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The role of control factors in the impact of occupational safety training based on immersive virtual reality

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Introduction

- Occupational safety training offers an important preventive approach for increasing individuals' competencies and knowledge regarding how to protect themselves at work (see, Robson et al., 2012)
- The potential of immersive virtual reality (IVR) in the implementation of occupational safety training has been highlighted in earlier studies (Rey-Becerra et al. 2021). Nevertheless, there is a lack of theory-based pedagogical models to guide the design of safety training process based on IVR
- The current study addresses a gap in the OSH research and presents an integrated pedagogical model for IVR-based safety training (Lehikko, Nykänen & Ruokamo, 2021)
- Furthermore, previous studies lack knowledge on the key elements that transmit IVR-based safety training outcomes. This knowledge is needed in order to direct future safety training efforts. We investigate whether control factors contribute to the efficacy of IVR safety training. In our study control factors refers to degree of user control in the VR-environment.
- This presentation presents preliminary results from an ongoing field study

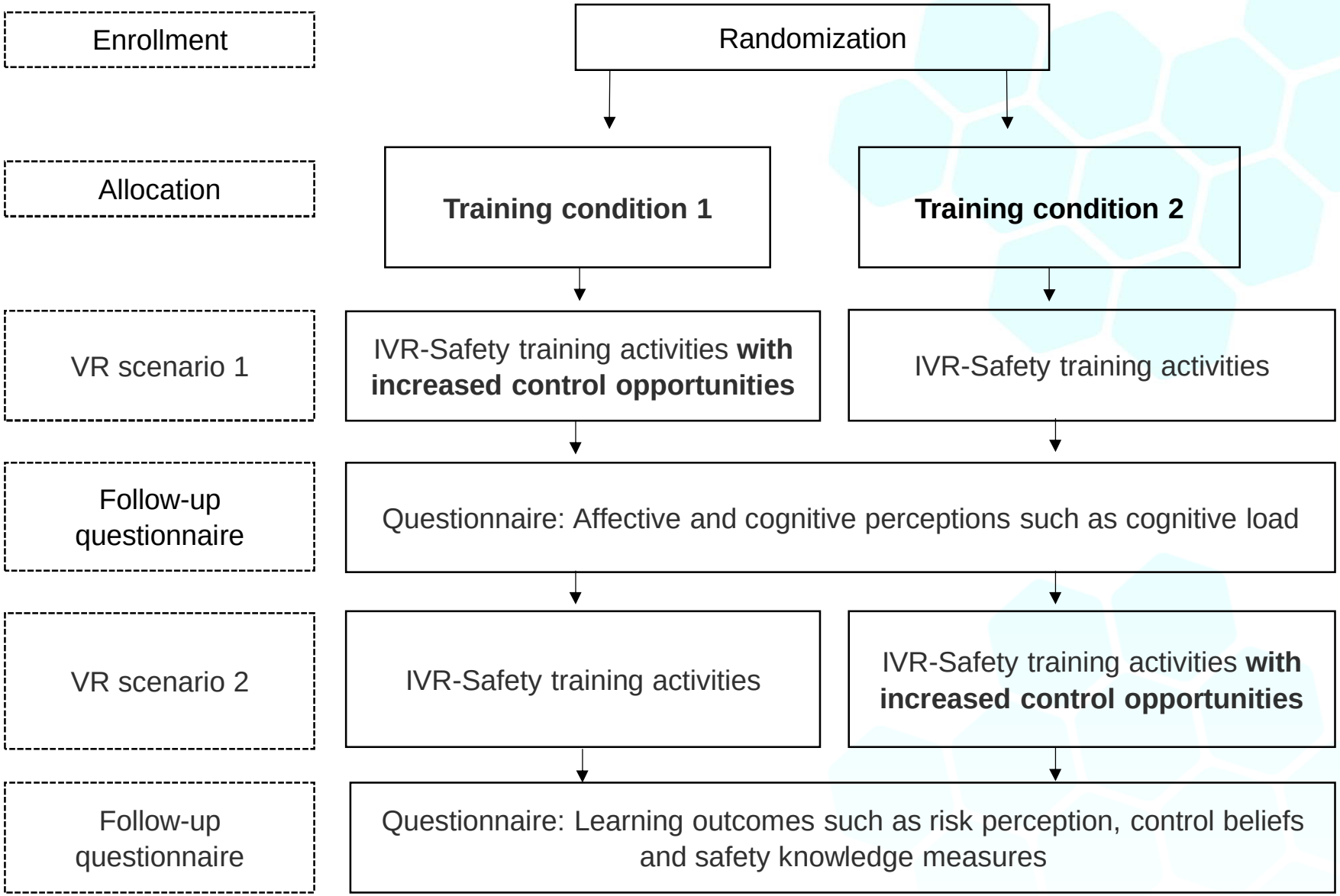
Study design

- Approximately 100 workers from two work organizations will be randomly allocated into two intervention conditions. This is a design-based research involving multiple cycles of implementation. Current results represent the first implementation wave.
- Study participants in 1. intervention condition participate in a safety training process, in which elements emphasizing the user's ability to exert control over their actions have been added to the IVR learning environment. Study participants in 2. intervention condition participate in a similar training process containing the same educational content in VR-learning environment without these additional elements
- Safety training process is implemented at workplaces. During the training, study participants practice safe working methods and identifying work-related hazards (e.g., machinery-related hazards). Following the principles of simulation pedagogy, the training process incorporates facilitated group discussions before and after IVR-based learning
- We will conduct follow-up measurements during the training, and immediately after the training (short-term outcomes) and 2 months after. This presentation presents preliminary results of short-term outcomes

Research questions

- Does a safety training process based on integrated pedagogical model for IVR enhance individual-level antecedents of safety behavior?

- Does the VR-learning environment design (increased opportunities for control) modify the safety training outcomes and participant cognitive load during learning process?


Enrollment
Randomization
Allocation
