

Shaping Human Performance for a Better (HCI) Future: Explorations in Games and Mixed Reality for Good

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Director of RIDSAI: Research Institute for Data Science and Artificial Intelligence

Director of Human-Computer Interaction Lab

Associate Professor, Faculty of Computer Science



SPECTRAL
Spatial Computing Research Centre





New Brunswick

Nouveau-Brunswick
Canada



Directions



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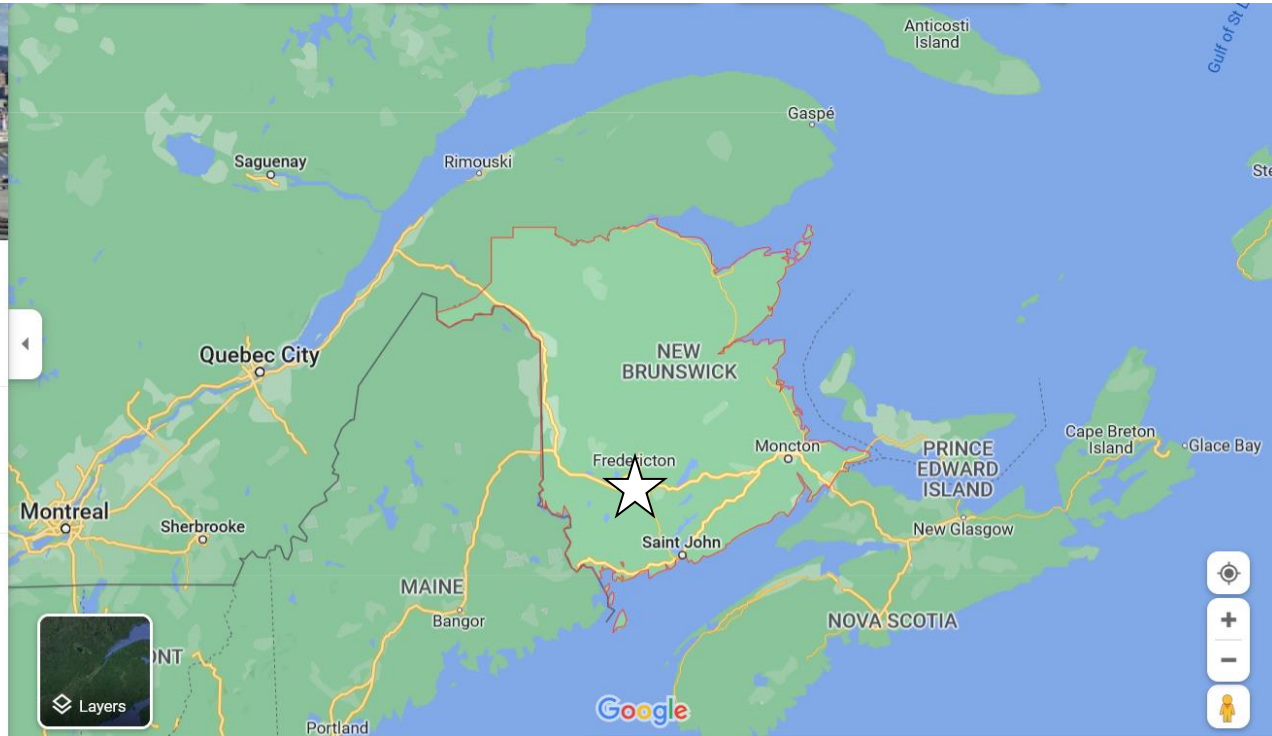
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phone



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Quick facts

New Brunswick is one of the ten provinces of Canada. It is one of the three Maritime provinces and one of the four Atlantic provinces. It is the only province with both English and French as its official languages. [Wikipedia](#)



The joker and queen featuring [@taylorswift13](#) is out right now. Me and Taylor first met and wrote + recorded our first song together in 2012, ten years ago now, I'm so so honoured to have her on this song. es.lnk.to/TJATQ



1:12 AM · Feb 11, 2022 · Twitter Media Studio



Lecture Contents

- Balancing Competition -> Frameworks for Designing Game Mechanics
- The Effect of Existing Game Designs on Performance and Experience
- Games for Learning: Software, Sports, and Careers
- Games for Therapy and Health

Balancing Competition -> Frameworks for Designing Game Mechanics

Target Assistance for Subtly Balancing Competitive Play

Scott Bateman, Regan Mandryk, Tadeusz Stach,
Carl Gutwin

CHI 2011 -  **Honorable Mention Award**





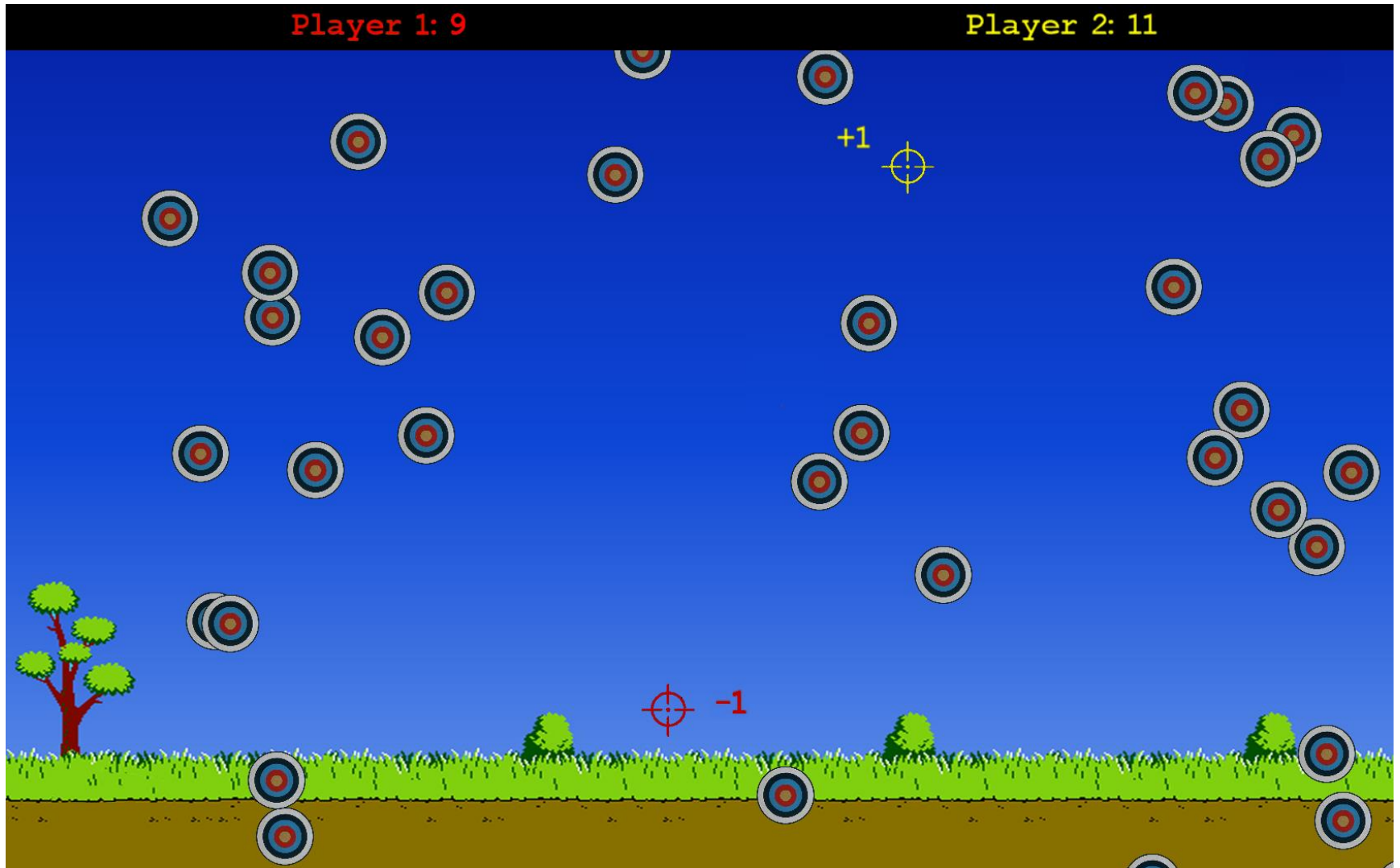








Target Assistance for Games



Shooting Gallery Game

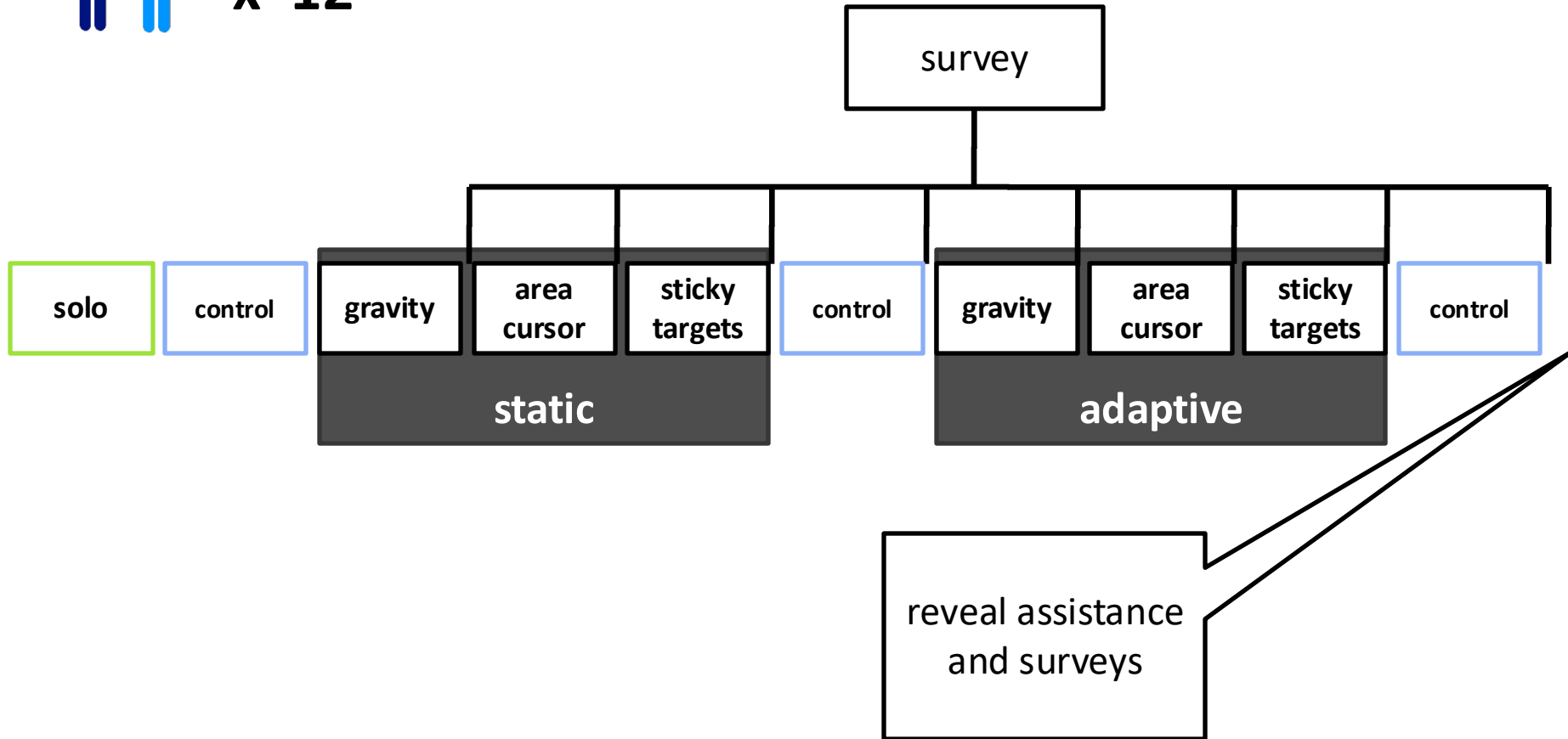
Study

- Does target assistance work?
 - Does it increase competition?
 - Does it increase enjoyment?
- Do players notice target assistance?
- Is it fair for players to receive assistance?
- Can target assistance be applied adaptively?

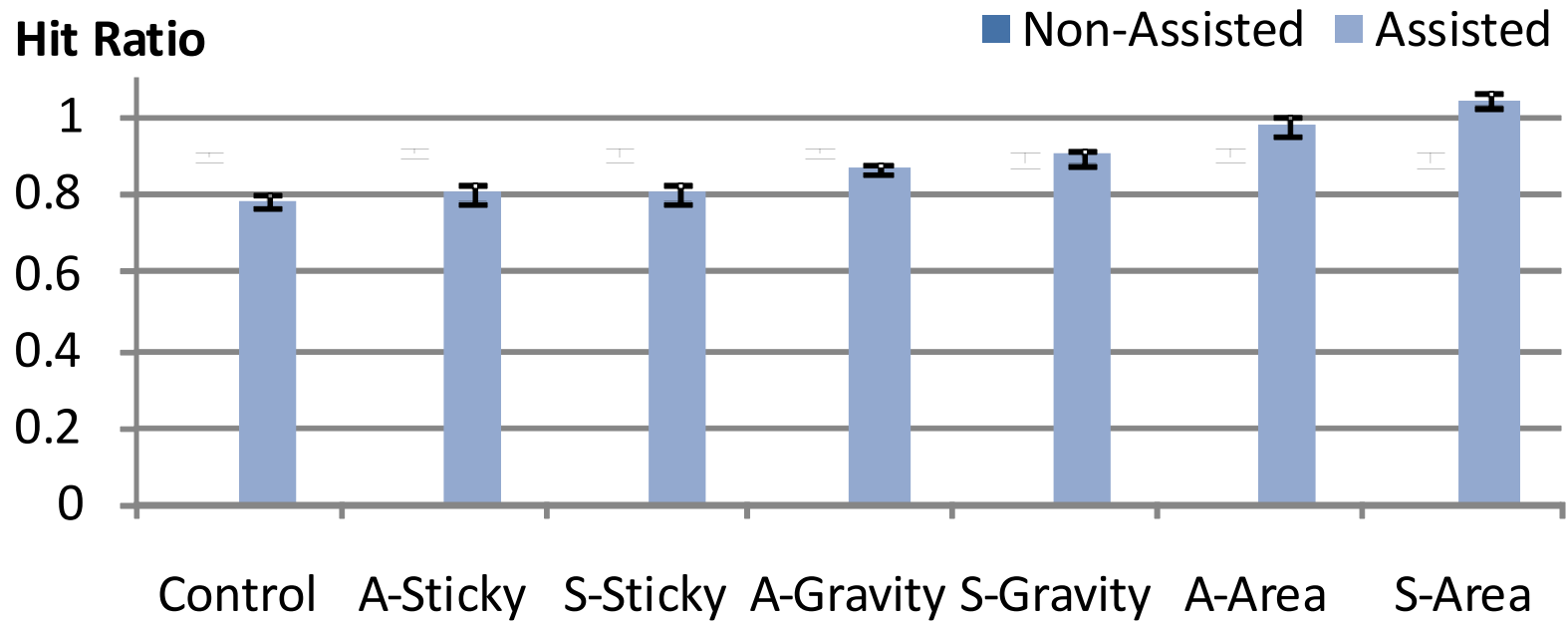
Study Design



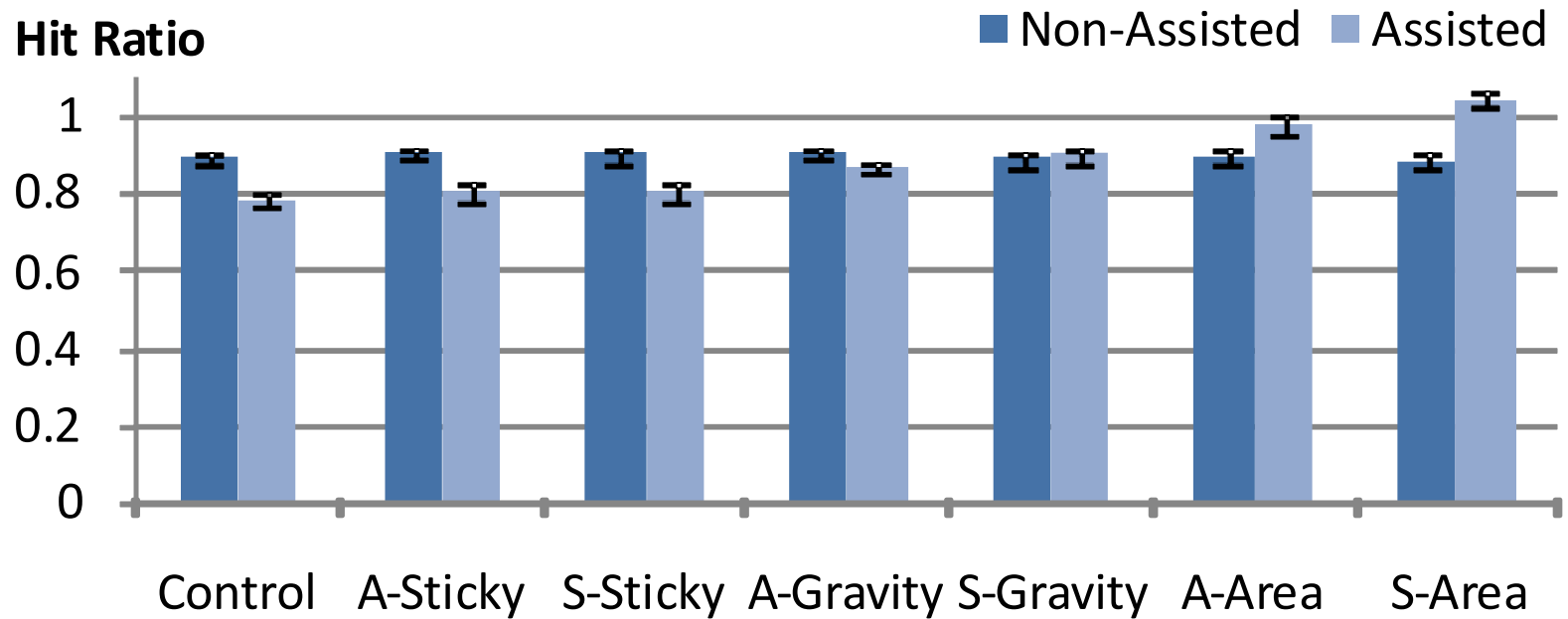
x 12



Increase competition?

