

Summary for publication: 5th (final) project period (01.10.2023 – 31.03. 2024)

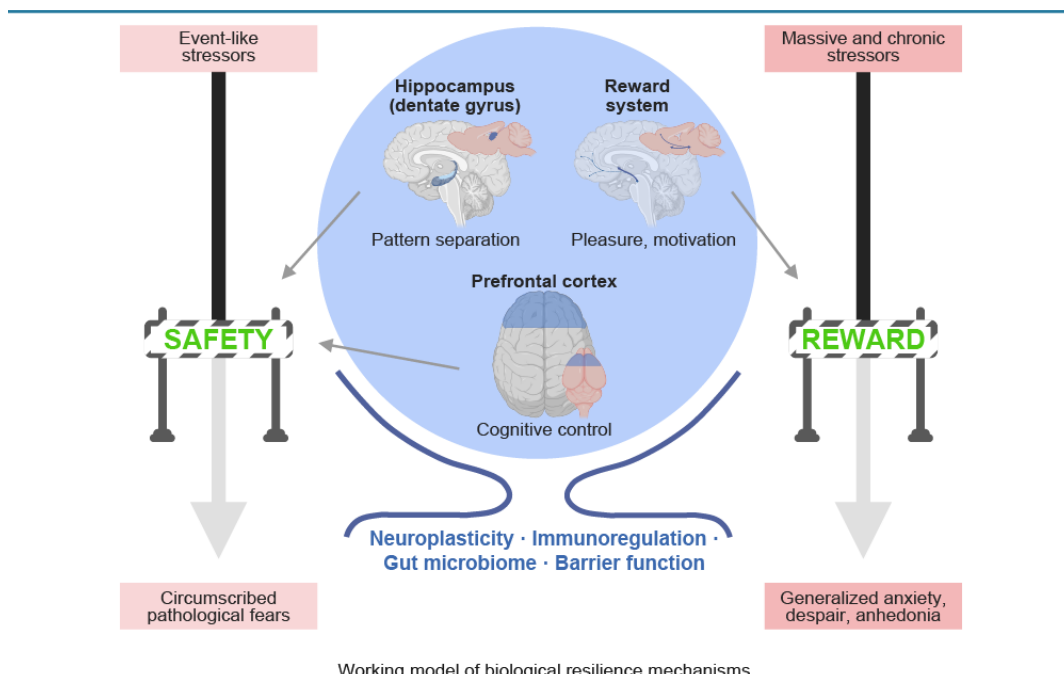
1. Summary of the context and overall objectives of the project

Stress-related disorders such as anxiety, depression, or post-traumatic stress disorder impose a significant burden on individuals, the economy, and society. The prevalence of these disorders has not decreased in the past decades despite huge efforts that were made in research on disease mechanisms and treatments. More recently evidence has accumulated for an exacerbation of stress-related public health problems, in particular in young people. The COVID-19 pandemic and other recent crises, including the climate crisis and armed conflicts, have further highlighted the societal relevance of stress-related burden. The overall aim of DynaMORE was to improve the prevention of, or quick recovery from, stress-related mental health problems.

DynaMORE’s approach was health- rather than disease-focussed: we tried to help avoid mental problems rather than cure them after they have already developed into full-blown psychiatric diseases. This was to increase individual well-being and reduce healthcare demands and indirect economic costs.

To achieve this, DynaMORE focused on the phenomenon of stress resilience: the maintenance or quick recovery of mental health during and after stressful life periods. DynaMORE investigated resilience by advancing the mathematical modelling of mental health in individuals under adversity; by using the insights from modelling to also deepen our conceptual and mechanistic understanding of resilience mechanisms; and by developing entirely new mobile Health (mHealth) products for the primary prevention of stress disorders. We anticipated our solutions to be pandemic-proof and facilitated coping with future pandemics for individuals and for societies.

2. Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far



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Figure 1. Graphical abstract of Kalisch et al. (2024).
 Neurobiology and Systems Biology of Stress Resilience.
 Physiological Reviews, 104(3): pp. 881-1408.

