MED1st MR Mixed Reality Training

TRAIN [SKILLS. RESILIENCE. PERFORMANCE] SAVE LIVES

D3.7

Multi-Dimensional Conceptual EPME Model and Research Agenda for Validation - final

Version
V1.0

Authors
Prof. Dr. Marie Ottilie Frenkel (HFU)
Prof. Dr. Cornelia Wrzus (UHEI)
Friederike Uhlenbrock (UHEI)

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Versions

Version	Date	Author(s)	Description
V0.1	20/09/2023	Marie Ottilie Frenkel (HFU)	First draft of the outline and the content
V0.2	25/09/2023	Friederike Uhlenbrock (UHEI)	Comments on the first draft
V0.3	27/09/2023	Cornelia Wrzus (UHEI)	Comments on the first draft
V0.4	28/09/2023	All partners	Comments on the review version
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Report review

Version	Date	Reviewer(s)	Statement
V0.4	28/09/2023	All partners	Comments on the review version
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RajdlovaV
29.09.2023

HSchrom
29.09.2023

List of acronyms and abbreviations

Acronym/ Abbreviation	
EPME	Effective performance in medical emergencies
FT	Field Trial
MCI	Mass casualty incident
MFR	Medical first responder
MR	Mixed reality
WP	Work package

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Relation to objectives

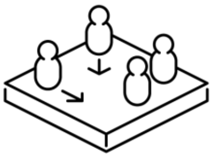
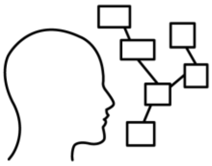
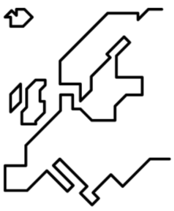
Objective	Description
	**Obj. 1: Pioneering MR training approach for enhanced realism** In order to assess whether the created MR environment indeed fosters a high degree of realism, we need to assess whether the behaviours by the MFRs during the MR training indeed reflect realistic behaviours. To do so, we present a well-established model from behavioural stress research and tailor it to the demands of MFR performance. This way, we can establish the precise link between stress, attention, decision-making, and behaviour.
	**Obj. 2: Effective training scenarios and a training curriculum** Realistic MFR training should induce some level of stress. Stress does not only cause physiological, but also behavioural reactions. It is desirable to alter some of these stress responses to perform optimally under demanding circumstances. The current model helps us to evaluate the different adaptations to stress.
	**Obj. 3: Physiological signal and trainee behaviour feedback loop and smart scenario control** By providing an empirical connection between the physiological responses, the psychological experience, and the behavioural output, we can optimize the feedback loop to detect what causes stress in the trainees and what may actually helps them to reach optimal arousal levels for performance.
	**Obj. 4: Position the pioneering MR training approach across Europe** The MR training will largely benefit from a strong empirical basis for its effectiveness. Furthermore, a model logically explaining the different responses can optimize training for end users.

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Table of content

List of tables

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Executive summary

The aim of this deliverable is to update the research agenda of the empirical validation of the model of Effective Performance in Medical Emergencies (EPME).

The multi-dimensional model, described in detail in D3.2, builds a theoretical basis for several studies in WP3 and WP6 and allows for a deeper understanding of how medical first responders (MFRs) perceive, decide, and act under stressful circumstances.

The EPME model takes into account that different behavioural patterns may emerge based on 1) individual differences in personality, 2) individual stress processes, and 3) immediate cognitive responses to the experienced situations.

The EPME model will serve as an underpinning for future research that aims to serve as a tool for designing interventions that exploit these mechanisms to enhance performance of MFRs under high stress levels.

Relation to other deliverables and tasks in MED1stMR

Table 1: The work and the document build on results from the following deliverables.

No.	Title	Information on which to build
D3.1	Overview of Current Training and Best Practices of Training Curricula in European MFR and Impacts on the EPME model and Training	The systematic review (https://osf.io/yn5v3) conducted within the scope of this deliverable yielded that very few medical studies utilize any model that attempts to explain EPME.
D3.2	Multi-Dimensional Conceptual EPME model and Research Agenda for Validation - v1	Outline of the research agenda to validate the conceptual model with human factor studies forming the basis for the present deliverable D3.7.
D6.1	Field Trials, Study Planning and Methods	Assessment and categorization of opportunities for study execution and study subject recruitment at the different end user partner locations to enable proper planning of forthcoming studies and experiments. Description of methods and measurement instruments used.