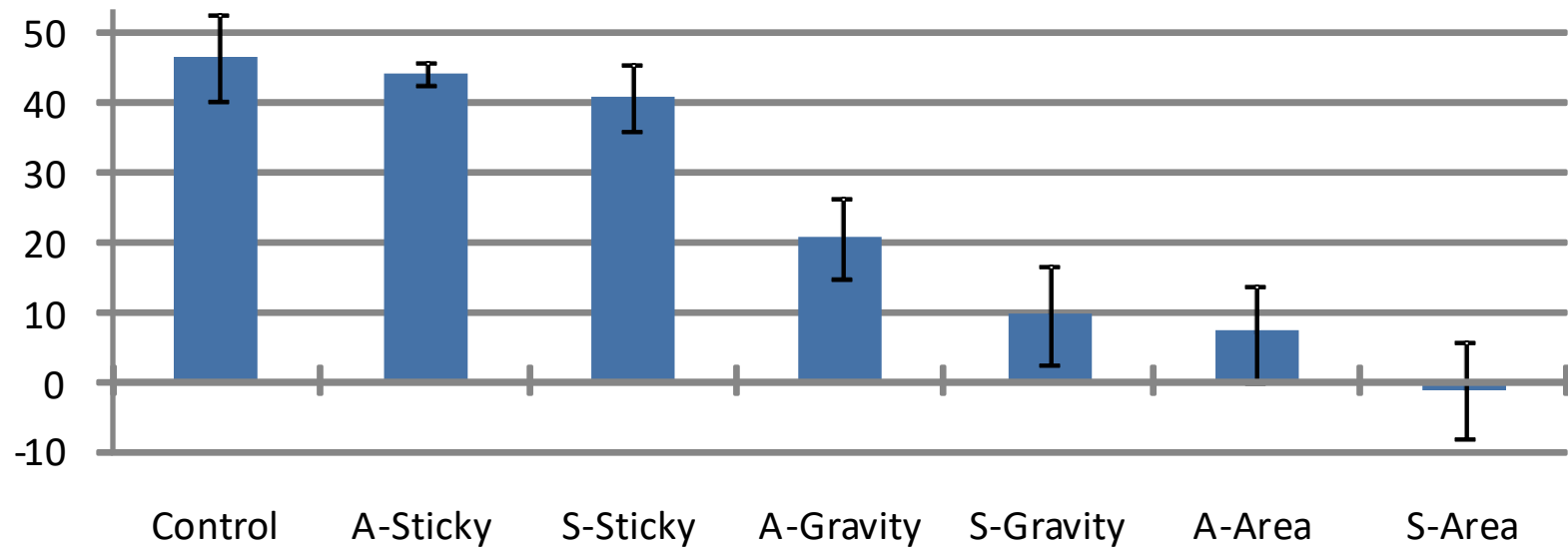


Does target assistance work?

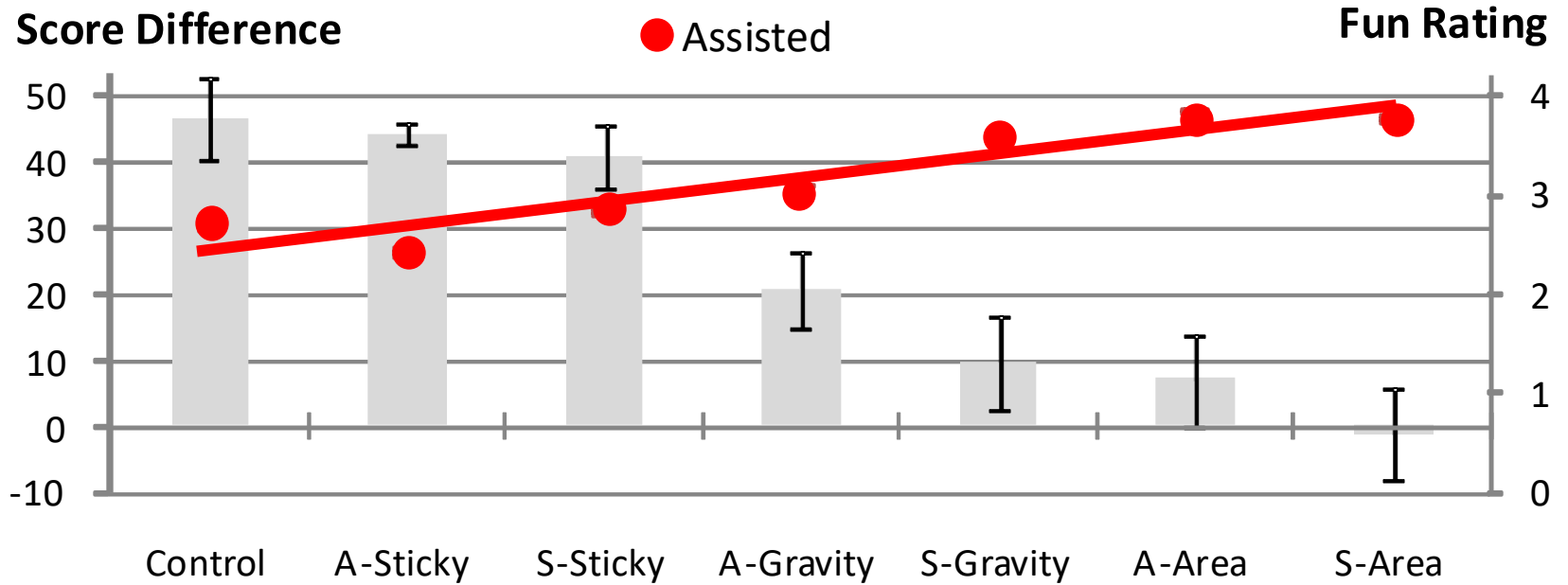


Competition

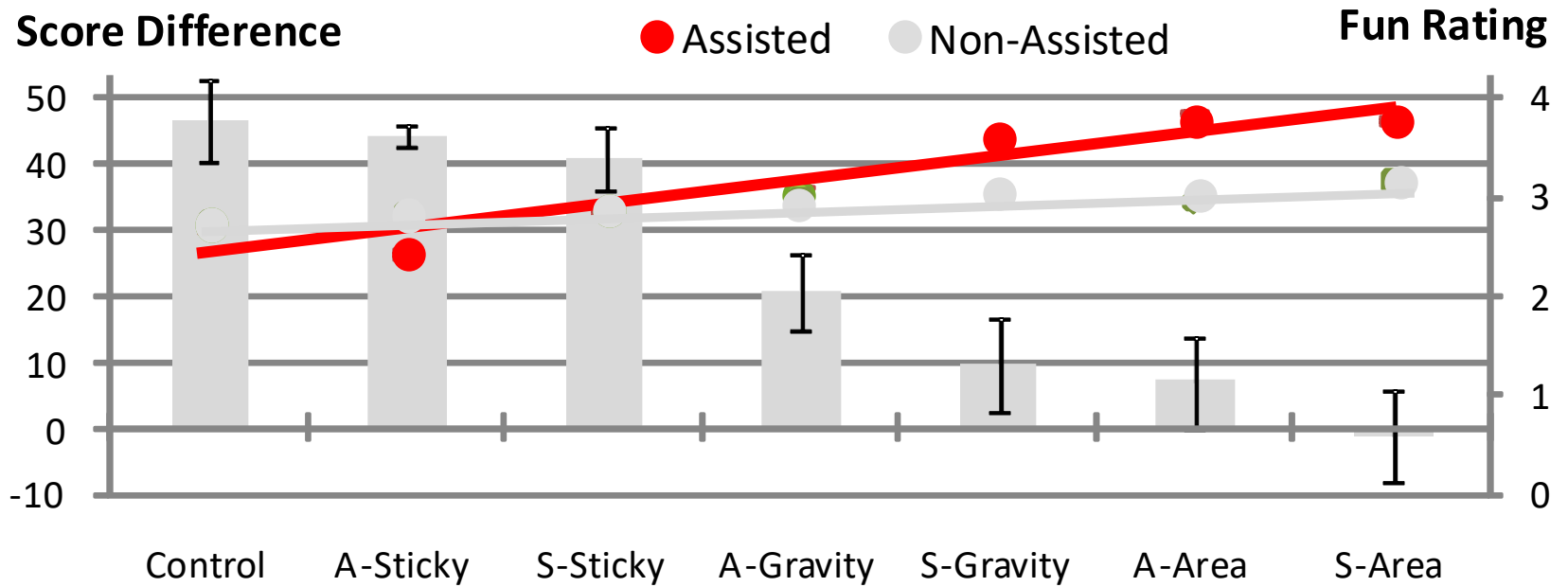
Score Difference



Competition and Fun



Competition and Fun



Players' feelings about assistance

Was the game fair?

	Assisted		Non-assisted	
	fair	unfair	fair	unfair
Before finding out	12	0	10	2
After finding out	5	7	10	2

Players' feelings about assistance

Was the game fair?

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Players' feelings about assistance

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Adaptive versus Static Assistance

- Static techniques led to more wins than adaptive techniques
- Both approaches increase competition
 - Adaptive did not change the outcome
 - Static technique did change the outcome



Improving Player Balancing in Racing Games

Jared Cechanowicz
Carl Gutwin
Scott Bateman*
Regan Mandryk
Ian Stavness

CHI PLAY 2014

University of Saskatchewan

*University of Prince Edward Island

CHI PLAY 2024 10-year lasting impact award

- Player balancing improves gameplay in racing games
- Enables competition between players of different skill

Game balancing and player balancing

- *Game balancing tries to make games “fair”*
 - Focus on consistency of game mechanics and outcomes

- *Player balancing tries to make games “fun”*
 - Focus on providing the best experience for all



Player balancing

- Alter game mechanics to make up for skill differences
- Goal:
 - More competitive
 - Less frustrating
 - Less boring

Suspense and Enjoyment

- Preference for games with more suspense
 - Suspense comes from not knowing the outcome

Abuhamdeh, Csikszentmihalyi, Jalal, 2014

What makes races feel competitive?

What makes races feel competitive?

- Chance of winning or losing



What makes races feel competitive?

- Chance of winning or losing
- Leader is within range



What makes races feel competitive?

- Chance of winning or losing
- Leader is within range
- Lead changes



Racing Games

What leads to good performance?

- 3 basic mechanics

- Steering

- Top speed

- Acceleration



Assists in Racing Games

- Forza 4, selectively assists for 7 mechanisms

- stability control
- traction control
- braking
- steering
- shifting
- damage
- visual path guidance



- People use assists, even when they become more expert
 - Debeauvais, et al. 2014

Mario Kart



Game and Study

GroupLab
University of Calgary

2nd

/3
Laps



Current: -0:04.88
Best: 0:00.00

the interaction lab
University of Saskatchewan

1st

/3
Laps



Current: -0:04.88
Best: 0:00.00

Balancing a racing game

- How to assist?
- Who to assist?
- When to assist?

How to assist?

- By manipulating 3 basic mechanisms
 - Steering
 - Top speed
 - Acceleration
- How much assistance?
 - Not overly obvious

How to assist?

- By manipulating 3 basic mechanisms
 - Steering
 - Top speed
 - Acceleration
- How much assistance?
 - Not overly obvious

Who to assist?

- Assists for weaker player
- Hindrance for stronger player

Pilot Study on Noticeability

- Players didn't notice hindrance
- Players noticed assistance

- Mechanisms can be combined
 - Less obvious more benefit

When to apply the assistance?

- Distance differential

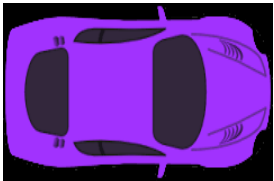
When to apply the assistance?

- Distance differential
- Many different to apply balancing mechanisms
 - We studied 4 different schemes

Raw Distance: RealTime 100

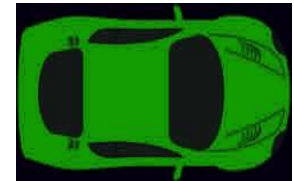
Assistance

+1 to each mechanism



Hindrance

-1 to each mechanism



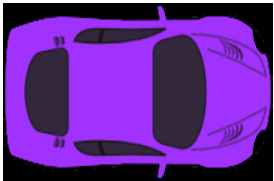
100 meters

- For each 100 meters
 - +1 top speed = 5 mph higher
 - +1 acceleration = reach top speed 10% sooner
 - +1 steering = 1 unit towards centre line
- Maximum effect at 500m

Raw Distance: RealTime 40

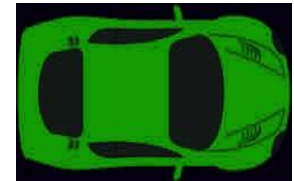
Assistance

+1 to each mechanism



Hindrance

-1 to each mechanism



40 meters

- For each 40 meters
 - +1 top speed = 5 mph higher
 - +1 acceleration = reach top speed 10% sooner
 - +1 steering = 1 unit towards centre line
- Maximum effect at 200m

Rolling Average

- Similar to RealTime 100

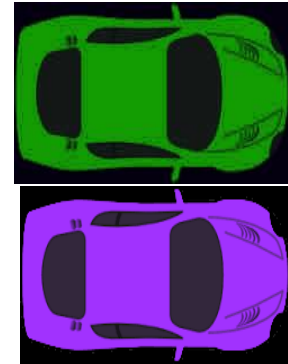
Assistance

+1 to each mechanism

50s

Hindrance

-1 to each mechanism



100 meters

Maximum effect = 500 m.

Maximum Distance

Assistance

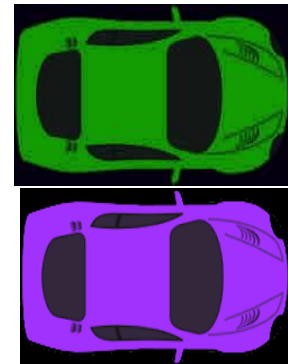
+3 to each mechanism

Assistance

+3 to each mechanism

Hindrance

-3 to each mechanism



Works like RealTime 100, but

- level of assistance is equivalent to the maximum level previously reached, and applied after 50 m.

