D3.2

Multi-Dimensional Conceptual EPME Model and Research Agenda for Validation

Version
V1.0

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Versions

Version	Date	Author(s)	Description
V0.1	08/08/2022	Yannick Hill (UHEI) Anke Baetzner (UHEI) Cornelia Wrzus (UHEI) Marie Ottilie Frenkel (UHEI)	First Draft.
V0.2	09/09/2022	Cornelia Wrzus (UHEI)	Prepared for finalisation.
V0.3	28/09/2022	Anke Baetzner (UHEI)	Final comments treated.
V1.0	28/09/2022	Vendula Rajdlova (AIT)	Finalisation for submission.

Report Review

Version	Date	Reviewer(s)	Statement
V0.2	06/09/2022	Vendula Rajdlova (AIT) Helmut Schrom-Feiertag (AIT)	Editing and proofreading suggestions, consistency with other deliverables.
V1.0	28/09/2022	Helmut Schrom-Feiertag (AIT)	Final review, ok for submission.

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List of Acronyms and Abbreviations

Acronym/ Abbreviation	
EPME	Effective Performance in Medical Emergencies
KPI	Key Performance Indicator
MCI	Mass Casualty Incident
MFR	Medical First Responder
MR	Mixed Reality
VR	Virtual Reality

Terms and Definitions

Terms	
Stressor	A stressor is an external stimulus causing stress to an organism.

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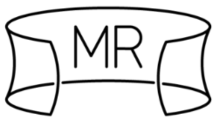
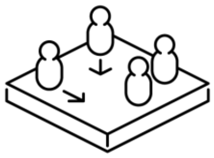
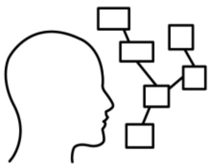
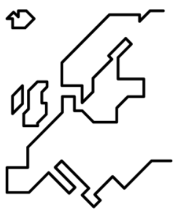
Relation to Objectives

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 actually causes stress in the trainees and what may actually help 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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Executive Summary

The first aim of this deliverable is to provide a **theoretical background** that serves as the foundation to understanding how medical first responders (**MFRs) act under stressful circumstances**. The second aim is to provide a thorough research agenda **to empirically validate the model**. This two-step process helps us to understand how different behavioural patterns may emerge based on 1) individual differences, 2) individual stress-process, and 3) immediate cognitive responses to the experienced situations. Therefore, this model includes not only general physiological stress-response models but combines them with psychological mechanisms to fully account for differences in effective performance in medical emergencies (EPME).

This deliverable first explains the background of the model and why it provides a logical fit with EPME. Then, the constituent elements of the model are outlined in detail. Given that the model also suggests a precise interplay between various elements, we also describe how the constituent elements influence each other. Finally, specific research questions are derived from the model alongside a research agenda tailored to answering these questions.

The EPME model will serve as the underpinning for future research that aims to 1) validate the mechanisms spelled out by the model to the context of medical first responders and 2) serve as a tool for designing interventions that exploit these mechanisms to enhance the performance of MFRs under high levels of stress.

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.

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.
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 developments in the entire work package.

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1 Background

In the first step of the EPME model development process, we searched for insights for models from the medical domain that aim to explain how individuals react to stressful events during medical emergencies. However, the initial search of the literature yielded that very few studies intended to explain medical performance under stress. Moreover, psychological aspects of medical training and mass casualty incident (MCI) performance were very scarce. This void was later confirmed by the systematic literature review of the key performance indicators (KPIs) and training evaluation methods (see Deliverable 3.1). Therefore, we expanded the search to other domains in which performance under stress is well researched with fully developed theoretical models.

Two domains in which stimulating peak performance under stress has received much attention in research are law enforcement and sports. In both domains, the performing individuals are exposed to high levels of stress. For example, whereas athletes have to perform under high physical demands under crowd noise to reach prize money or medals, police officers have to perform adequately even when in situations where their own safety may be at risk. MFRs also experience similar levels of stress. Their actions can be crucial to saving lives especially during MCIs. Another parallel of MFRs to sports and law enforcement is that MFRs need to pay attention to relevant stimuli without being distracted, make crucial decisions, and demonstrate both fine and gross motor skills to successfully complete their tasks. Therefore, models that can explain these processes for both athletes and law enforcement may have strong potential for being applicable to MFRs as well.

