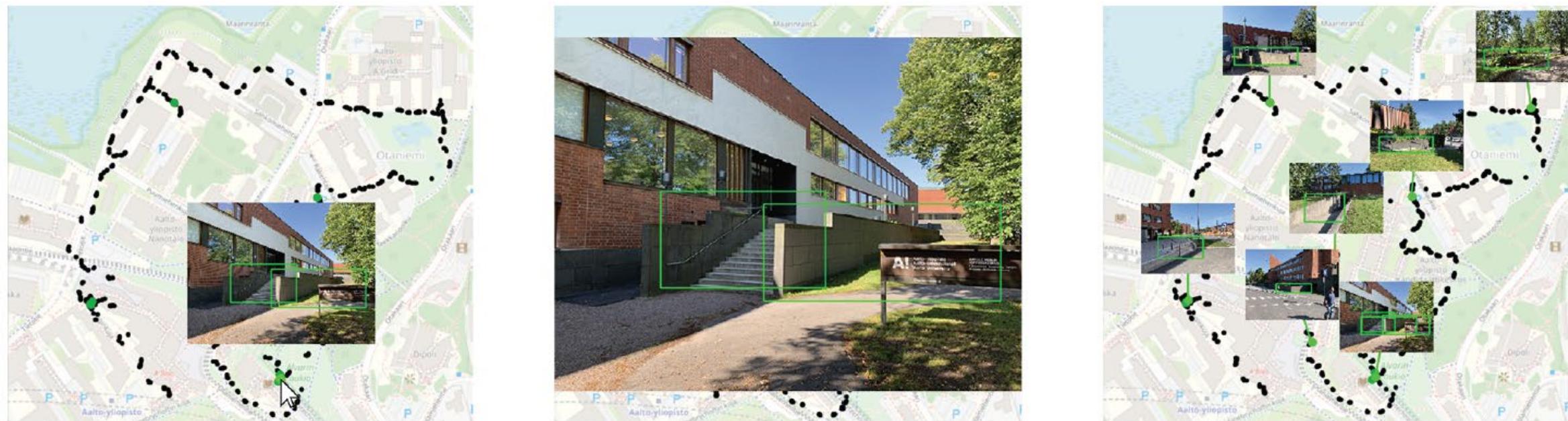


# Automatic Recognition of Playful Physical Activity Opportunities of the Urban Environment

Tuure Saloheimo<sup>1</sup>, Maximus D. Kaos<sup>2</sup>, Pia Fricker<sup>1</sup>, Perttu Hämäläinen<sup>1</sup>

1) Aalto University

2) University of Southern Denmark



**Figure 1:** Our neural network detects parkour spots from street level photographs. The figure shows example visualizations of the results. Left: map view with dataset images as black and green dots, green ones containing detected spots. The image closest to the mouse pointer is shown to allow quick browsing of the data. Middle: mouse click expands the image. Right: visualizing the top-scoring detections.



# Curiosity/novelty through crafting mechanics



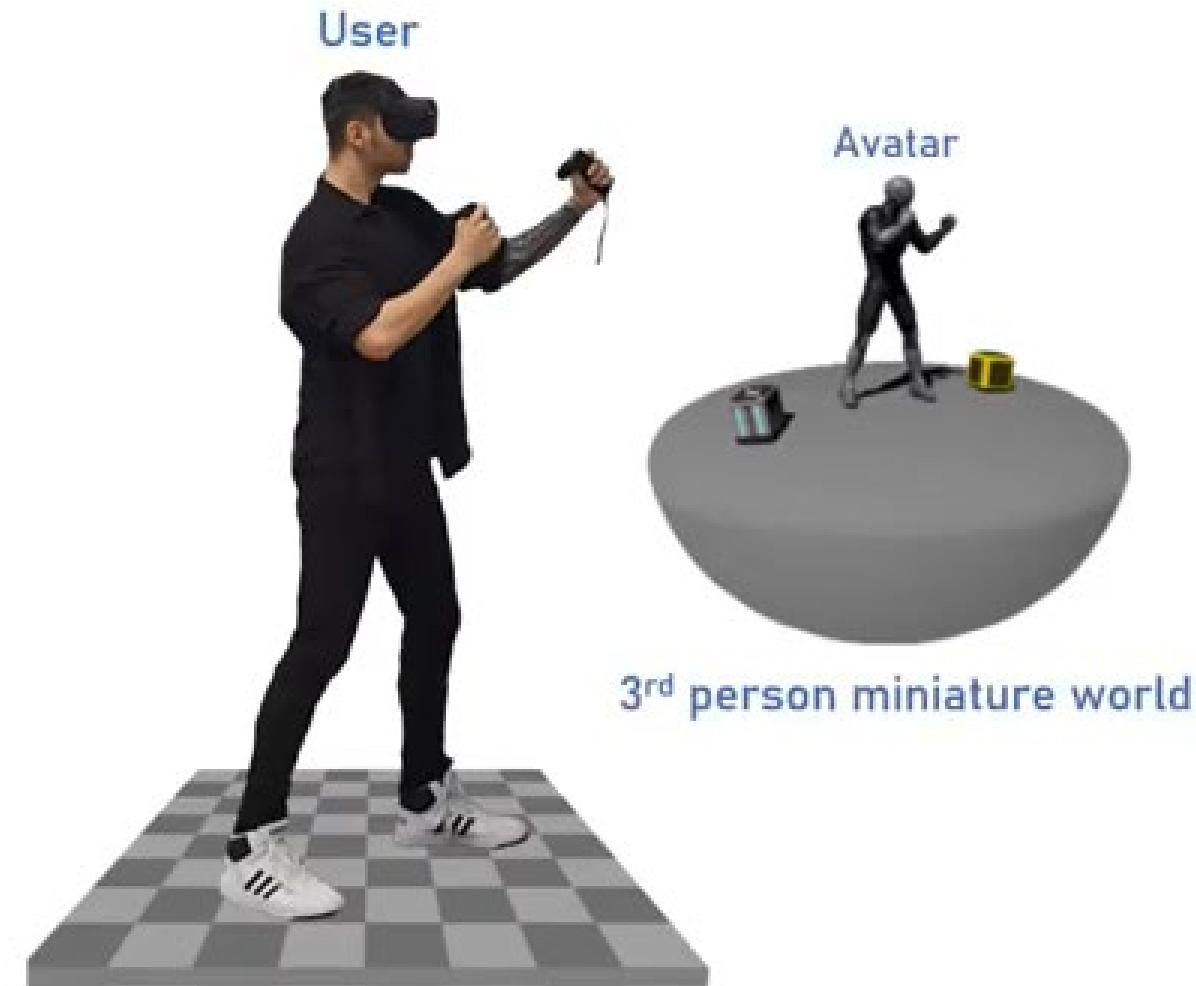
# Curiosity/novelty through user-generated content

x2





# Intro: A novel VR display and interaction technique



Papers, videos, contact:  
<http://perttu.info>  
<http://valomotion.com>

# Takeaways

- Empower what the user cannot develop rapidly during a game
- If you can't empower, diversify the palette of challenges
- Mixed Reality Empowerment – design both the digital and the physical
- More generally: Which intrinsic motivation factors can you support?





# Want to work on movement empowerment in VR?



CS department summer employee call now open (you can also email me directly):

<https://www.aalto.fi/en/department-of-computer-science/summer-employee-positions-at-the-department-of-computer-science-2022>