Table 2: The results of this work will be incorporated into following work and developments

No.	Title	Basis for
D3.6	European Framework for Training and Assessment (using VR) of EPME Behaviour of Medical First Responder Professionals	The performance indicators identified by the EPME model may be utilized for the training assessment.

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WP6	Field Trials	This work package includes designs of studies in the field as well as further evaluations of the model. Therefore, the current model and the results of the proposed research agenda provide an important foundation for the development of the entire work package.
D6.4	MED1stMR Final Evidence-based EPME model	Finalized human factor model for EPME after the end user trials.

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1 Introduction

At the beginning of the search for a suitable model to explain how MFR react to stressful events during medical emergencies, we focused on models stemming from a medical context. However, as demonstrated in our systematic literature review (Baetzner et al., 2022), very few studies intend to explain medical performance under stress. Furthermore, psychological aspects of medical training and mass casualty incident (MCI) performance have been rarely investigated. Therefore, after careful consideration, we chose a multi-dimensional conceptual model applied in the domain law of enforcement and competitive sport where performance under stress is well researched (Nieuwenhuys & Oudejans, 2012, 2017; see also D3.2). An application of the adapted model to the medical context seems plausible due to the necessary motor precision needed by both athletes and medical professionals. In order to extend the model to the context of medical emergencies, we implemented several modifications to its original conceptualisation (see also D3.2). These modifications mainly concerned the focus on the psycho-physiological stress process, the assumption that stress can be a performance enhancer, the redefinition of the dynamics of attention, and the temporal separation of attention, decision-making and action.

In the next section we will update the research agenda for the model validation, which is broadly outlined in D3.2 as well as in D6.1.

2 Research agenda

The research agenda is tailored to validate the EPME model. The model will be presented in its final version in D6.4. The research agenda is split into three sections. Various premises of the conceptual model will be tested in the natural work environment of MFRs (WP3, see 2.1.1 and WP6), manipulated virtual environment experiments in the lab (WP3, see 2.1.2) as well as applied training settings in real-life and mixed reality (WP6, see 2.2). Finally, we will present which additional research questions that can be derived from the model and how they can be answered in the course of the project.

2.1 Current studies in WP3

The **ReD Study** (Recovery and Decision-Making study), a pre-registered ecological momentary assessment study taking place in the natural work environment of the MFRs, focused on two main topics: 1) The stress reactions and subsequent decisions made during the shift (https://osf.io/pgb5n) and 2) the dynamics between workload and recovery the following day on duty (https://osf.io/tuynd). Furthermore, because the EPME model outlines the role of specific individual factors, we investigated the potential buffering role of optimism and the potential amplifying role of neuroticism.

To progress from everyday stress to MCI-specific experiences, we developed a VR-based study called **XVR study** to assess the main components of the EPME model:

- Human (personal, contextual and organisational) factors,

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- Psycho-physiological stress responses,
- Mental effort,
- Attentional processes,
- Decision-making, and
- Action and interaction.

During the study, participants (i.e., trained MFRs) complete five disaster scenarios in VR in which they have to triage patients accurately and call for backup forces. The scenarios vary in difficulty to monitor changes caused by increasing stress. The results of the XVR-study can help to monitor changes concerning behaviour and physiology under stress, enabling smart scenario control (D5.5) and adequate feedback for performance under stress (D5.6). A further aim of the study is to investigate potential performance indicators for VR training and to assess the influence of the level of expertise. To achieve that, we combine traditional performance indicators, such as time and accuracy of the triage process, with specific measures that can be extracted from the VR technology, such as eye-tracking for attentional processes (e.g., time spent looking at ir/relevant cues). Finally, to ensure effective interventions, precise stress-performance dynamics need to be examined (for details see D3.2). Therefore, we investigate how the different processes underlying performance under stress change with increasing stress during a disaster scenario.