Training condition 1
Training condition 2
VR scenario 1
IVR-Safety training activities with increased control opportunities
IVR-Safety training activities
Follow-up questionnaire
Questionnaire: Affective and cognitive perceptions such as cognitive load
VR scenario 2
IVR-Safety training activities
IVR-Safety training activities with increased control opportunities
Follow-up questionnaire
Questionnaire: Learning outcomes such as risk perception, control beliefs and safety knowledge measures

Training intervention

- Learning content was developed in collaboration with the participating workplace
- The aim is to enhance individual-level safety competencies that support preventive safety behaviors at work
- Hypothesized learning outcomes include safety knowledge, safety control beliefs and risk perception

T1 Questionnaire

2-4 weeks

Introduction — 20 min

IVR Briefing — 5 min

Scenario 1 T2A — 20 min

Scenario 2 T2B — 20 min

Debriefing — 30 min

Introduction	Introduction group discussion: Topic, concepts, goals
IVR Briefing	Orientation to using VR-equipment
Scenario 1 T2A Scenario 2 T2B	Individual VR-exercises 1 & 2: Practicing hazard identification and safe working methods
Debriefing	Debriefing group discussion: Guided reflection

2 weeks

Stimulated Recall Interviews

2 months

T3 Questionnaire

Results

- Study analyses and pre-post measures indicate that the study participants in both training conditions benefitted from safety training in terms of safety knowledge. Statistically significant differences between training conditions were not detected on measured outcomes.

- In terms of cognitive load, the participants taking part in training process with increased control opportunities had significantly higher scores on germane cognitive load after first training scenario

Conclusion and discussion

- Considering the safety training effect on safety knowledge we propose that the new integrative pedagogical model offers a potential tool for designing VR-based learning
- Increasing control opportunities in IVR did not influence safety learning. Due to small sample size, low statistical power may have reduced the chance of detecting a true between-group effect. The analyses will be repeated, when all the research data has been collected
- Our study indicate that increased control opportunities has an impact on germane cognitive load. Schnotz, Fries & Horz (2009) pointed out that instructional design should direct the learner's attention to processes that are relevant for learning by construction of cognitive schemas. They suggested that germane load should therefore not be reduced, but rather increased if the total cognitive load stays within the limits of working memory capacity
- In the future, the role of control possibilities in terms of learning motivation and learning ability should be examined more
- Due to the small sample, our preliminary results should be viewed with caution

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