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HUMAN-COMPUTER INTERACTION

KIVR SPORTS: INFLUENCING THE USERS PHYSICAL ACTIVITY IN VR BY USING AUDIOVISUAL STIMULI IN EXERGAMES

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ABSTRACT

Current VR technologies open up possibilities for more **active gaming styles**.

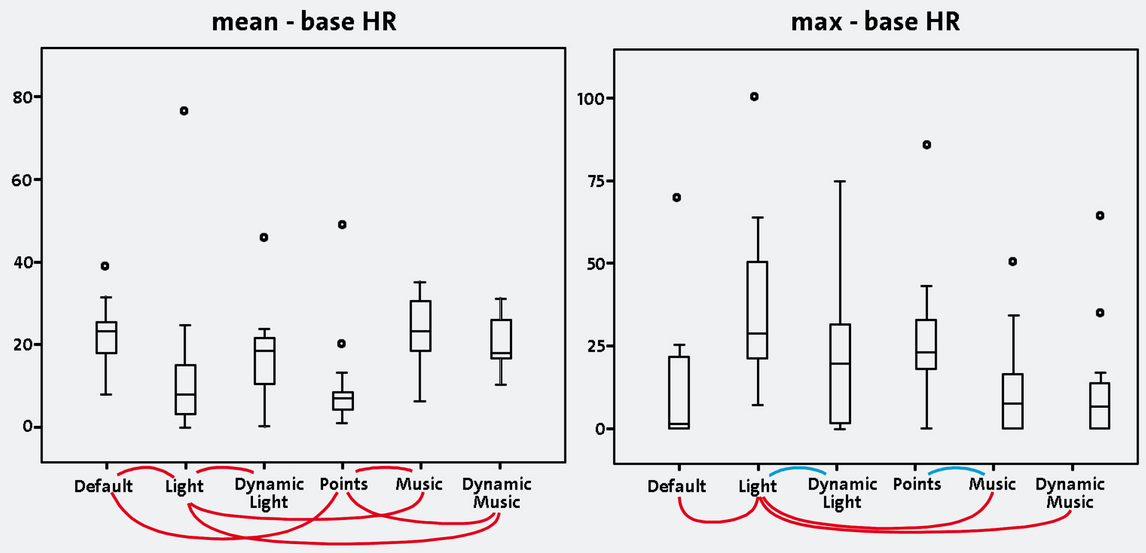
We explore the effects of typical game design elements and mechanics, i.e. **music**, **score** and **lighting** on engagement in performance in a VR exercising game with short activity intervals of fixed duration. Many participants reached a **heart rate suitable for High-Intensity Interval Training**.

EXPERIMENT

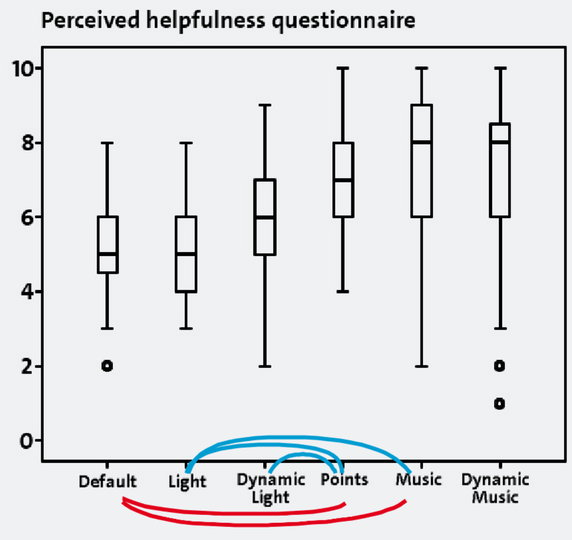
19 participants (4♀, 15♂) aged from 20 to 59. Only 7 never used an HMD before.
Each participant played **6 conditions** . Order randomized in a **latin square** design:

- **Default**: No music, no score, no direct lighting.
- **Light**: Constant direct lighting.
- **Dynamic Light**: Light intensity linearly increases with the players pulse.
- **Points**: Hit targets give points to the player which are displayed on the bow.
- **Music**: Background music with static speed.
- **Dynamic Music**: Background music adapts ist speed depending on the pulse.

Differences in mean- and max pulse increase (significant, trend)



Differences in reported perceived helpfulness (significant, trend)



Players shot with an **accuracy of 85.8%** and were able to **evade 86.7%** of the shots fired by targets.

Simulator Sickness Questionnaire [1]
Before: M=2.84 (SD=2.85)
After: M=6.11 (SD=4.48)
mainly caused by sweating