Study

- 30 Participants
 - Identified as expert or novice
 - 15 experts and 15 novices
- Participants told they were playing a real person in another lab
- Experts played novice simulation
- Novice played expert simulation



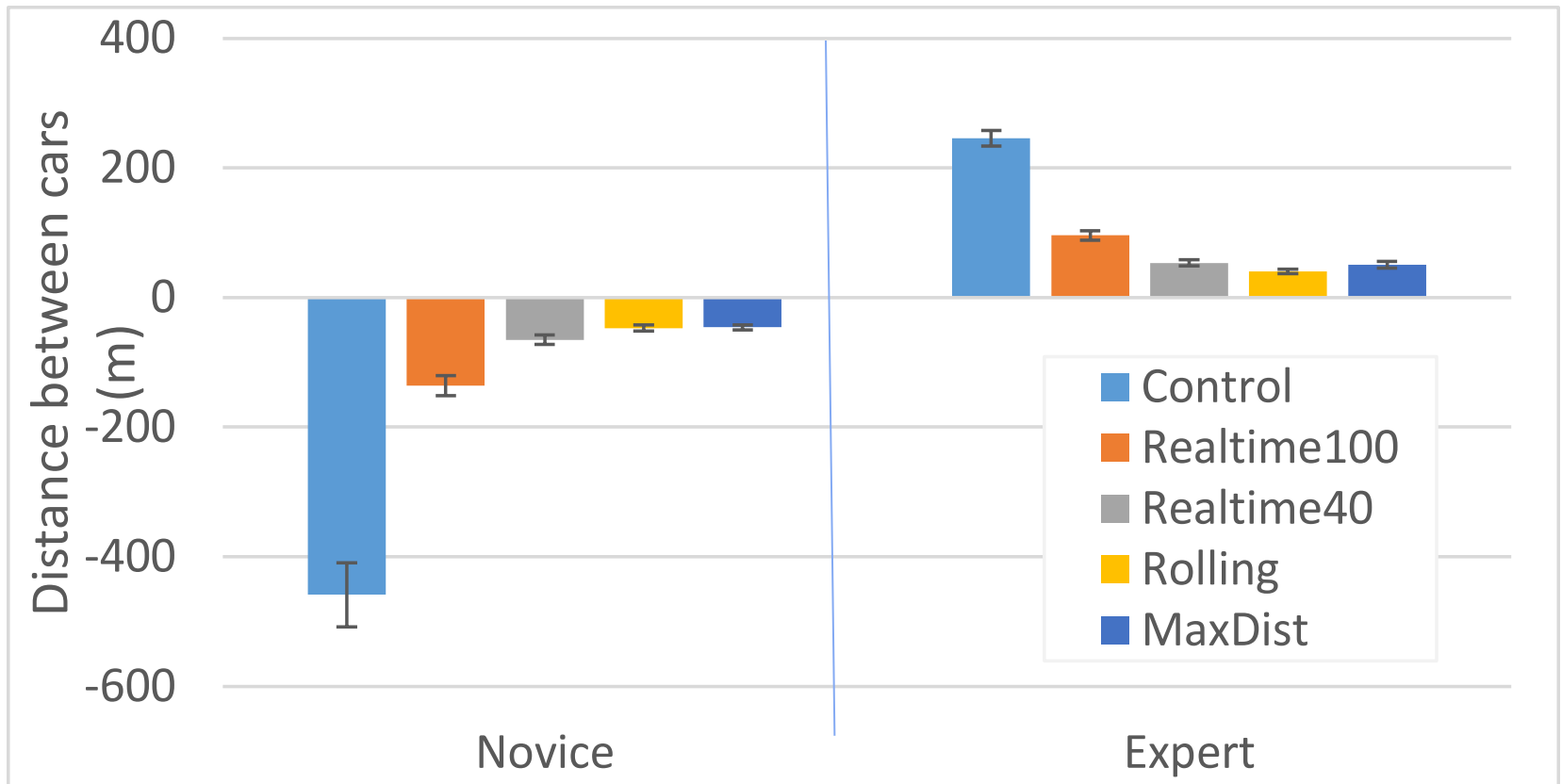
Simulated Drivers

- Based on pre-recorded traces of experts and novices
 - Added variability
- Provides a consistent and reliable level of performance
- Allowed us to apply assistance and hindrance directly

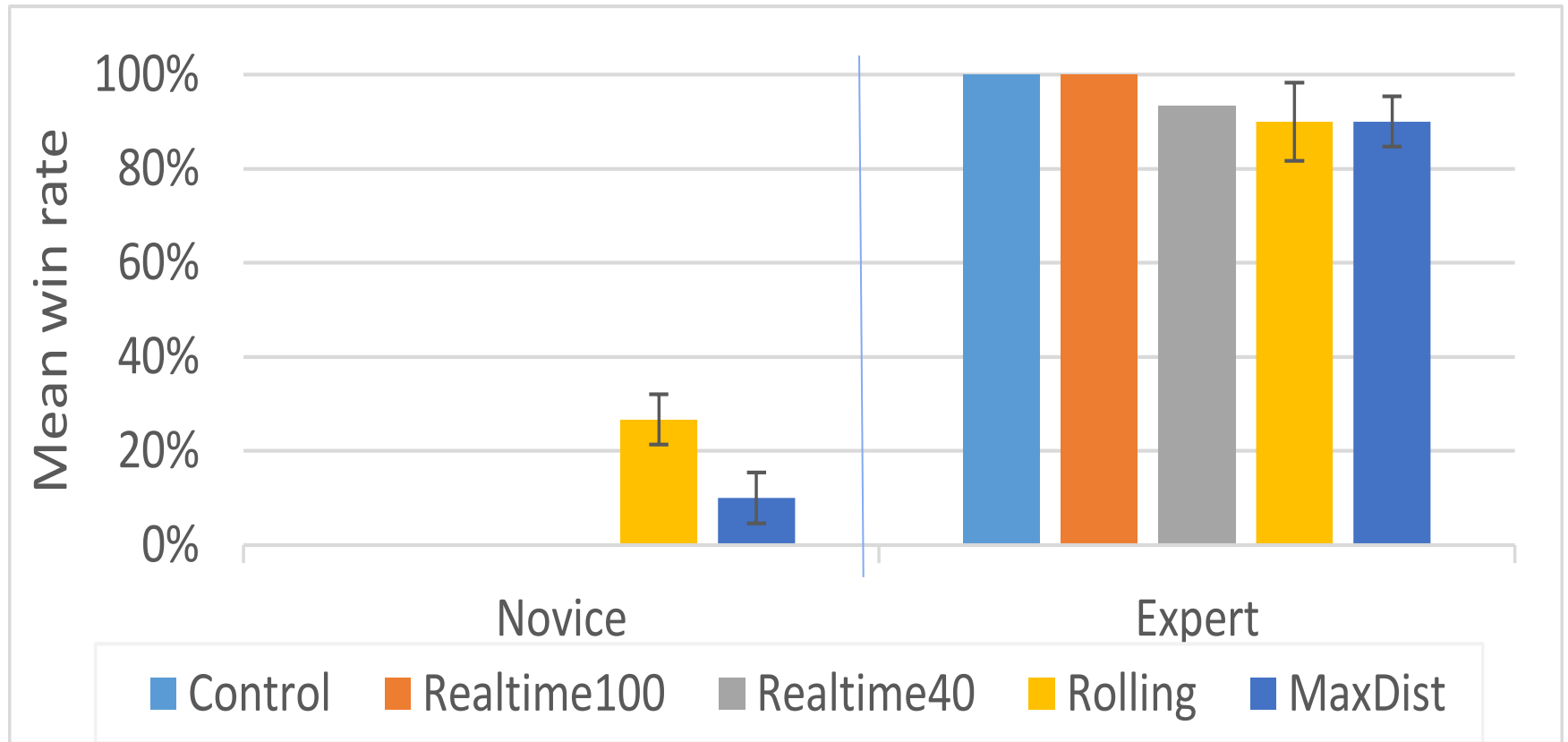
Evaluation

- Which adaptation scheme worked best?
- What effects they had on play experience?
 - wins and losses
 - distance between cars
 - lead swaps
 - subjective experience

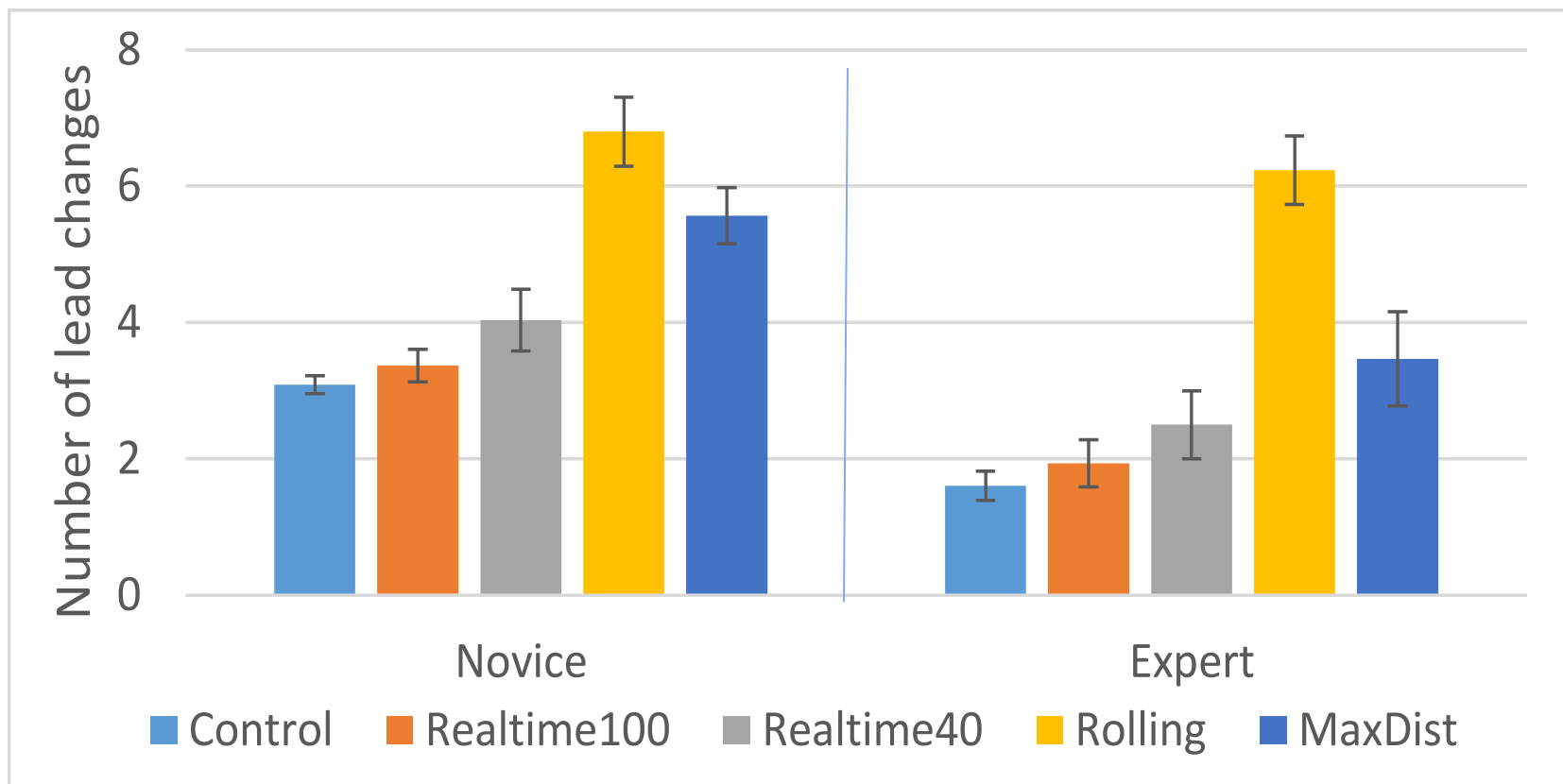
Effects on balancing: distance between cars