A suitable model based on insights from law enforcement and sports research has been proposed by Nieuwenhuys and Oudejans (2012) and since been reworked with slight adaptations based on empirical developments in these domains (Nieuwenhuys & Oudejans, 2017). Moreover, according to the authors, the integrated model of anxiety and perceptual-motor performance may be extended to the medical field given the similarity of the necessary motor precision between athletes and medical professionals. However, in order to extend the model to medical emergencies, we propose some changes to its original conceptualisation. First, given that as indicated by its name, the original version placed anxiety as a central concept, we will focus on the broader stress process within MED1stMR. Note that anxiety is typically seen as an emotional response to stress. Therefore, we expand on this notion by also considering physiological stress responses that emerge when exposed to potentially threatening stimuli in addition to the pure psychological reaction. Additionally, while anxiety is typically seen as a purely inhibiting factor for performance, research has shown that stress may be performance enhancing in the short-term (see Section 2). Second, we integrate the attentional processes with the stimulus-driven and goal-driven changes that stress induces. Thereby, the attentional processes are not seen as a result of the changes in threat-related cues, but rather are integrated in the change process. This means that the attention of the MFRs is directly coupled to the cues in the environment that they attend to (or overlook). Finally, the EPME model views attention, decision-making, and action as a temporal sequence that can be distinguished from each other. This is

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a slight adaptation from a more integrated process where attention, decision-making, and action are inherently linked and only difficult to distinguish.

In the next section, we will introduce the EPME model with all its constituent elements. However, the focus will not be placed on each factor in a vacuum, but the interaction between these elements will also be outlined. Finally, the research agenda for the model validation will be introduced.

2 EPME Model

The EPME model represents a causal chain model that explains how the stress experienced during medical emergencies can lead to changes in the attention, decision-making, and action of a MFRs (see Figure 1). Specifically, the model consists of three main elements that directly interact with each other following the exposure to the stressor before alterations to the attention, decision-making, and action chain occur. These three elements can be categorised into "human factors", "stress response", and "extra effort". In short, the **human factors interact with the potential stressor** (e.g., the MCI scenario) to evoke or buffer against a stress response. This stress response, in turn, may elicit extra mental effort. Together, the stress response and the increased effort cause alterations in the attentional processes, which influence the decisions that the MFR makes, and eventually what actions are taken.

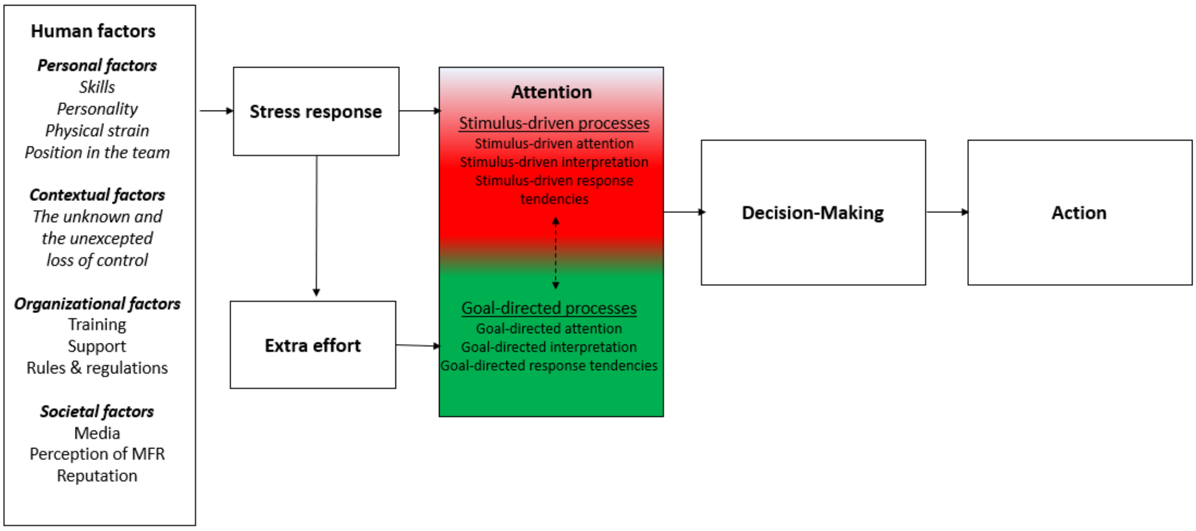

Figure 1: Visualisation of the EPME model.