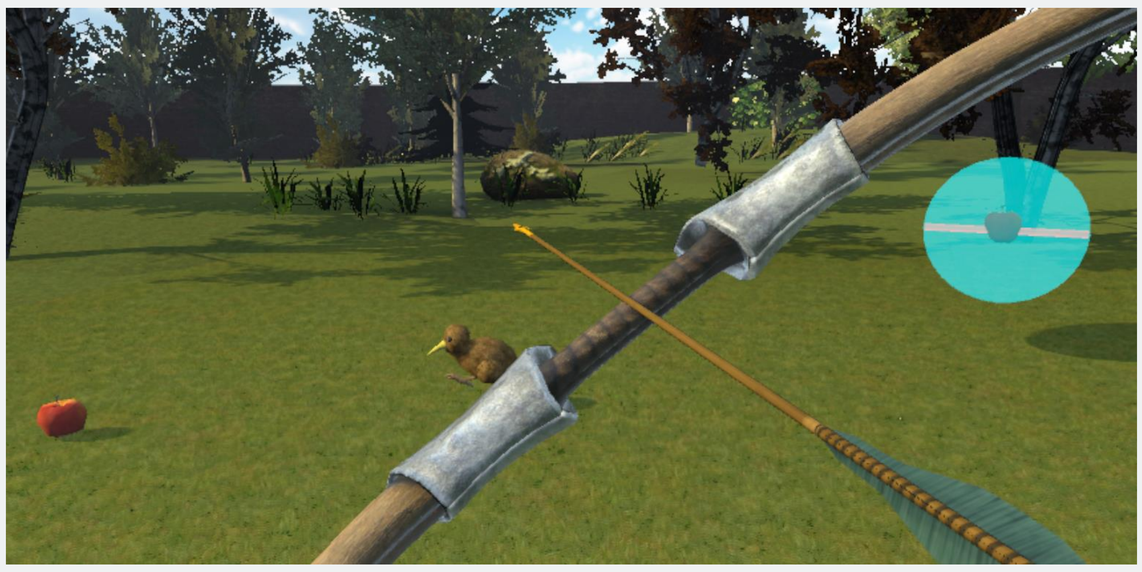
The **Slater-Usoh-Steed** [2] mean score (sense of being present in the virtual environment) indicated a **high sense of presence** with M=4.763 (SD=0.81).

The heart rate was close to **80% of the maximum heart rate** in all conditions (no significant differences) which suggests KiVR Sports is suitable for **High-Intensity Interval Training** [3].

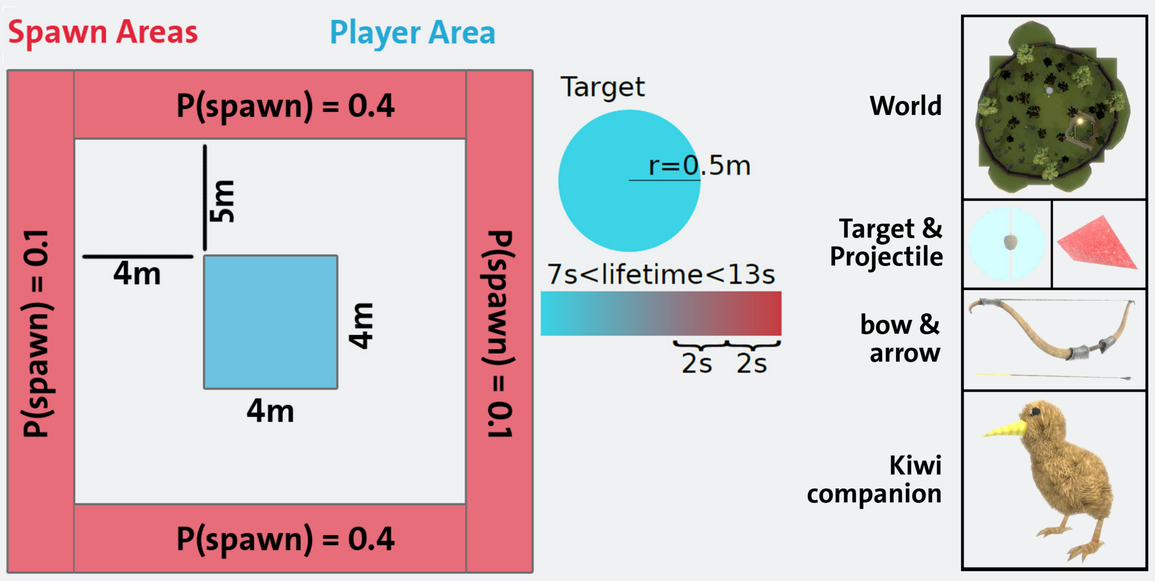
[1] Kennedy, R. S., Lane, N. E., Berbaum, K. S., & Lilienthal, M. G. (1993). Simulator sickness questionnaire: An enhanced method for quantifying simulator sickness. The international journal of aviation psychology, 3(3), 203-220.
[2] Slater, M., Usoh, M., & Steed, A. (1994). Depth of presence in virtual environments. Presence: Teleoperators & Virtual Environments, 3(2), 130-144.
[3] Bartlett, J. D., Close, G. L., MacLaren, D. P., Gregson, W., Drust, B., & Morton, J. P. (2011). High-intensity interval running is perceived to be more enjoyable than moderate-intensity continuous exercise: implications for exercise adherence. Journal of sports sciences, 29(6), 547-553.

GAME

The player is **surrounded by multiple targets** that they can shoot with bow and arrow. If a target is hit it fires an oriented row of projectiles back at the player which **the player needs to dodge**. The random orientation encourages the player to use many **different movement patterns**. A hit target releases fruits that are picked up by a little Kiwi companion. Targets explode on their own after a while (without dropping food) but warn the player audio-visually before.



PLAYING FIELD & GAME ELEMENTS



HARDWARE

HTC Vive head mounted display featuring controllers that provide simple haptic feedback. The corresponding **lighthouse tracking system** was used for positional tracking and calibrated for an available walking space of $4m \times 4m$.

NEULOG Heart Rate and Pulse Logger: Sensor data was collected via http-interface and was used for real-time adaption of the scene as well as general data collection.

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