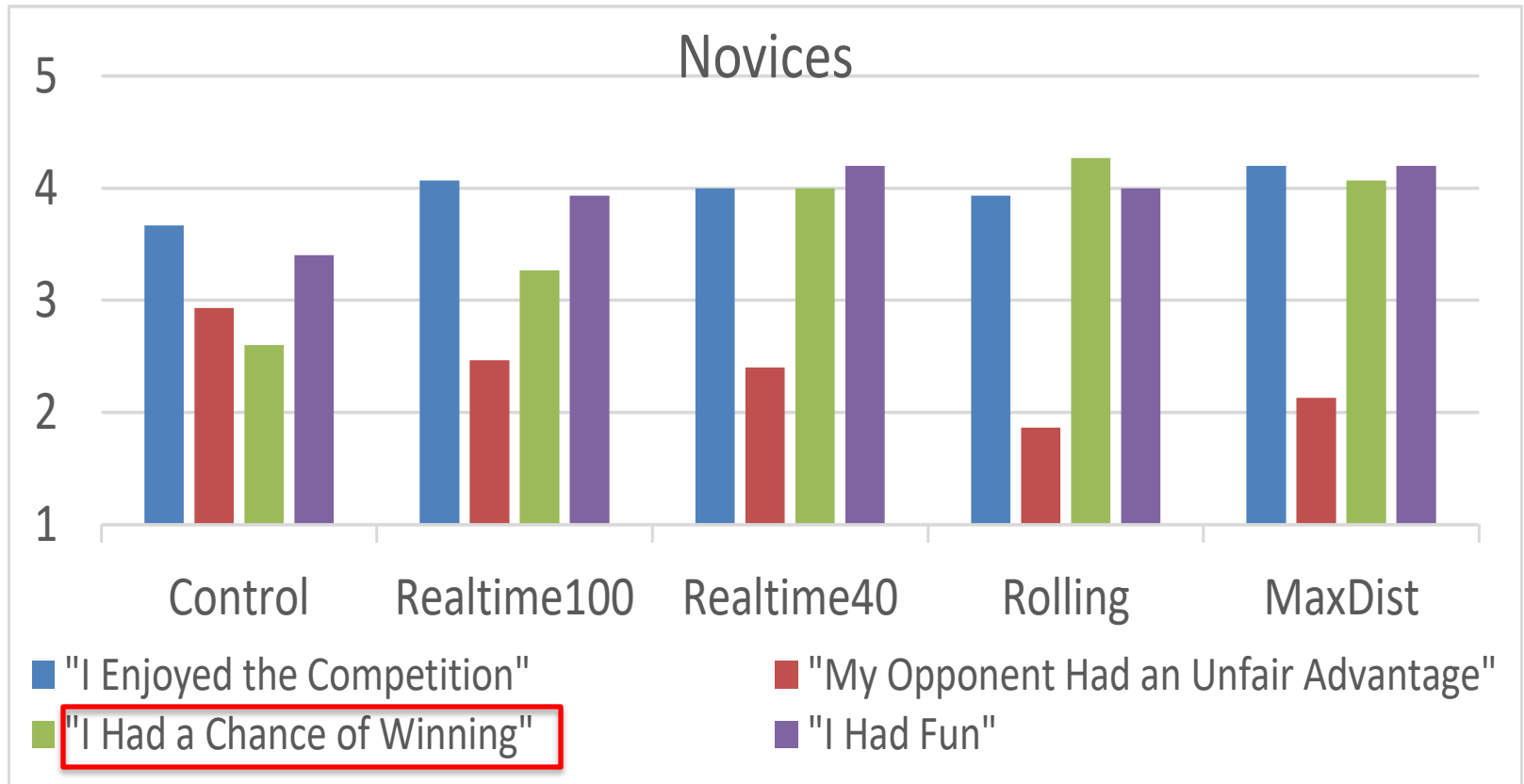
Effects on balancing: wins and losses



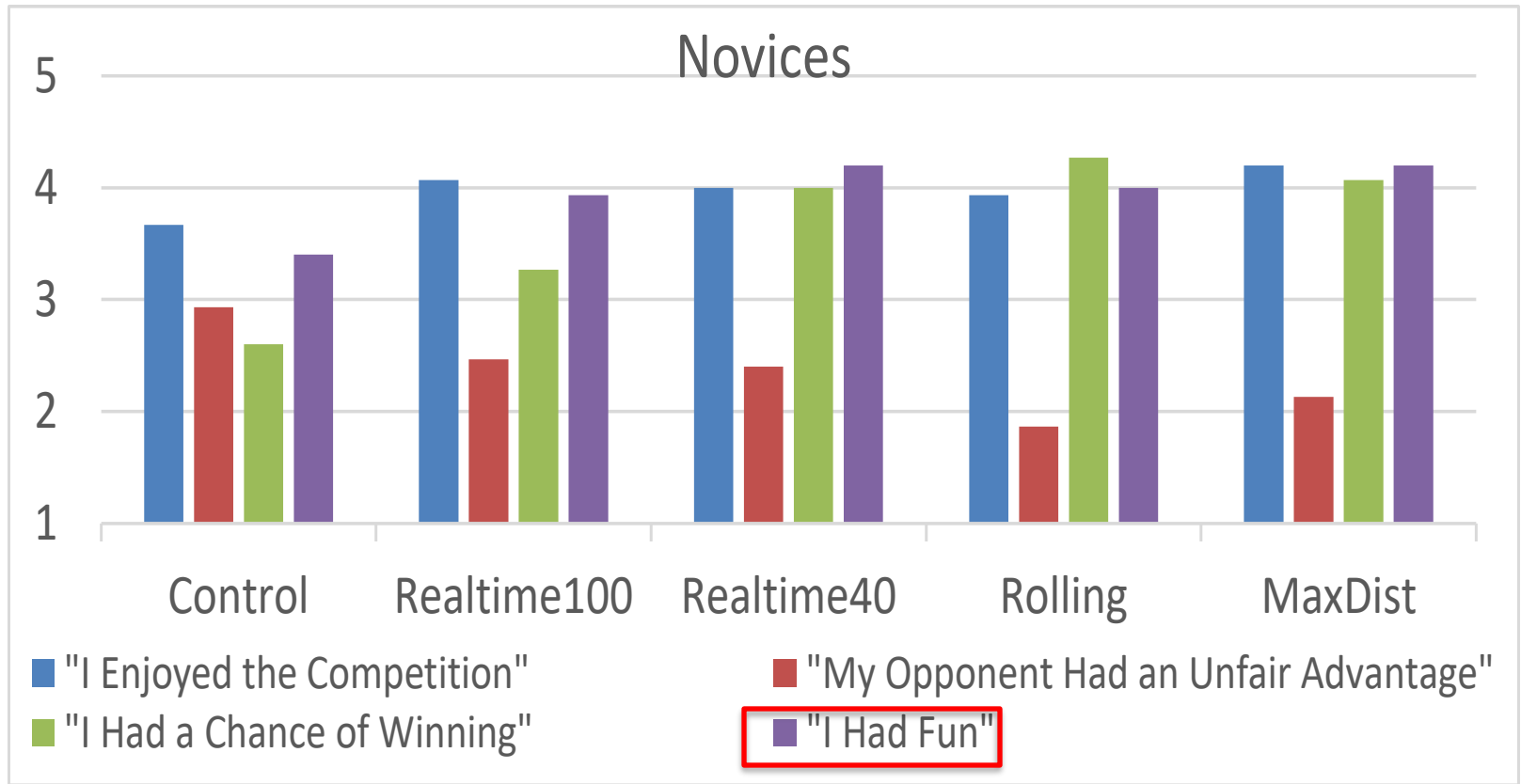
Effects on balancing: lead changes



Effects on player experience: novices



Effects on player experience: novices



Effects on player experience: experts



Summary of findings

- Player balancing worked well
- Schemes for applying balancing mechanisms work differently
 - Rolling works best for leads swaps
 - Maximum Distance works best for keeping close
 - Rolling and Max. Dist help novices win
 - RealTime40 works well, no as aggressive
- Multiple mechanisms helped reduce obviousness
- No real downside in player experience

Assistance in First-Person Shooters

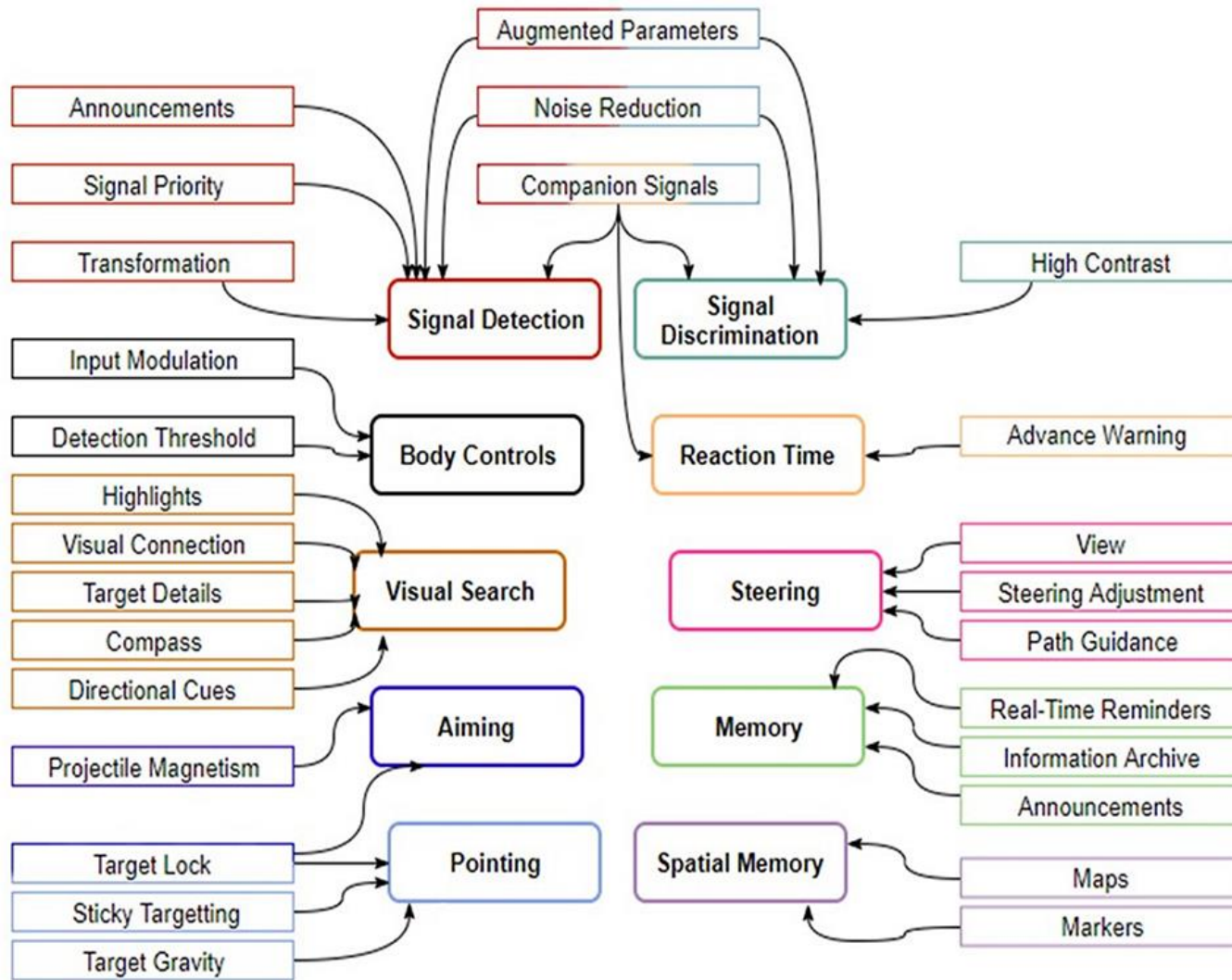


Applying the idea to other domains



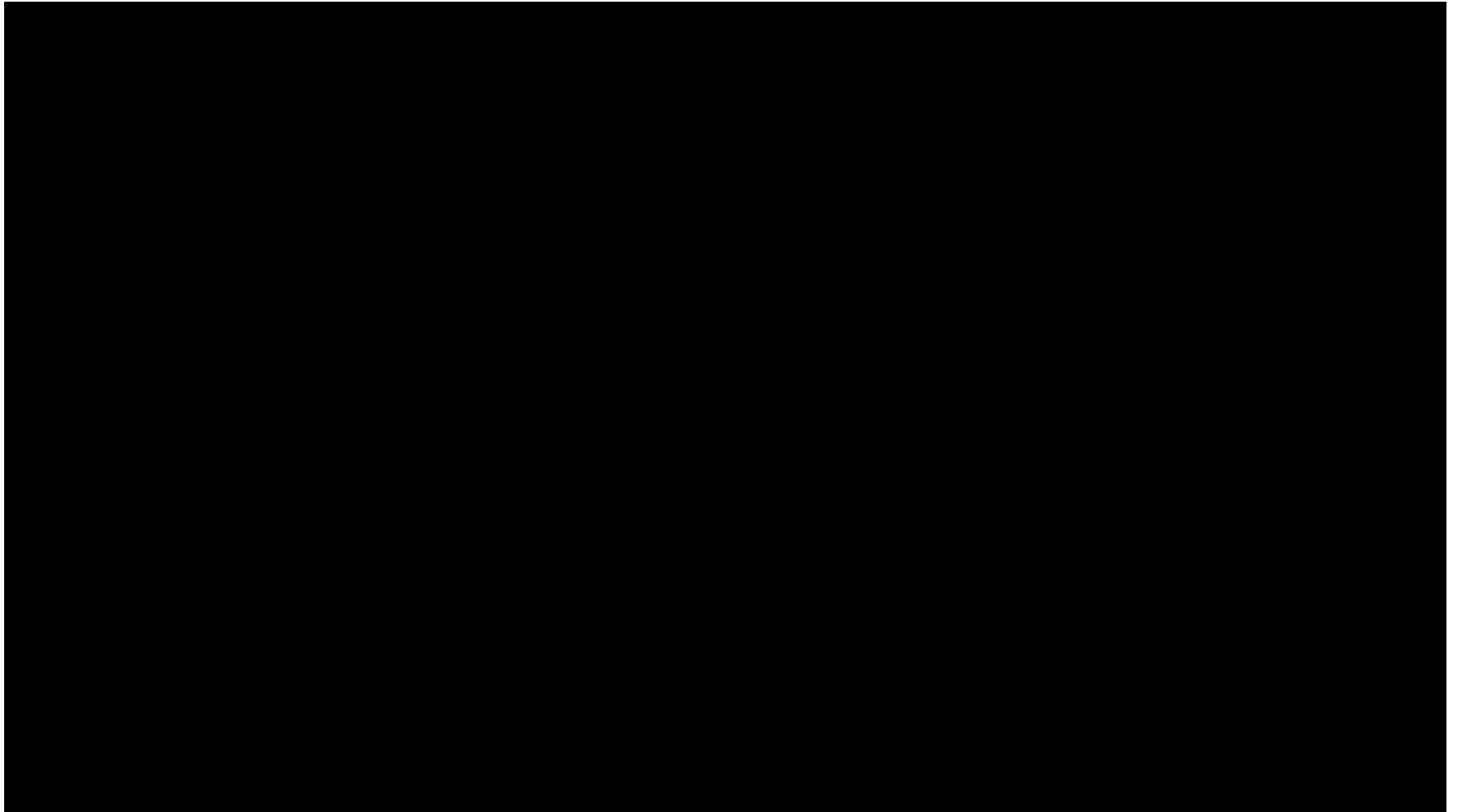
ASOKAN, Vinod; BATEMAN, Scott; and TANG, Anthony. Assistance for target selection in mobile augmented reality. (2020). *Proceedings of Graphics Interface 2020, University of Toronto, May 28-29*. 1-10.


Generalizing what we learned



Jawad Jandali Refai, Scott Bateman, and Michael W. Fleming. External Assistance Techniques That Target Core Game Tasks for Balancing Game Difficulty. *Frontiers in Computer Science* 2 (2020), 1–16.

Others building on these ideas



Bastian Ilsø Hougaard and Hendrik Knoche. 2024. Aiming, Pointing, Steering: A Core Task Analysis Framework for Gameplay. Proc. ACM Hum.-Comput. Interact. 8, CHI PLAY, Article 292 (October 2024), 48 pages.  **Best Paper.**

Understanding the Effect of Existing Game Designs on Performance and Experience



The Effects of Hand Representation on Experience and Performance for 3D Interactions in Virtual Reality Games

Nicholas Balcomb, University of New Brunswick, Fredericton, Canada
Max V. Birk, TU/e Eindhoven, Eindhoven, Netherlands
Scott Bateman, University of New Brunswick, Fredericton, Canada

CHI PLAY 2023

Hand Representations

Sphere



Study

Controller



Hand



Mass (2018)



Game Example

Keep Talking and Nobody Explodes (2015)



Half-Life: Alyx (2021)



8

VR Games & Hands

- **Virtual Hands:** The primary method for representing how we interact with the virtual world



Moss (2018)



Keep Talking and Nobody Explodes (2015)



Half-Life: Alyx (2020)

Research Questions

- Helps VR game designers understand the **impact** of virtual hand representation
 1. Does hand representation affect performance?
 2. Do hand representations perform differently during different interactions?
 3. Does hand representation affect player experience?

Hand Representations

Sphere



Controller



Hand



Moss (2018)



Keep Talking and Nobody Explodes (2015)



Half-Life: Alyx (2020)



Study

Game Example

Hand Representations

Sphere



Controller



Hand



Study

Moss (2018)



Keep Talking and Nobody Explodes (2015)



Half-Life: Alyx (2021)



Game
Example

What makes bad guys look like bad guys?

Reyhan Pradantyo, Max V. Birk, and Scott Bateman. 2021. How the Visual Design of Video Game Antagonists Affects Perception of Morality. *Frontiers in Computer Science* 3 (2021), 17.
<https://doi.org/10.3389/fcomp.2021.531713>



Intro → Consent → MTurk ID → Demographics → Instructions → **Characters** → End

1

1 of 105 characters

[Instructions](#)

2



3

4

Is the following feature prominent in the design of this character?
Eyebrows

5.1

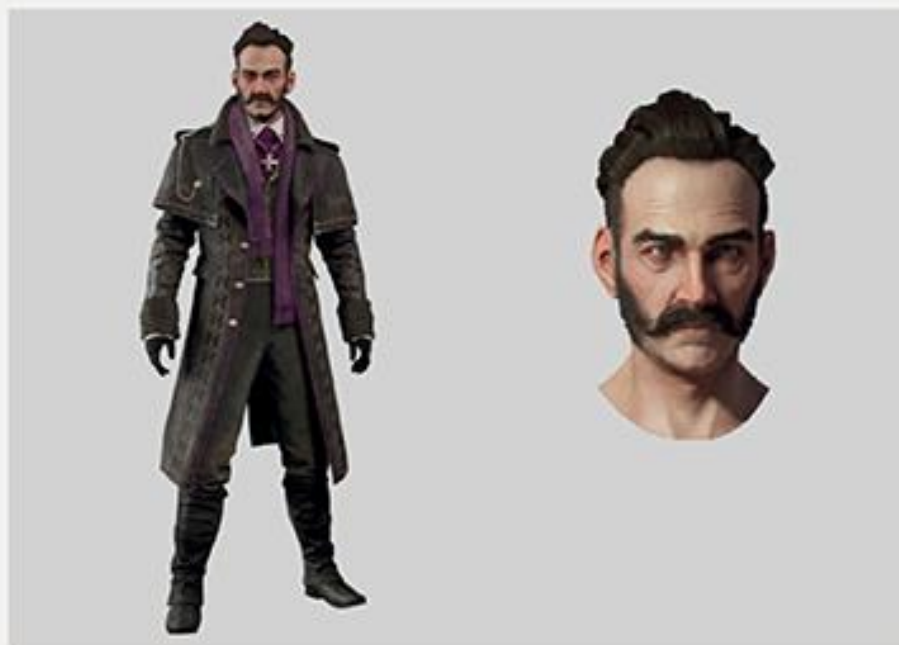
Yes

No

Intro → Consent → MTurk ID → Demographics → Instructions → **Characters** → End

2 of 105 characters

[Instructions](#)



Rate your agreement:

5.2

This character would physically hurt another person.