2.1 Human Factors

According to the classic conceptualisation by Lazarus (1999), stress emerges when the demands of a situation are weighted against a person's perceived capacity to successfully deal with the demands. In the first step of this process, the so-called primary appraisal, a person examines whether the situation bears significant relevance for their goals. If the situation is deemed relevant, the secondary appraisal

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begins. Here, the coping possibilities are evaluated against the situational demands. When the person perceives the situation as controllable given their resources, no stress response is elicited. However, when the demands exceed the available coping resources, the person experiences distress, which leads to various physiological responses (see Section 2.2).

The human factors predominantly influence the secondary appraisal process. Specifically, they represent the array of coping resources that are available to a person. This means, the different and individual composition of human factors cause an individual perception of stress for each human being. In terms of MFRs during medical emergencies, the relevant factors can be split into four main categories.

First, **personal factors** include characteristics and skills inherent to the individual. These include personality traits that are more stable and difficult to change, but also trainable characteristics. For example, a MFR who scores high in the personality trait neuroticism may be particularly vulnerable to stress due to frequent rumination and self-doubt. In contrast, a person scoring low on this trait may demonstrate more self-confidence and therefore attribute themselves better coping resources, which in turn leads to lower stress. However, both individuals may be trained to implement breath control, which can regulate physical arousal and help individuals focus in stressful situations. Being aware of such skills can function as a coping resource.

Second, **contextual factors** are inherent to the specific situation that the MFRs are exposed to. One particular contextual factor that is relevant to MFRs is the patient demographic. For example, when children are involved in a MCI, the perceived demands of the situation may increase compared to an incident with exclusively adult patients. However, contextual factors can also function as a coping resource. Working with an experienced partner can help individuals to cope more efficiently with the demands when guidance is provided or the experienced partner remains calm during the incident.

Third, **organisational factors** represent the influences of the administration body on the MFRs. This includes the training that is provided as well as the guidelines or rules and regulations that need to be followed. The better the MFRs are trained for their tasks, the firmer skills are developed which can be relied on during demanding situations. Furthermore, clear rules and regulations (that do not hinder implementing the actual tasks) can function as a coping resource. For example, if there are clear triage procedures, they may be implemented almost automatically. Knowing exactly what to do can help to reduce the uncertainty posed by a demanding situation. The more unclear the regulations under which life-saving procedures are to be performed are, the higher the demand on the MFR is in such a situation.

Fourth, **societal factors** may also have an influence on how a MFR can cope during a medical emergency. Specifically, a bad reputation for medical personnel may actually induce another layer of threat that would have to be coped with. In such a case, a person may be second-guessing their skills. In contrast, when MFRs are well respected and depicted positively in the media, this may enhance their confidence in their skills and also foster positive responses from the patients.

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Thus, all in all, the human factors summarise the coping resources that are available to MFRs. These resources can be either inherent to a person or even be induced by society. Furthermore, some factors are easier to alter than others and may therefore be targeted in training to suppress potential negative effects of stress.

2.2 Stress Response

In the scientific literature, stress is conceptualised as a dynamic process that unfolds over time. In the traditional conceptualisation, three main periods were identified (Seeman & Robbins, 1994). First, a person needs to be exposed to potentially **threatening stimulus** (see Section 2.1). Following this *exposure*, the person's ***reactivity*** captures how intense the reaction to the stressor is. Finally, the person ***recovers*** and returns back to the previous resting state. While this three-stage model is well-accepted, it has been more recently pointed out that individuals can already show initial levels of reactivity when they expect a stressor to occur (Luong et al., 2018). This *anticipation* period therefore precedes the actual exposure and elevates stress levels (see Figure 2).