2.2 Current studies in WP6

Within WP6, the MED1stMR consortium initially planned the following 16 studies, taking place in six FTs in different countries and 2 real-life exercises (see Table 3 and D6.1). For a better assessment of MR training, a direct comparison between MR scenarios and real-life exercises with the same emergency situations was foreseen. The two real-life exercises should comprise a small-scale exercise in the tunnel infrastructure of the partner MUL and a second large scale exercise at the emergency department of the UKHD. Subsequently, we list the research questions of the studies, which will be conducted as planned and go into more detail on the studies whose implementation is uncertain or which has been rescheduled (marked green in Table 3).

The following table summarizes the information related to lead organisations and lead persons of the different WP6 studies, the names of the studies, the implementable sample size, as well as a potential follow up.

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Table 3: Overview of the studies in WP6

Study (lead partner)			Field Trial Events								Follow-Up
			Austria (n = 36)	Germany (n = 52)	RL ZaB (n = 31)	Sweden (n = 36)	RL MCI (n = 80-100?)	Belgium (n = 56)	Spain (n = 72)	Greece (n = 30?)	
AIT	1	**SysEval** (Jakob Uhl)	X	X	-	X	-	X	X	X	
	2	**Manikin** (Jakob Uhl)	X	X	-	-	-	X	-	-	
	3	**Dashboard** (Olivia Zechner)	X	X	-	X	-	X	X	X	
	4	**SSC** (Olivia Zechner)	X	X	-	X	-	X	X	X	
UHEI	1	**EPME-Main** (Anke Baetzner)	X	X	-	X	-	X	X	X	
	2	**Comp RL & MR** (Anke Baetzner)	X	-	X	-	-	-	-	-	
	3	**EMA** (Friederike Uhlenbrock)	X	X	-	X	-	X	X	X	X
	4	**Brief Intervention** (Matthias Beutel)									
UBERN	1	**WOLF** (Rafael Wespi)	X	X	-	-	-	X	-	-	
UKHD	1	**Clinical MCI exercise** (Maik von der Forst)	-	-	-	-	X	-	-	-	
	2	**Hybrid MCI** (Gabriel Salg)	-	-	-	-	X	-	-	-	
UMU	1	**Learning outcomes** (Fredrik Schulz)	X	X	-	X	-	X	X	X	
	2	**Teaching and learning** (David Sjöberg)	-	-	X	X	-	-	-	-	
	3	**Learning retention** (Fanny Petterson)	-	X	-	X	-	-	X	-	X
SERMAS	1	**Fatigue** (Ana Maria Cintora)	X	X	-	X	-	X	X	X	
	2	**Self efficacy** (Carmen Cardós Alonso)	X	X	X	X	X	X	X	X	

2.2.1 Studies as planned

The studies under the lead of the AIT use a technology-centered approach and concentrate particularly on personal and contextual factors as a central base of the EPME model. Within the **SysEval study,** the MR system as a whole is evaluated concerning its different stages of development. The user experience of the trainees, their sense of presence as well as technology acceptance are topics addressed by the SysEval study. The **Manikin study** examines the impact of different levels of tangibility and immersion on the sense of presence and technology acceptance.

The studies under the lead of UHEI are conceptualized from a psycho-physiological perspective and aim at the validation of the core components of the EPME model (attention, decision-making, action). In the **EPME study,** participants of all six FTs will be tested. While the **Train Compare study** offers a comparison of real-life mass casualty training in a tunnel with the MED1stMR training in mixed reality, the **EMA study** evaluates parallels and differences between a controlled setting as experienced in the FTs and everyday work contexts.

The research group UBERN has their focus on interaction and communication in teams, which allows a deeper and more complex analysis of the actions of MFRs in MCIs. The **WOLF study** aims at assessing team performance using objective measures.

Under the lead of UKHD the **simulation of a clinical MCI** including a preclinical procedure will be evaluated.

Two studies under the lead of UMU will focus on learning and teaching aspects. The **Learning study** evaluates the learning outcome following participation in the MED1stMR training in mixed reality. In the **Teaching and learning study,** one team per day will be narrowly monitored and questioned during the whole training day.