Strongly Disagree



Disagree



Slightly Disagree



Neutral



Slightly Agree



Agree



Strongly Agree



Continue



Tsumugi Shirogane
Danganronpa V3: Killing Harmony
NIS America, 2017

Care/harm: **moral**
Fairness/reciprocity: **moral**
Ingroup/loyalty: **moral**
Authority/respect: **moral**
Purity/sanctity: **moral**

Eyes: 85.1% Hair/lack of hair: 90.74%
Clothing: 87.03% Masculinity/femininity:
61.11%



Lonnie
The Walking Dead: A New Frontier
Telltale Games, 2016

Care/harm: **slightly moral**
Fairness/reciprocity: **moral**
Ingroup/loyalty: **moral**
Authority/respect: **moral**
Purity/sanctity: **moral**

Skin colour: 69.64% Clothing: 51.78%
Stance: 41.07% Nose: 41.07%



Cleopatra
Assassin's Creed Origins
Ubisoft, 2017

Care/harm: **moral**
Fairness/reciprocity: **slightly moral**
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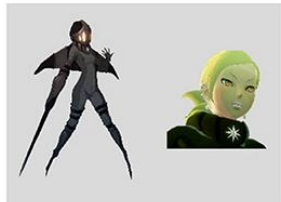
Clothes: 100% Jewelry/accessories:
92.98% Hair: 80.70% Attractiveness:
71.93%



Yuriko
Shin Megami Tensei IV: Apocalypse
Atlus, 2016

Care/harm: **moral**
Fairness/reciprocity: **slightly moral**
Ingroup/loyalty: **slightly immoral**
Authority/respect: **slightly moral**
Purity/sanctity: **slightly moral**

Hair: 80.70% Clothing: 80.70%
Masculinity/femininity: 75.44%
Attractiveness: 73.68%



Yunica
Gravity Rush
Sony Interactive Entertainment, 2017

Care/harm: **slightly immoral**
Fairness/reciprocity: **slightly moral**
Ingroup/loyalty: **slightly moral**
Authority/respect: **slightly moral**
Purity/sanctity: **moral**

Clothing: 98.11% Stance: 88.68%
Weapons: 86.79% Face cover: 77.36%



Aaron Keener
The Division 2
Ubisoft, 2019

Care/harm: **immoral**
Fairness/reciprocity: **slightly immoral**
Ingroup/loyalty: **slightly moral**
Authority/respect: **slightly immoral**
Purity/sanctity: **slightly moral**

Weapons: 84.21% Face cover: 98.25%
Clothing: 91.23% Eyes: 54.39%



Heiss
Radiant Historia
Atlus, 2010

Care/harm: **slightly moral**
Fairness/reciprocity: **slightly immoral**
Ingroup/loyalty: **immoral**
Authority/respect: **slightly immoral**
Purity/sanctity: **slightly immoral**

Hair/lack of hair: 96.23% Nose: 96.23%
Clothes: 92.45% Facial hair: 66.04%



Kaos
Skylanders: Imaginators
Activision, 2016

Care/harm: **slightly immoral**
Fairness/reciprocity: **slightly immoral**
Ingroup/loyalty: **slightly immoral**
Authority/respect: **immoral**
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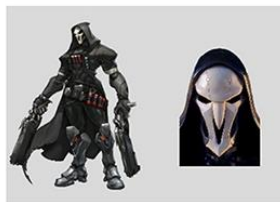
Eyes: 98.28% Hair/lack of hair: 87.93%
Height: 82.76% Tattoos: 74.14%



Heihachi
Tekken 7
Bandai Namco Entertainment, 2015

Care/harm: **immoral**
Fairness/reciprocity: **slightly immoral**
Ingroup/loyalty: **slightly immoral**
Authority/respect: **slightly immoral**
Purity/sanctity: **slightly immoral**

Clothes: 100% Hair: 92.73 % Build:
81.82% Stance: 81.82%



Reaper
Overwatch
Blizzard Entertainment, 2015

Care/harm: **immoral**
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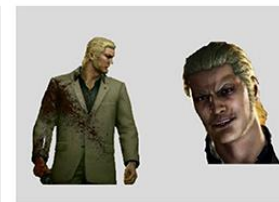
Face cover: 98.21% Clothes: 98.21%
Weapons: 94.64% Mouth: 48.21%



Dr. Eggman
Sonic Mania
Sega, 2017

Care/harm: **slightly immoral**
Fairness/reciprocity: **immoral**
Ingroup/loyalty: **immoral**
Authority/respect: **immoral**
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Clothing: 93.10% Eyes: 89.66%



Ryuji Goda
Yakuza Kiwami 2
Sega, 2017

Care/harm: **immoral**
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Ingroup/loyalty: **slightly immoral**
Authority/respect: **immoral**
Purity/sanctity: **immoral**

Dermatological problems: 80.70% Hair:
78.95% Eyebrows: 70.18%
Masculinity/femininity : 61.40%



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Bandai Namco Entertainment, 2015

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 Masculinity/femininity: 75.44%
 Attractiveness: 73.68%

Healthy Lies

The Effects of Misrepresenting Player Health Data
on Experience, Behavior, and Performance

Jason Wuertz
University of New Brunswick

Max Birk
Eindhoven University of Technology

Scott Bateman
University of New Brunswick

Games for Learning: Sports, Software, Careers

The Behavioral and Motivational Effects of Collectibles in Gamified Software Training

TIM NAGLÉ, MAX V. BIRK, SCOTT BATEMAN



Tim Naglé, Scott Bateman, and Max V. Birk. 2021. Pathfinder: The Behavioural and Motivational Effects of Collectibles in Gamified Software Training. Proc. ACM Hum.-Comput. Interact. 5, CHI PLAY, Article 264 (September 2021), 23 pages.
<https://doi.org/10.1145/3474691>

Designing a Technique-Oriented Sport Training Game for Motivating a Change in Running Technique

- Ian Smith, Erik Scheme, and Scott Bateman
- University of New Brunswick



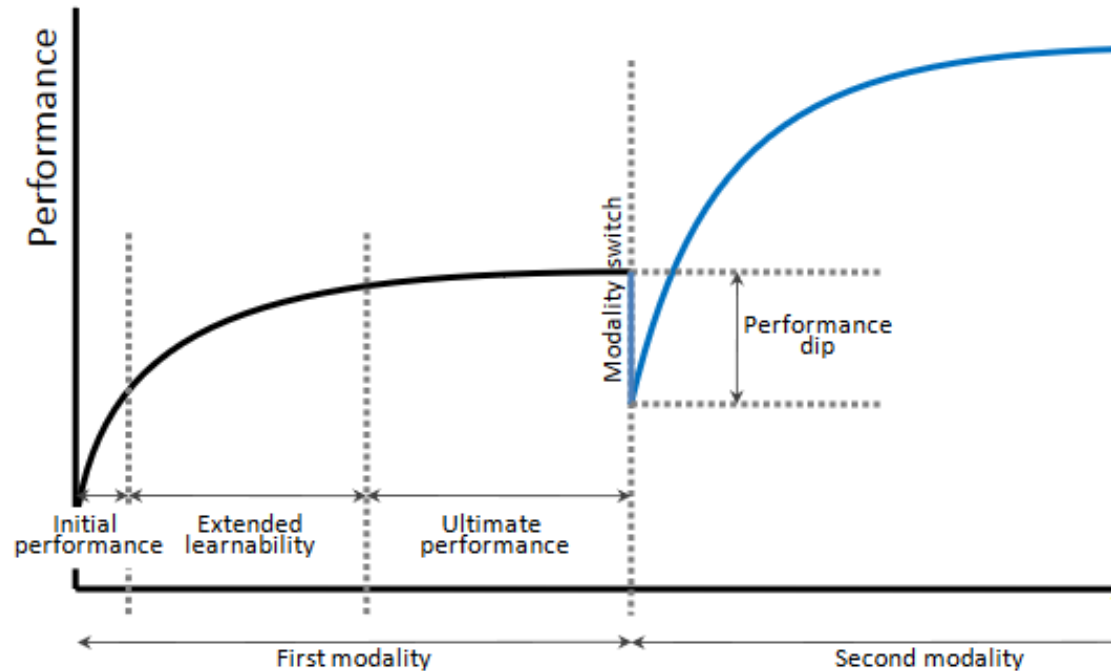
SPECTRAL
Spatial Computing Research Centre

Institute of
Biomedical Engineering



Introduction

- Benefits of sport
- Technique is important
- Change is demotivating
 - Performance dip
 - Boredom

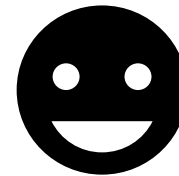
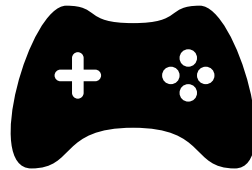


Scarr et al. *Dips and Ceilings: Understanding and Supporting Transitions to Expertise in User Interfaces*. CHI 2011

<https://www.pexels.com/photo/man-in-blue-sneakers-playing-football-7188095/>

Introduction

- Make training fun
- Too immersive?



Juicy
→

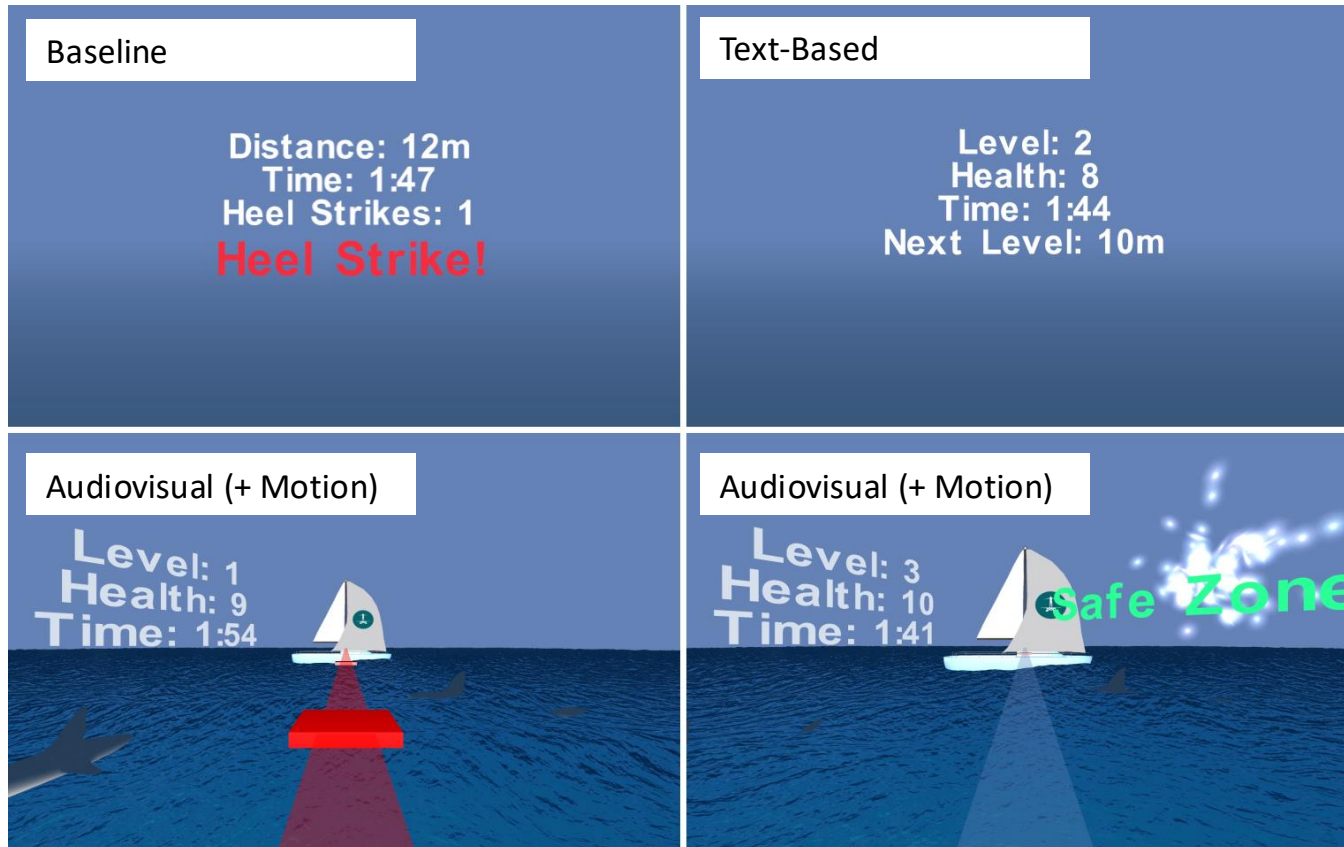


Experiment

- Compared 4 versions of a running game
 - Goal: promote toe strikes (mid- or fore-foot)
- CAREN System