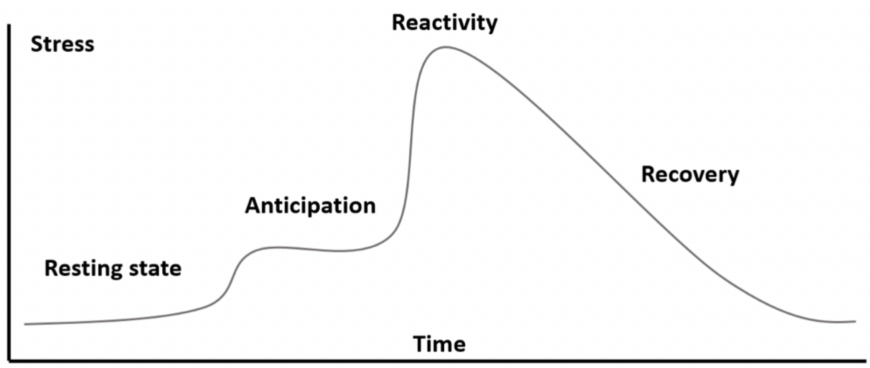

Figure 2: Visualisation of the different sequences within the temporal stress process.

During the reactivity, several **automatic (or uncontrollable) physiological changes** take place. These changes can be differentiated into **immediate** responses and **slower** responses. Immediate responses include elevated breath rate, increasing blood pressures, or changes in the heart rhythm (i.e., heart rate variability). Slower responses consist of hormonal changes, such as elevated cortisol levels which peak approximately 20 minutes following the exposure to the stressor. In general, these physiological changes enable the body to easily engage larger muscle groups and increase our attention (Hermans et al., 2014). Therefore, this increase of energy resources is typically considered adaptable in the short-term, but may lead to deterioration if the activation period persists for too long.

On the psychological level, **stress leads to anxiety**. This **emotional response** is marked by uncertainty regarding the outcomes of the situation. As a consequence, disrupting negative thoughts may emerge (Ehrlenspiel & Mesagno, 2020). In terms of MFRs, **anxiety may lead to intrusive worrisome thoughts regarding the outcome of a patient's life**.

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On the behavioural level, the traditional responses to stress are related to the fight-or-flight responses (Cannon, 1914). This means that the person would either withdraw or engage the stressor. Additionally, humans may also show a “freezing” response during which a person seems to be stuck and engages in neither of the classic engagement or disengagement responses. For example, an MFR may not make any triage decision for a given patient before moving on to the next. In line with the freezing response, stress may also lead to delays in motor movements. This means that actions are not immediately performed, but the motor response rate is reduced. Alternatively, motor patterns may also be executed with too much intensity under high levels of stress. For example, if an MFR intends to open a sealed bag, too much force may be applied. This may in turn lead to the equipment being dropped when the bag opens with too much pressure. Furthermore, changes in the visual field occur under stress. While low levels of stress may be beneficial because they increase focused attention, levels of stress too high may constrict the visual field too much and induce tunnel vision. In such a state, a MFR may be too focused on a single patient or a single detail (e.g., a bleeding wound) and neglect other relevant pieces of information within their surroundings.

2.3 Extra Effort

The potential negative effects of stress, such as heightened anxiety states and its consequences can be combated with **intentional behavioural changes**. A central feature of the EPME model for this is extra effort. Specifically, extra effort may help to either reduce stress directly or to maintain goal-directed behaviours and suppress impulsive actions (Eysenck et al., 2007; Nieuwenhuys & Oudejans, 2017). Indeed, emotional responses of stress, such as anxiety, may even directly motivate individuals to engage in **compensatory extra effort to reduce this unpleasant state**. In the case of MFRs, extra effort may be used to focus on the trained procedures, such as the correct sequence of steps for the triage categorisation. This way, the MFR may reduce stress because the plan of action is clear and other impulses can be suppressed because the sequence of actions is pre-determined and only needs slight adaptations to be executed in specific situations.

However, it should be noted that merely spending more resources in terms of mental effort to maintain control is not sufficient to combat the negative impacts of stress. It is crucial to consider where the extra resources should be allocated to and what resources are actually available (Frenkel et al., 2022). Therefore, specific training is required to properly react under stress (Ignacio et al., 2016; LeBlanc et al., 2009). Training specific habituations for MCIs that can help to reduce stress may help MFRs to develop default responses that a) allocate the extra effort to helpful situations and actions and b) can be engaged with relative ease as an automated response. The habituation process is particularly important because the high demands of a MCI may limit the cognitive resources so much that coming up with sensible solutions on the spot may not be possible. Finally, the compensatory effects of extra effort are likely to only work within certain levels of stress. Under extremely high or enduring levels of stress, performance declines cannot be prevented anymore.