DynaMORE WPs 1-3 developed a basic theoretical approach to the mathematical modelling of resilience and techniques to analyse real-world data from longitudinal resilience studies in individuals exposed to stressful life situations. These techniques include improved ways of quantifying resilience and of predicting such good mental health outcomes (Kalisch et al. 2021, Köber et al. 2021, Köber et al. 2023). WP3 developed a new measurement tools for resilience factors (Petri-Romao et al. 2024). DynaMORE WP3 applied these techniques to existing data sets, while WP4 conducted several studies during the COVID-19 pandemic (e.g., Veer et al. 2021, Riepenhausen et al. 2022, Bögemann et al. 2023, Zerban et al. 2023, van der Heide et al. 2024), in which these techniques are used. Results point towards a key role for positive appraisal style (PAS), originally posited in 2015 by DynaMORE researchers as a major resilience mechanism (Kalisch et al. 2015). Several reviews and meta-analyses have confirmed our conclusions (Riepenhausen et al. 2022, Schäfer et al. 2022, Morello et al. 2023; Kalisch et al. 2024).

To further test this and other identified resilience factors and to establish a formal mathematical model, WP4 conducted a longitudinal multi-centre study at sites in Germany (Mainz, Berlin), the Netherlands (Nijmegen), Poland (Warsaw), and Israel (Tel Aviv) (Wackerhagen et al. 2022). The study used extensive baseline subject characterization, including with a neuroimaging battery specifically adapted for this project from experiences in earlier studies; high-frequent longitudinal online monitoring of mental health, stressor exposure, and resilience factors; as well as ambulatory methods, using smartphone-based ecological momentary assessment of stressors, emotional states, and physiological reactions, as developed by WP5 and WP6. Subsequently, WP4 has conducted a replication study at the same sites (Bögemann et al. 2023) that had the additional goal of evaluating two smartphone-app based ecological momentary interventions (EMIs) that have been developed by WP5 and WP7 to boost specific resilience factors. These are positive cognitive reappraisal (and thereby positive appraisal style: *ReApp app*, Marciniak et al. 2023) and positive future anticipation (*Imager app*: Marciniak et al. 2022). In particular, the study aimed at establishing personal characteristics that predict whether a given EMI is likely to be effective in an individual. The information will be used to design randomised controlled trials (RCTs) in follow-up projects in which the effectiveness of the EMIs for their specific target group will be tested.

The study allowed us to get a first glimpse into whether the apps indeed boost the intended resilience factors and whether this has causal effects on resilience outcomes, which would further support the importance of these factors. Both apps include an element of just-in-time adaptive intervention (JITAI), developed by WP5 and WP6, meaning that the apps in the later phase of training propose cognitive exercises only at time points in a day when participants are in need. JITAIs use data from self-report of affect via smartphones and from a wristband-wearable that records physiological changes, which are input into an automated decision algorithm. Moreover, DynaMORE enhanced training and mentoring of junior staff, for who a program with a retreat, workshops, international symposia as well as a mentoring structure was designed.

3. Progress beyond the state of the art, expected results until the end of the project and potential impacts (including the socio-economic impact and the wider societal implications of the project so far)

DynaMORE has contributed to developing resilience research into a discipline that increasingly uses the methods of exact mathematical science to predict results, test interventions and generate new manipulations intended to support the prevention of stress disorders. This goal was intertwined with the objectives to gain a better understanding of resilience and, moreover, to find new ways to combat stress-related disorders. If sustainably successful, our approach will help improve public health and reduce the individual, societal and economic burden of stress-related disorders. DynaMORE has also advanced the field of in-silico modelling and simulation, through the refinement of existing and the generation of new methods, and has promoted health technology, through the development of a product prototype with significant potential for commercial exploitation and valorisation. We further expect wider impacts on the fields of computational psychiatry, in particular in the areas of disease prediction and prevention.

4. Address (URL) of the action's public website

<https://dynamore-project.eu/>

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