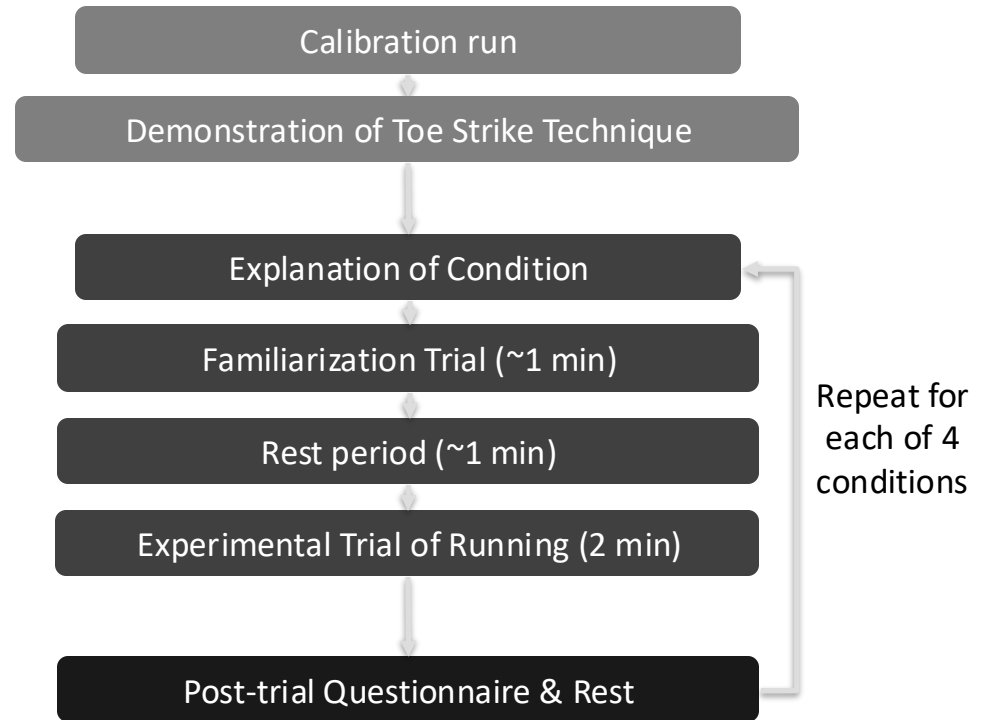


Experiment Conditions

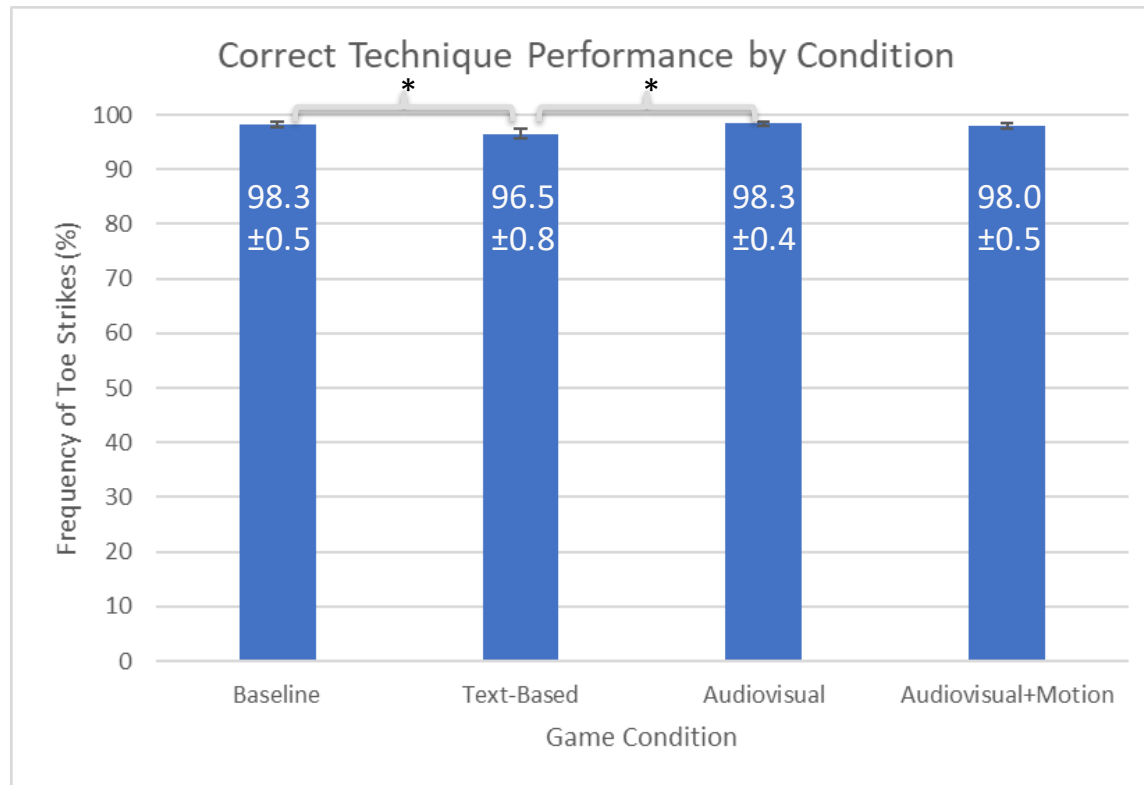




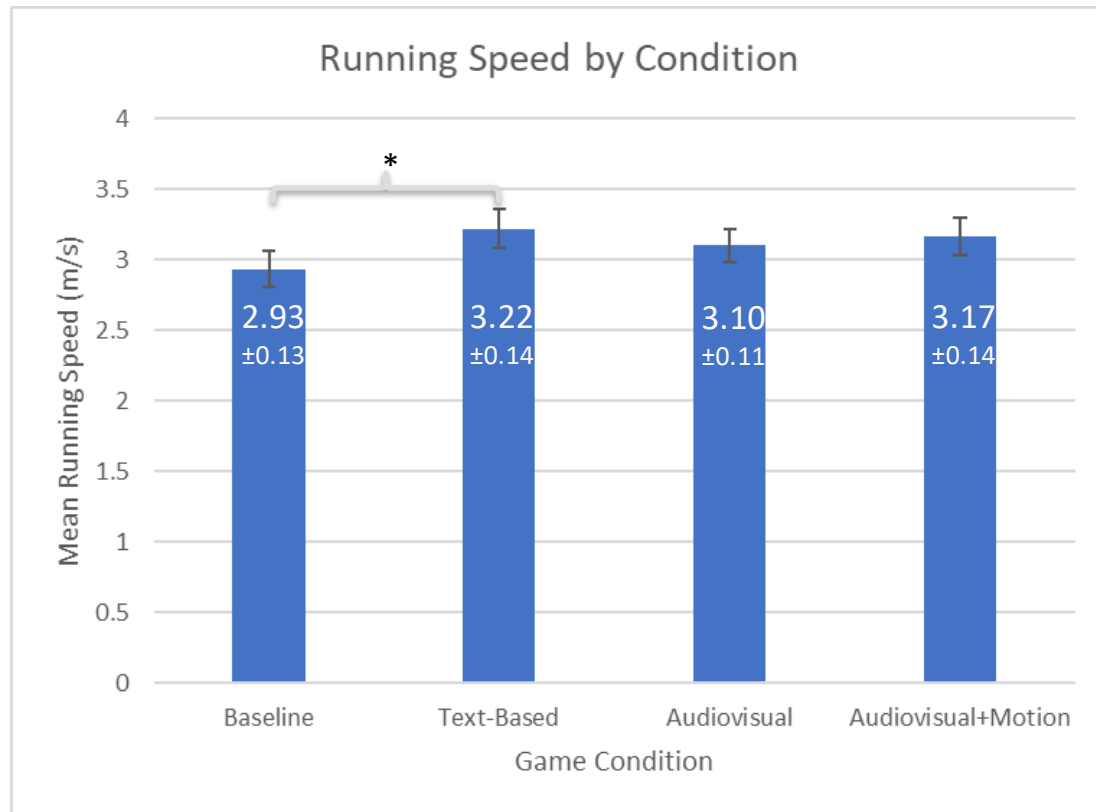
Distance: 57m
Time: 0:37
Heel Strikes: 7



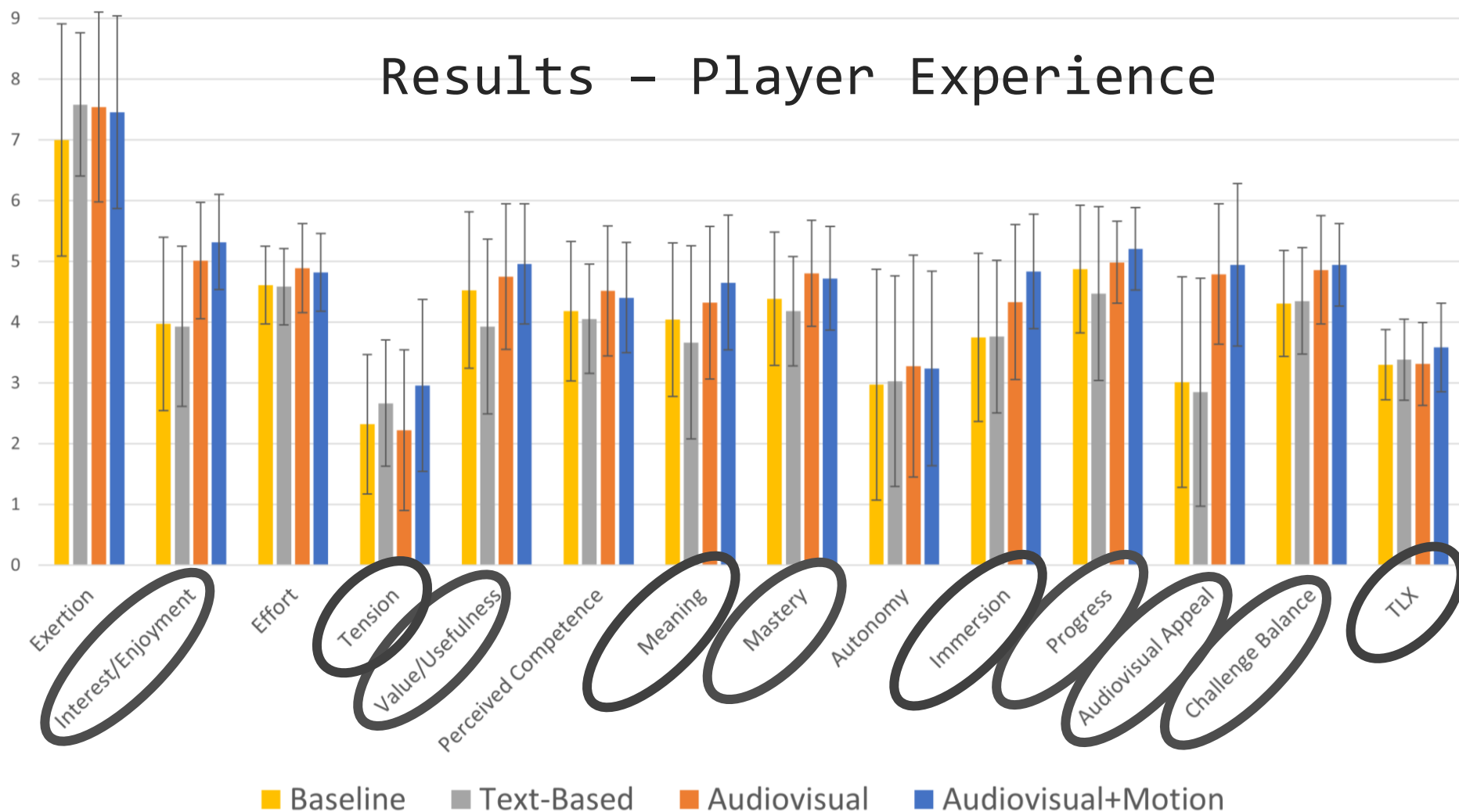
Results - Technique



Results - Speed



Results - Player Experience



Discussion

- Games are engaging
- As effective as baseline



Discussion

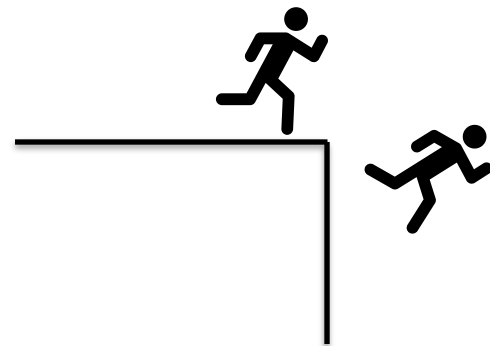
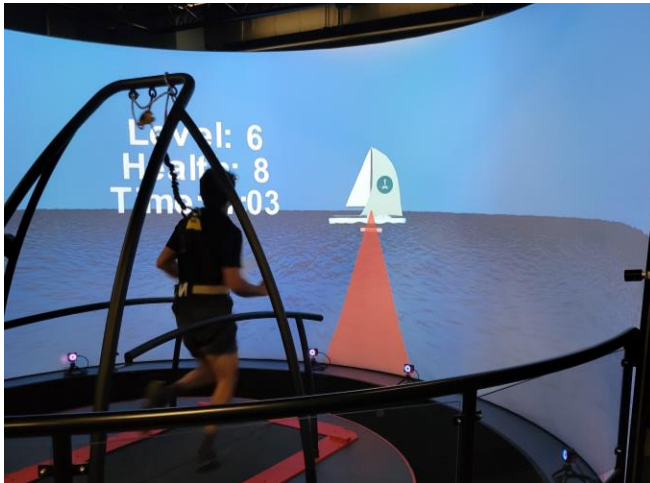
- Simple game performed poorly
- New technique → Dip in performance

Level: 2
Health: 8
Time: 1:44
Next Level: 10m



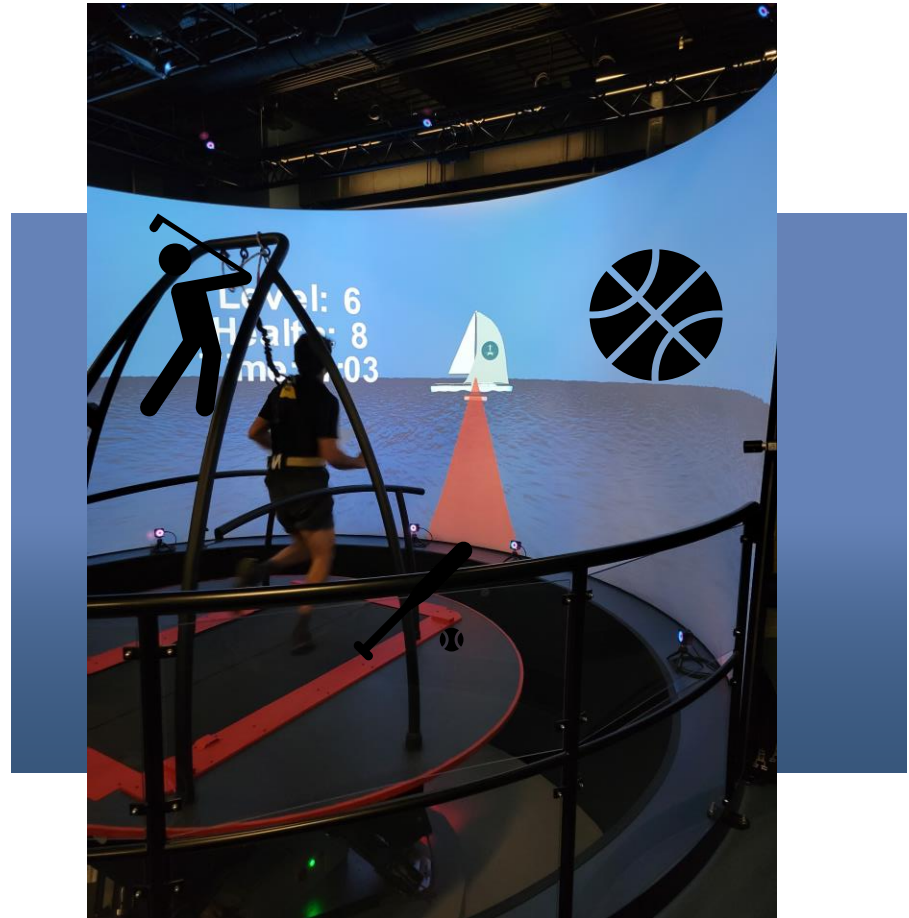
Discussion

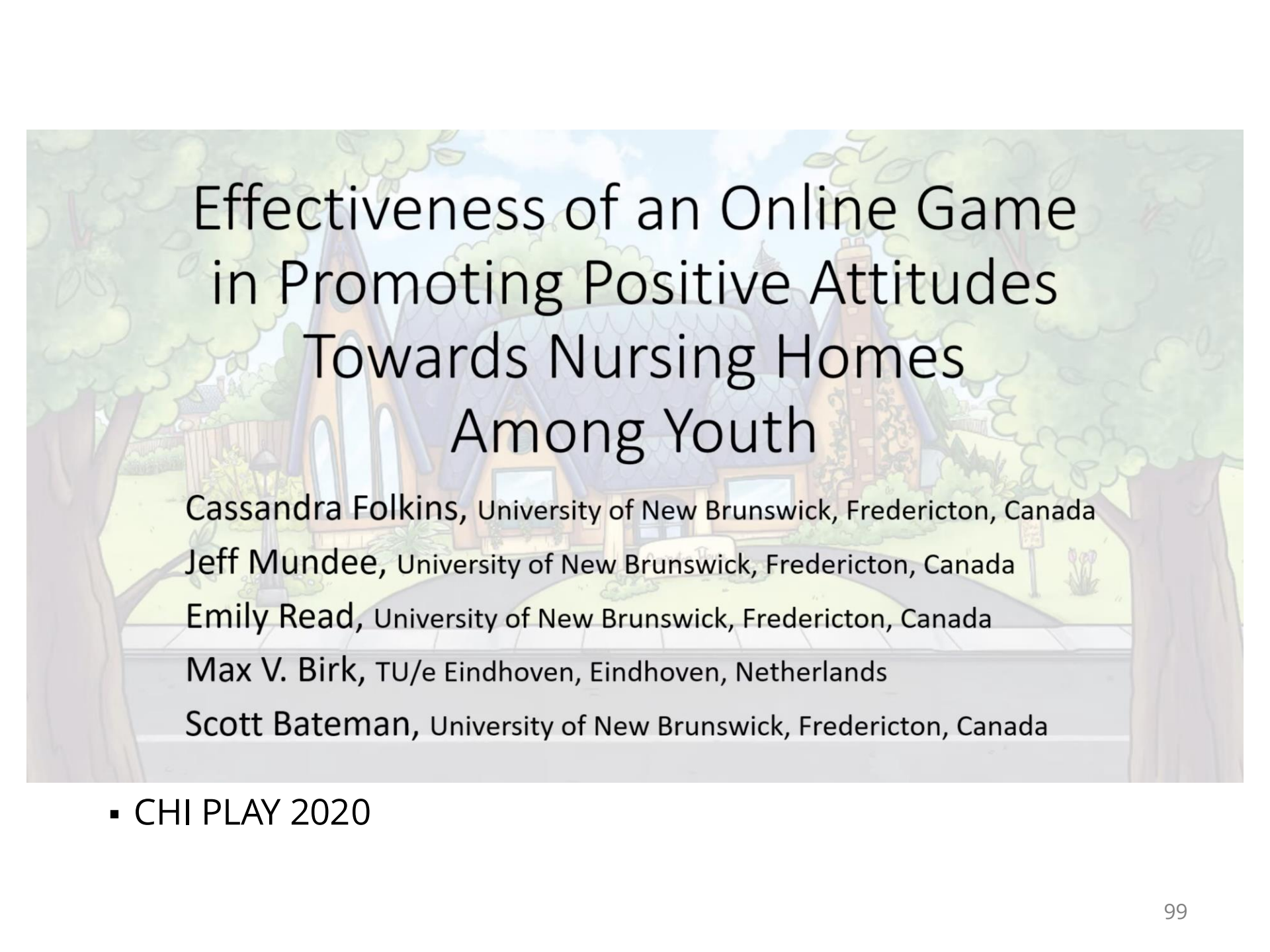
- Should sport training games be immersive?
- Motion can increase tension
- Conflicting opinions