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2.4 Attention

Broadly speaking, attention reflects the process of selecting the stimuli in the environment that are chosen to engage with and the stimuli which are to be ignored (in order to reach a desired end state) (Posner, 1980). As previously indicated, stress can have a direct influence on attention (e.g., changing the visual field, Section 2.2), which can be buffered against (to some degree) by extra effort. In our model, we distinguish between two types of processes that underlie attention. Stimulus-driven processes are considered a reaction to the immediate environment and therefore mainly be driven from outside of a person. In contrast, goal-directed processes are largely based on a person's goal-directed behaviour and therefore fostered by the individual itself (Corbetta et al., 2008). The different processes have specific influences on both the specific things that we pay attention to as well as how the information is processed. Therefore, the locus of causality for the processes that guide attention play a central role in the effectiveness of the resulting behaviour.

2.4.1 Stimulus-Driven Processes

As previously pointed out, stimulus-driven processes are set in motion through the direct perception of the environment. Under stress, the focus of attention is guided towards threat-related stimuli (Eysenck et al., 2007). This means that a person becomes more alert to potentially harmful things in their environment. Moreover, in order to execute pre-planned actions, it is oftentimes important to disregard irrelevant information from the environment. For example, a MFR should disregard questions from bystanders when attending to a patient. However, under high levels of stress, a MFR may be prone to look at or respond to the bystanders more than necessary. Once such a distracting stimulus is not inhibited anymore, it also becomes more difficult to redirect one's attention to the relevant task at hand. Thus, individuals are not only distracted more often, but also for longer periods of time.

2.4.2 Goal-Directed Processes

Goal-directed processes are marked by a pre-planned pattern that aims to reach a desired end state. This means that a MFR engages in a situation with a specific goal. In order to reach this goal, specific actions need to be completed. Therefore, attention is paid to the relevant stimuli that aid this goal or interfere with relevant processes and therefore need to be removed. Meanwhile task-irrelevant stimuli are successfully ignored. This combination typically allows for an accurate assessment of the situation and the environment. Therefore, a MFR who is focused on the necessary end state and correctly identifies the relevant stimuli in their environment, while not being distracted is likely to make more accurate decisions and execute their actions more accurately.

2.5 Decision-Making

Depending on the information that is attended to (i.e., goal-directed or stimulus-driven), MFRs engage in the decision-making process. Decision-making reflects the selection of a preferred action possibility. This implies that there are typically several options to choose from. Therefore, different options are weighted against each other to arrive at the optimal solution (Nieuwenhuys & Oudejans, 2017). With

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increasing levels of stress and changing attentional foci, the options to choose from change. While goal-directed attention leads to the perception of options that conform to the pre-planned actions, stimulus-driven attention leads to ad hoc decisions based on the options presented by the immediate environment. Stress even alters the degree to which options are perceived. Specifically, action capabilities are underestimated when stress induces feelings of anxiety (Pijpers et al., 2006).

Translated to the context of MFRs, a prime example for decision-making is the triage process. When categorizing patients during a MCI, the final decision can be either correct, incorrect, or absent. An absent decision would reflect a situation during which no decision is made, relating to the freezing response in the stress process model (see Section 2.2). Ideally, a MFR is trained to accurately assess the relevant categorisation information and adequately evaluate the patients' condition. This would reflect a goal-driven decision-making process: the MFR approaches the patient with a desired end-state (i.e., the correct categorisation), attends to the selective information, and arrives at the decision based on the combination of the relevant details. However, if a MFR experiences high levels of stress, they may become distracted by irrelevant stimuli (e.g., non-fatally bleeding wounds) and thereby delay the decision-making process and increase the chance of making the wrong decision due to the distractions. Thus, the stimulus-driven attention processes distort the decision-making process and lead to incorrect outcomes.

2.6 Action

Once a decision for a particular action is made, the according movement pattern is executed. Because high levels of stress change the blood flow and muscle activity (see Section 2.2), the resulting movements execution diverts from the usual pattern. Specifically, movements become less precise (for fine motor skills), more explosive, delayed, less fluent, and more rigid (see Nieuwenhuys & Oudejans, 2012). This means that stress first drives the attention away from relevant cues. This in turn influences what decisions can be made based on the available information. And finally, the execution of the decisions also becomes disrupted due to decreases in motor patterns. Thus, actions are impaired by both the direct effects of stress on the motor system, but also indirectly due to the limitation of action possibilities mediated by alterations in attention and decision-making processes.