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For the studies under the lead of SERMAS, two questionnaires with practical implications for the training in MR have been developed and will be validated during the FTs. Within the first **study, fatigue** evoked through the training is evaluated, within the second **study,** the effects of the training on the **self-efficacy** of the trainees will be investigated.

Table 4 gives an overview of the research sequences of the FTs, outlining the different phases in which data are collected, the methods and questionnaires used and the duration of the single tasks in minutes.

Table 4: Research Sequence of the Field Trials in WP6

		Pre-Training		During Training		Post-Training		Trainers
	General (Online Pre-Questionnaire)	Demographics Experience with VR/MR Informed consent (pp)						
AIT	**SysEval**					UEQ-S UTAUT 2 MPS Open questions	15	Usefulness of the system Intention to use Improvements
	MRManikin					Manikin + questionnaires	(45)	
	Dashboard	NASA-TLX	1,5	NASA-TLX VAS stress	1,5 0,5	Open questions		Open questions Interview (end of the week)
	SSC					Open questions		Open questions Interview (end of the week)
UHEI	**EPME-Main Comp RL & MR**	BFI-2-S MAAS Optimism Trait decision making Baseline strain MCI-self efficacy	3,5	Strain (perceived stress & fatigue, wellbeing, emotion regulation) Self-rated performance Decision making, MCI self efficacy Flashlight questions	6	Open question (compare)		
	EMA					Contact for follow-up (only 2 teams of 4 at Tuesdays)	(5 - 10)	
UBERN	**WOLF**	KSS	0,5	KSS TEAM	0,5 2,5			
UMU	**Learning outcomes**					Learning questionnaire	3,5	
	Teaching and learning			Training observation		Focus group interview	10	
SERMAS	**Fatigue**					Post-fatigue	2,5	
	Self efficacy	Pre-self-efficacy	1,5			Post-self efficacy	1,5	

2.2.2 Changes in studies

Originally, we aimed for 420 trainees to be included in the studies conducted in the six FTs (cf. D6.1). In the further planning of the FTs, the sample size was reduced to currently 282 participants. There were several reasons for this adaptation: The duration of the training and testing of a single team was extended so that all planned research questions could be implemented. As a result, fewer groups were able to train in one day, but the invited participants can practise more intensively and be interviewed thoroughly. Furthermore, it turned out that not all end users have the possibility to realise the originally aspired number of trainees.

The feasibility of the **Dashboard study** and the **SSC study** (Smart Scenario Control) cannot be currently assessed. If the technical implementation of the two tools is further delayed, these two studies under the lead of the AIT will have to be rethought.

The **Hybrid MCI** study led by UKHD has been cancelled due to a new prioritisation of technological development. The consortium has decided to put all resources into fine-tuning the two scenarios (on the road and in the tunnel) and to forego the development of a third independent scenario on a clinical MCI.

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The **Learning retention study** under the lead of UMU was cancelled. The reason for this is that the technological innovations of the MED1stMR system are being developed further from FT to FT, which may limit the comparability between the separate FTs.

The study plan of the **Brief intervention study** (UHEI 4) was changed. The planned intervention was focused on reducing stress in the intervention group and included both an active control group and a group without any intervention. As the sample sizes were reduced at each field trial, this would have only been made possible by splitting the already smaller groups into three groups and having only one group without an intervention where the data can be used for the EMPE study (UHEI 1). Instead, we now set up an online study assessing regulatory behaviour of MFRs on the outward journey to accident sites as well as at accident sites in all partner organizations. In addition, we ask them which of the adaptive regulatory strategies (e.g., focus on breath, distraction, humour) they are interested in trying out in their work life.

3 Future directions

The learnings from the research that has been implemented until now and that is planned for the upcoming FTs allow conclusions for future studies. The role of the trainer needs to be further examined. The trainer is supposed to adapt the scenarios during the training to either increase or decrease the demands of a particular exercise scenario. The effect of such dynamic changes within scenarios needs to be assessed in more detail in order to be able to give recommendations on when and how a trainer should intervene. Additionally, future research should focus more strongly on studies evaluating a longer and repeatedly applied MR training, studies assessing potential long-term benefits of the training as well as studies comparing MR training with real-life training as well as mixed training forms including both MR and real-life training.

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