Conclusion

- Immersive games are effective
- Simpler games less effective
- Immersive elements are a tool
- Special design requirements
- Future work





Effectiveness of an Online Game in Promoting Positive Attitudes Towards Nursing Homes Among Youth

Cassandra Folkins, University of New Brunswick, Fredericton, Canada

Jeff Munde, University of New Brunswick, Fredericton, Canada

Emily Read, University of New Brunswick, Fredericton, Canada

Max V. Birk, TU/e Eindhoven, Eindhoven, Netherlands

Scott Bateman, University of New Brunswick, Fredericton, Canada

- CHI PLAY 2020

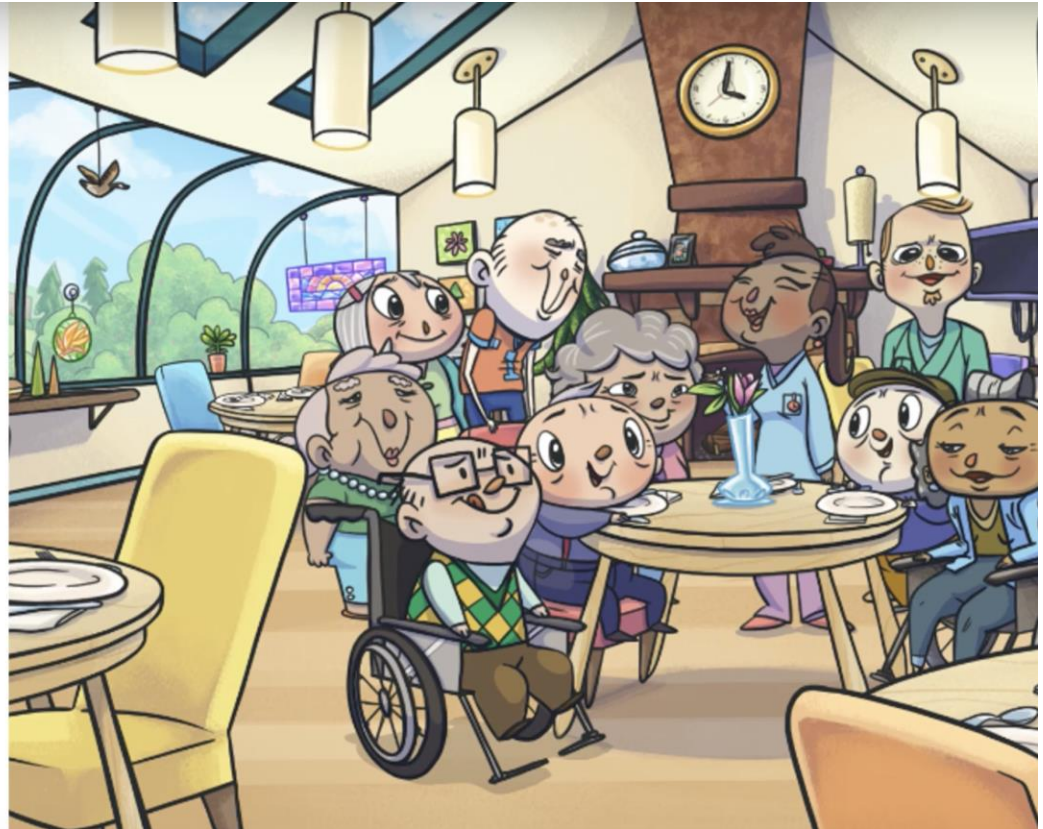
Carington House: Game Design

- Point-and-click adventure -> engage with characters
- Focus on positive imagery -> counteract negative stereotypes
- Play at: <http://nursinghomejobsnb.ca>



What did we learn?

- Game changed perceptions
- Interactive narrative and use of humour promising for impacting pers



Games for Therapy and Health



Designing Game-Based Myoelectric Prosthesis Training

Aaron Tabor, Scott Bateman, Erik Scheme,
David R Flatla, Kathrin Gerling

CHI 2017



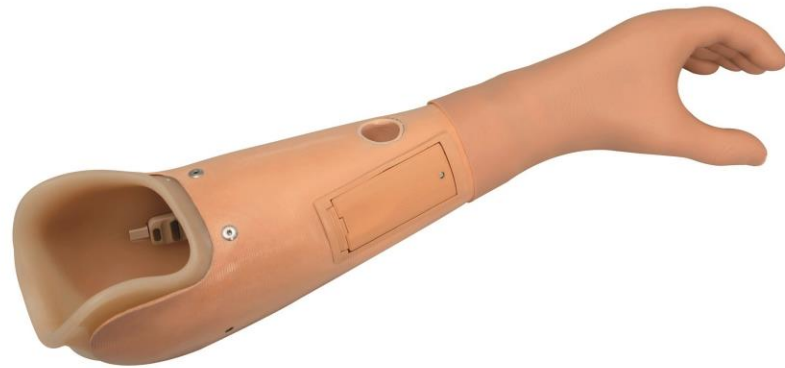
KU LEUVEN



**University
of Dundee**

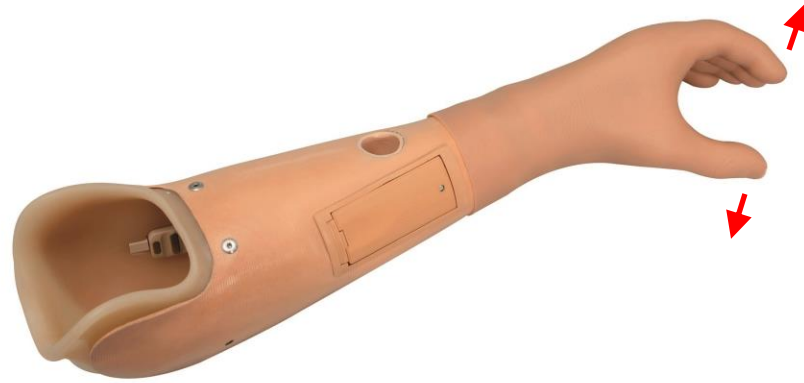


What is Myo?





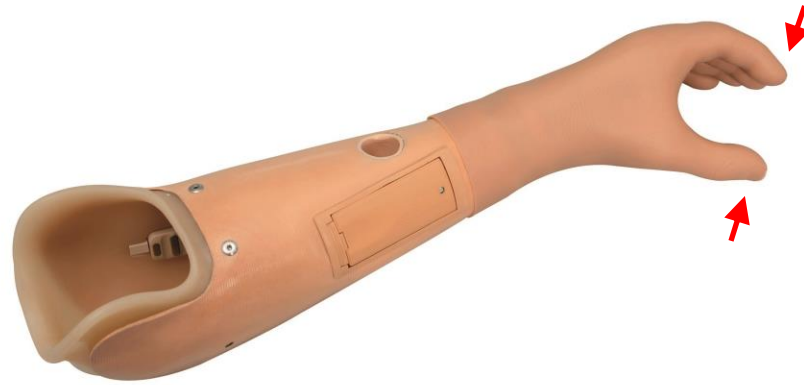
What is Myo?



Open



What is Myo?



Close

Challenges of Learning Myoelectric Control



- Myoelectric control is **difficult**
- Require lots of practice
 - BUT, it's **boring** and **no feedback**
- Myo Abandonment Rate:
 - **45% - 75%**



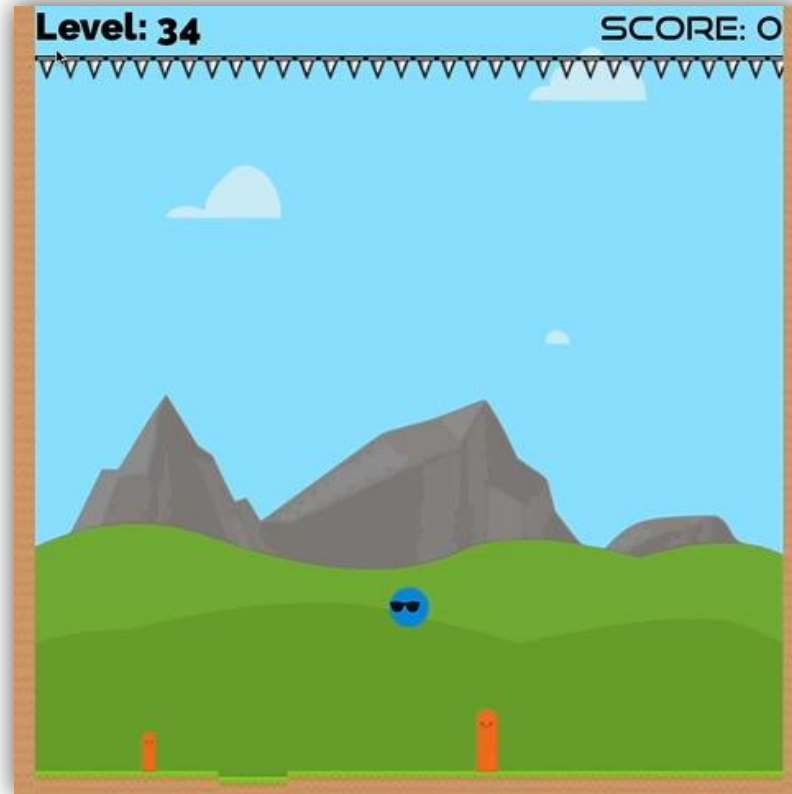


Training Games





The Falling of Momo

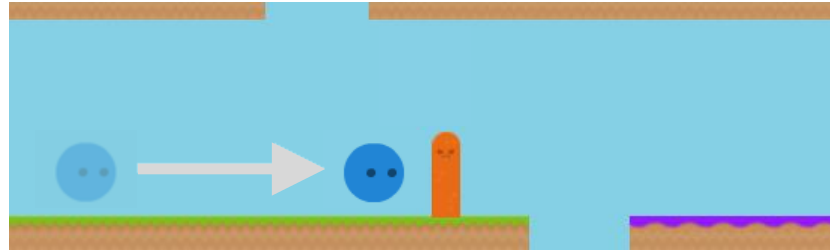




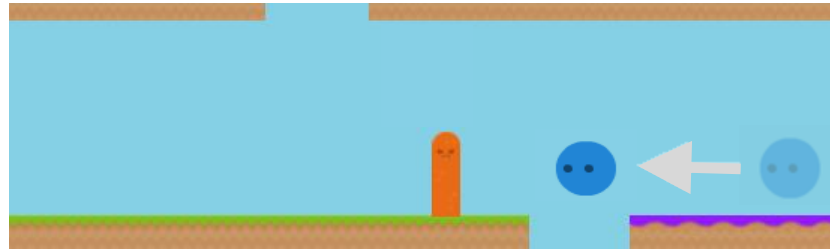
Controlling Momo's Movement



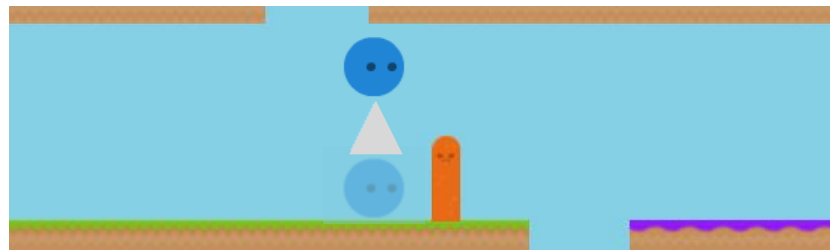
right



left



jump





The Falling of Momo

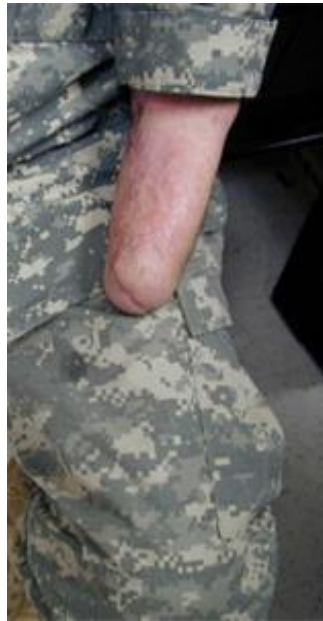


Aaron Tabor, Scott Bateman, Erik Scheme, David R. Flatla, and Kathrin Gerling. Designing Game-Based Myoelectric Prosthesis Training. Proceedings CHI 2017, 1352–1363. <https://doi.org/10.1145/3025453.3025676>

Findings / Design Guidelines

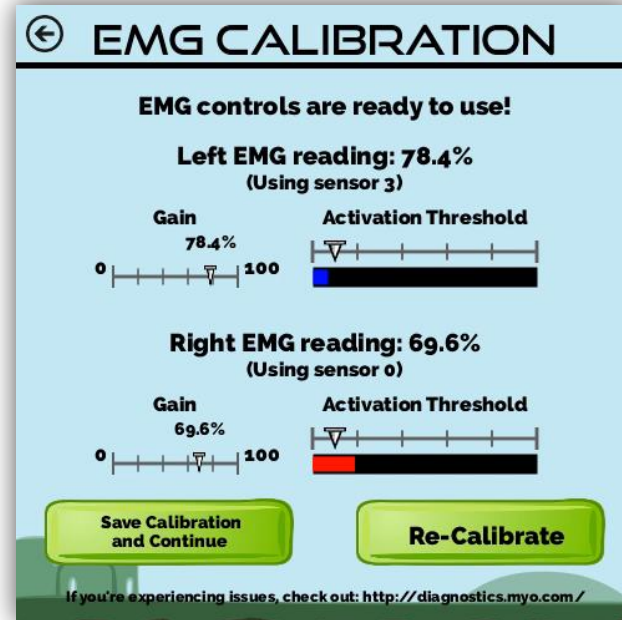
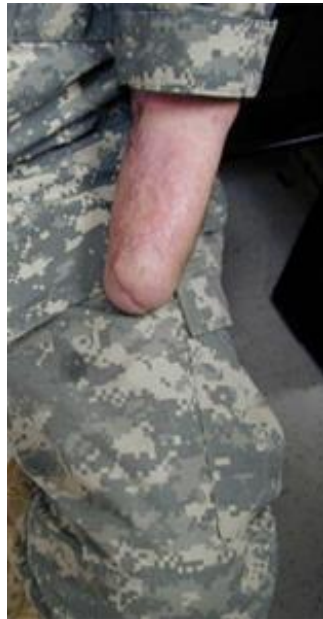
Guideline 1

Adapt to Varying Skill



Guideline 1

Adapt to Varying Skill



Guideline 2

Balance Challenge with Vulnerabilities

Guideline 2

Balance Challenge with Vulnerabilities

I was flexing the entire time, which is good... I think this is a really good exercise for strengthening.