According to the EPME model, stress plays a central role for the performance of MFRs during demanding events, such as a MCI. For stress to emerge, the situational demands have to exceed a person's perceived coping resources (Lazarus & Folkman, 1984). High levels of stress can then drive attentional processes away from pre-planned executions to become distracted by (irrelevant) stimuli within the immediate environment (Fox et al., 2001). This process may be buffered against by increasing mental effort to focus on the task-relevant information. Once a MFR becomes increasingly distracted, their pool of options for decisions shifts is decreased overall. This, in turn, leads to less effective actions, which are also executed less optimally. Therefore, to combat the potential negative effects of stress, interventions can be placed at several steps of the process. For example, the perceived coping resources may be increased (e.g., more training time) or the effective implementation of extra effort may be enhanced. Additionally, psychological skills, such as

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mindfulness may also help a MFR to redirect their attention, while breathing exercises can help to buffer the immediate physiological responses.

3 Research Agenda

The research agenda is tailored to validating the proposed EPME model. This means that we will engage in testing whether the interplay between the different elements of model as explained in Section 2 indeed proof to be the mechanisms of effective performance for MFRs. The research agenda is split into two sections. First, we will present specific studies that are currently running or in the planning phase (see D6.1) and their relation to the EPME model (see D3.1). Next, we present what additional research questions can be derived from the model and be answered over the course of the project.

3.1 Current Studies

3.1.1 Running

In one of our first pre-registered research projects (https://osf.io/pgb5n), we aim to specify the stress process in MFRs during their everyday work. Due to the COVID-19 pandemic, prehospital and hospital staff have to attend to multiple patients at once. Increasing demands at work may alter the stress response by increasing the reactivity and recovery time (see Section 2.2). Indeed, research has shown that both stronger reactions to stress and slower recovery rates can be a sign of resilience losses (cf. Hill et al., 2018, 2021; Scheffer et al., 2018). Such resilience losses need to be detected as early as possible because they can lead to sudden changes psychological well-being (e.g., Van de Leemput et al., 2014). Therefore, we examine the dynamics between the perceived workload and the rate of perceived recovery in the following day to identify whether high demands lead to reduced recovery and vice versa (https://osf.io/tuynd). Additionally, to capture the effect of anticipatory stress (see Section 2.2), this study assesses whether expected demands before a shift correlate with the staff's perceived recovery and may predict the perceived demands for the upcoming shift. Furthermore, because the EPME model outlines the role of specific personal factors (see Section 2.1), we investigate the potential buffering role of dispositional optimism and the potential amplifying role of neuroticism (i.e., emotional instability).

To capture these dynamics, we designed an ecological momentary assessment study (Shiffman et al., 2008). This means that we obtained non-intrusive, brief measures of the relevant factors at several moments in time. In this case, data was collected at two separate four-day intervals during which the participants had a work shift. Before the shift started, they filled in information regarding their well-being, recovery, and anticipated stress. After each shift, the well-being was re-assessed alongside the perceived demands and the decisions that were made during the day. The personal factors were assessed once during a baseline assessment (including demographic information) given that these factors typically remain stable over such a short period of time.

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The assessment of the decisions that were made during the shift was tailored to the second aim of the study (https://osf.io/pgb5n). Hereby, the relationship between stress and decision-satisfaction, decision-confidence, and decision mode (i.e., intuitive vs. deliberative) was assessed. Specifically, in line with the EPME model, decisions are assumed to become more intuitive (i.e., stimulus-driven) than deliberative (i.e., goal-directed). That is, the increased demands guide the attention to the stimuli in the immediate environment and limit the cognitive capacity for pre-planned actions. The shift to more intuitive decisions is also assumed to lead to a decrease in the satisfaction with the decisions as well as a decrease in the confidence in the decisions. Therefore, this study examines a) the specifics of the stress model and the buffering effects of personal factors and b) how stress changes the decision-making process.

3.1.2 Planned

To move from everyday stress to MCI-specific experiences, we are currently developing a VR-based study to assess the entire EPME model means that will assess 1) personal factors, 2) physiological stress-responses (and perceived stress), 3) mental effort, 4) attentional processes, 5) decision-making, and 6) action. During the study, the participants (i.e., trained MFRs) will complete several VR scenarios during which they have to accurately triage the patients and call for backup forces. The scenarios vary in difficulty in order to monitor changes with increasing stress. Based on the results of this study, several follow-up studies will be implemented that aim to assess individual elements of the EPME model and specific interactions with others to provide additional in-depth validations.