[Claire – myo user for 10 years]

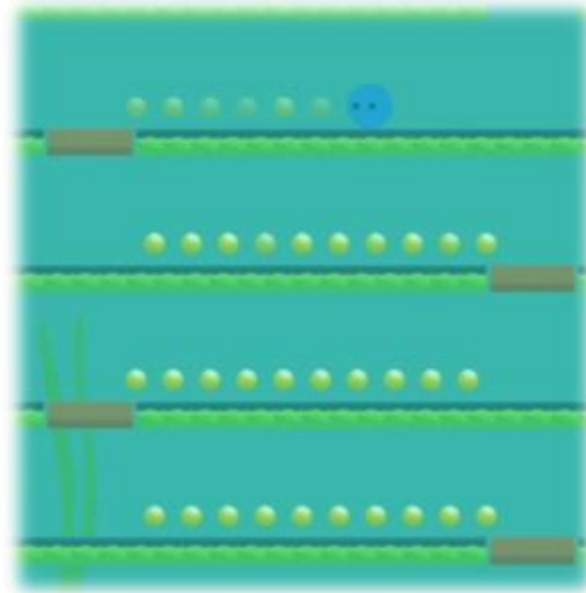
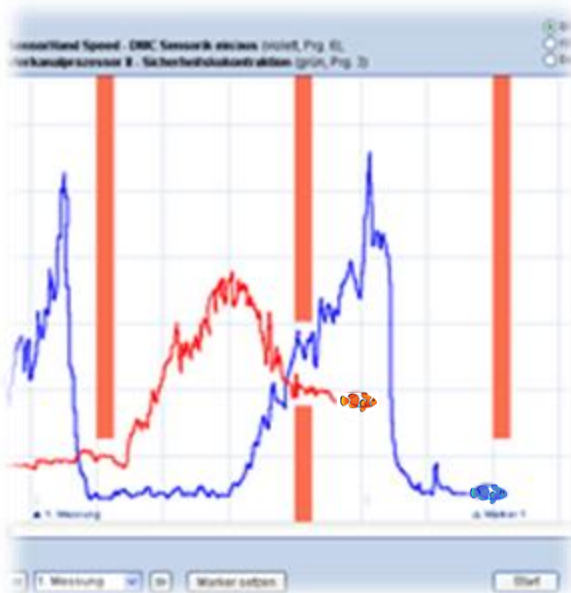
Guideline 3

Positive, Visible Feedback



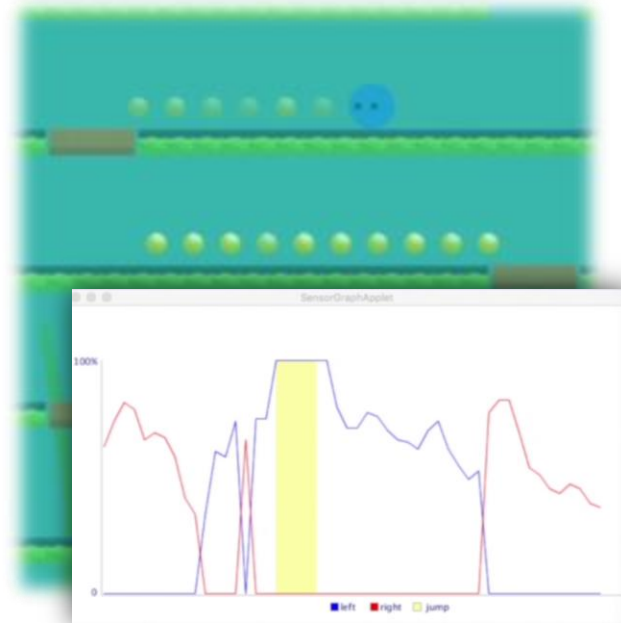
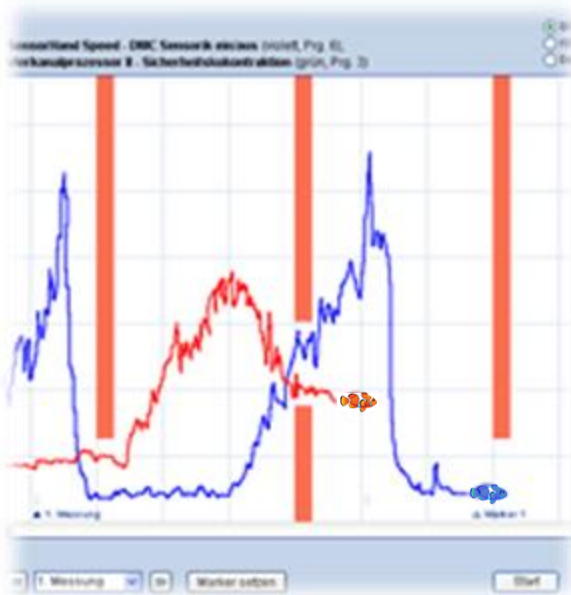
Guideline 3

Positive, Visible Feedback



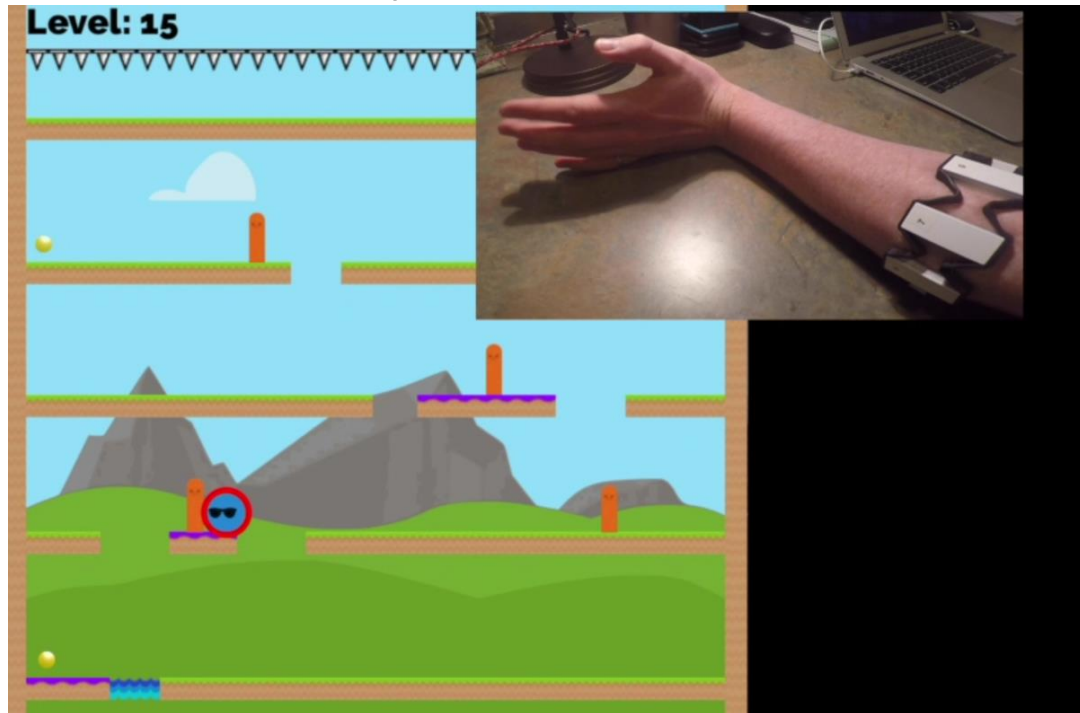
Guideline 3

Positive, Visible Feedback



Guideline 3

Positive, Visible Feedback

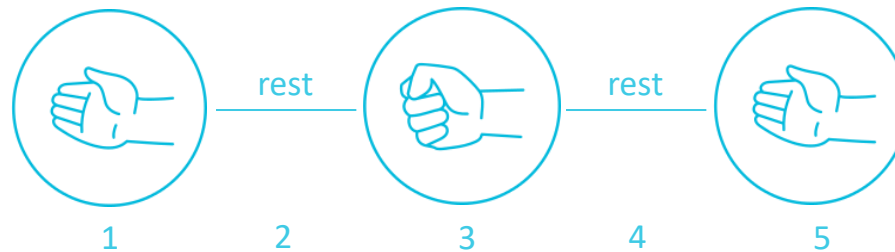
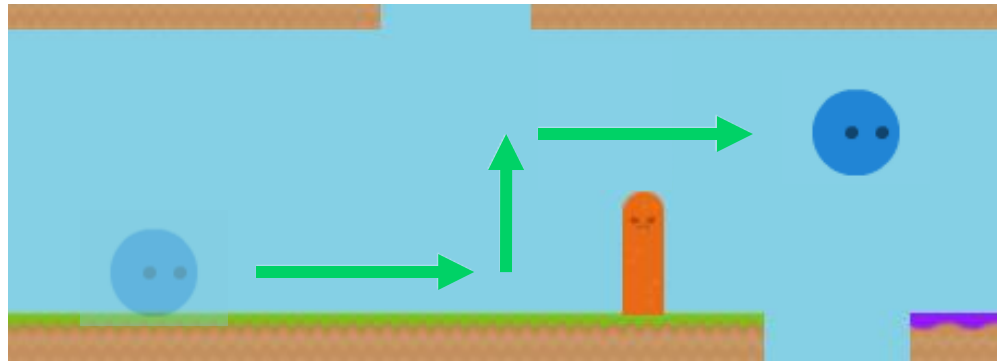


Guideline 4

Support Training Goals

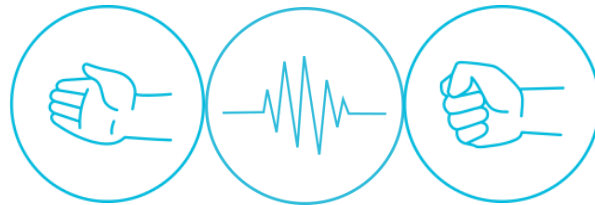
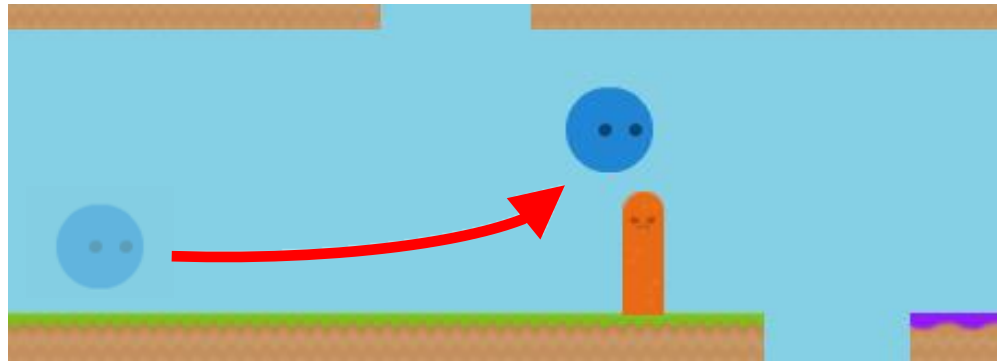
Guideline 4

Support Training Goals



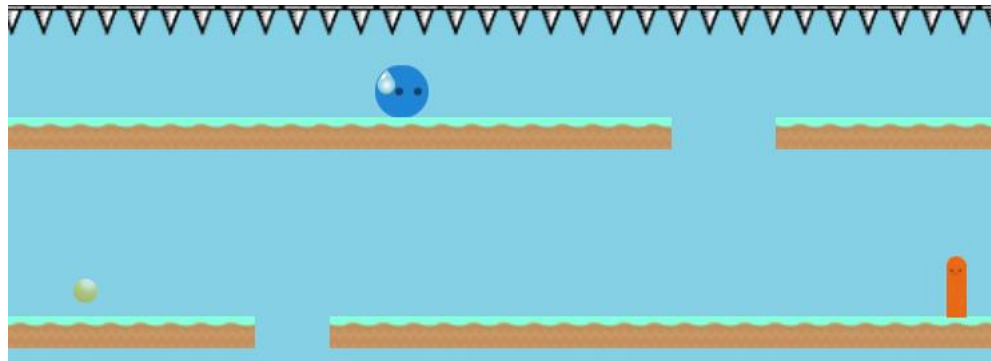
Guideline 4

Support Training Goals



Guideline 4

Support Training Goals



Guideline 5

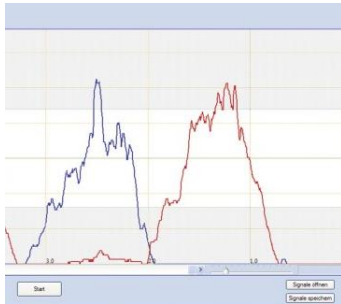
Make Accessible and Low-Cost



+



= \$200



+

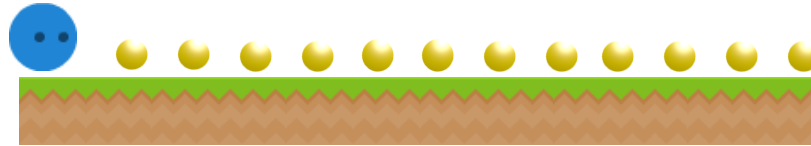


= \$5,000

Summary

- Myoelectric control is **hard**
- Require lots of practice
 - BUT, it's **boring** and **no feedback**
- We've designed a **training game** to help
- Learned critical **design details**





Designing Game-Based Myoelectric Training

A. Tabor, S. Bateman, E. Scheme, D. Flatla, K. Gerling. 2017. "Designing Game-Based Myoelectric Training," in *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*.



aaron.tabor@unb.ca



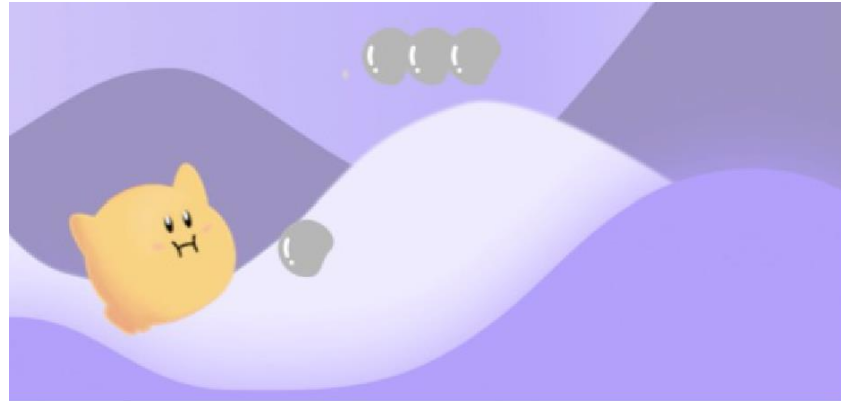
NBIF · FINB



Game Design



CHI PLAY 2021
Best Game, Student Game Design



CHI PLAY 2020
Best Game, Student Game Design



Book Sadprasid, Anne Mei, Alex Mariakakis, Scott Bateman, and Fanny Chevalier. 2024. Leveraging Idle Games to Incentivize Intermittent and Frequent Practice of Deep Breathing. In Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems (CHI '24)., Article 714, 1–17. 🏆 **Honorable Mention Award**

Reflections

- Game Research in HCI is still relatively new...
 - many basic questions available for study
 - play games, observe your experiences and those of others, get curious
- Game Designers and Researchers are like researchers with their attention to detail and reading of the literature
 - <https://www.gamedeveloper.com/design>
 - Watch YouTube: e.g., GameMaker's Toolkit and GDC Talk
- Understanding of how technology makes us feel is quite mature in the CHI PLAY community
 - Experiments include behavior and questionnaires (for experience) metrics

Reflections

- My interests
 - figuring out how we can use games for good
 - how little sign choices can have significant impact on experience

Setup for Activity

- In p5.js, a JavaScript version of Processing, you will extend a game to add player balancing
- You can either run p5.js on your local machine
 - VSCode: install the p5.vscode extension
- Or, on the p5.js website:
 - <https://editor.p5js.org>
- We will look at a quick tutorial now:
 - <https://editor.p5js.org/scottbateman/sketches/>

Activity

- With one or two partners, you will extend a game to add player balancing... to try and make games consistently competitive
- The game is a 2-player game played on one keyboard, called **Super Ball Catch**
 - For p5.js Copy **Super Ball Catch** from my sketches
<https://editor.p5js.org/scottbateman/sketches/>
 - For vscode download or clone
<https://github.com/scottbateman/p5-super-ball-catch/>
- Play the game for 5 minutes.
- Take 10-15 minutes to think carefully about how they game can best be balanced BEFORE YOU START CODING
 - It's OK to change the existing mechanics or parameters (like the score to win) to get a better game
- When we have 15 minutes left you should be ready to present what your strategy was