As a one central aim of the study, potential performance indicators for VR training will be examined. As trainings, and especially new training methods, need to be evaluable, meaningful performance indicators are needed. In fact, several performance indicators exist, but it is unclear how well they apply to VR training and whether VR-specific indicators add additional value. Therefore, we will test the relationship between several performance indicators for MFRs during disaster scenarios in VR and assess whether they can discriminate different levels of expertise. Hereby, we will 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 build effective interventions, the precise stress-performance dynamics need to be examined. Therefore, we will examine how the different processes underlying performance change with increasing stress during a disaster scenario. The literature distinguishes between three dominant stress-response models which describe the (behavioural) response to increasing stress loads (see Agathokleous et al., 2018). The linear non-threshold model describes a linear decline in the response with increasing stress. The threshold model predicts that the response stays stable for low to medium stress and then starts to decline linearly once a particular load threshold is exceeded. Finally, the hormetic response model describe an initial increase in the response for low to medium stress and a decline for high stress. Depending on the exact model, the intervention may aim to a) decrease the decline rate of increasing stress (i.e., non-threshold model), b) increase the limit when stress begins to

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impact performance negatively (i.e., threshold response), or c) increase the area where stress enhances performance (i.e., hormetic model).

3.2 Future Directions

While several research interests within the consortium, the future directions described here refer explicitly to the EPME model. For example, because the EPME describes the mechanisms on a personal level, team research will be reserved for Deliverable D3.5. Similarly, research interests outside the scope of the model are not elaborated on here.

3.2.1 Research Ideas

One key topic for the future research is the comparison between VR/MR and real-life performance. For interventions to be effective, it is insufficient if the mechanisms of the EPME model cannot be transferred to the actual context in which MFRs need to perform. Therefore, a validation of the model not only within VR/MR studies, but in real-life is essential.

Additionally, the role of the trainer needs to be examined. First, it is valuable for the implementation of the developed technological training solution to integrate a 360-degree perspective on the effectiveness. That is, while we may present empirical indicators of the system's effectiveness, the implementation is rather unlikely if trainers do not find the training solution useful. Therefore, an effectiveness assessment that considers expert opinions may need to be evaluated. Additionally, the trainer is supposed to be able 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 order to optimize when and how a trainer should intervene.

Following the notion of interventions, one of the implications of the EPME model is to specify how stress-responses can be optimized for MFRs. This means that the model can identify what mechanisms need to be altered to optimize attentional, decision-making, and behavioural processes under stress. Consequently, designing and testing methods to reduce the potential negative impact of stress and to foster EPME will be explored. The effectiveness of such interventions will not only be evaluated based on immediate effects, but also based on whether long-term benefits result from the training.

3.2.2 Research Designs

While the currently running and planned studies mainly focus on quantitative data, future studies will incorporate qualitative elements as well. Such mixed-methods studies can verify whether the findings of the quantitative data align with the perceptions and experiences of the participants. Furthermore, qualitative data may also provide additional insights into cognitive processes. For example, attentional processes are typically examined with eye-tracking in VR studies. This means that the duration for which an object is in the focused visual field will typically be regarded as seen and recognised. In this case, this assumption may be verified by asking the participant to elaborate on the gaze behaviour and what they saw.

Furthermore, more long-term designs may be implemented within the project. First, such designs may refer to the duration of a training. Typically, training is not completed within a single session.

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Therefore, to yield comparable results in the field, MFRs may need to train several times within VR to yield adequate data. Second, long-term data may also be used to examine long-term effects of trainings and interventions (see Section 3.2.1).

4 Conclusions

Based on the concept, that stress, workload, and performances of MFRs is comparable to law enforcement and athletes, same models for stress measuring can be used. Nevertheless, the suitable model must be adapted to medical emergencies. Moreover, studies within MED1stMR will focus on broader stress process as well as integration of the attentional processes with stimulus-driven and goal-driven changes that stress induces. The EPME model views attention, decision-making, and action as a temporal sequence that can be distinguished from each other.

The first study will assess personal factor, physiological stress-response, mental effort, attentional processes, decision-making and action. Future studies will be defined derived from the results.

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