Leibniz Institute for Resilience Research
MAINZ

Satellite Workshop

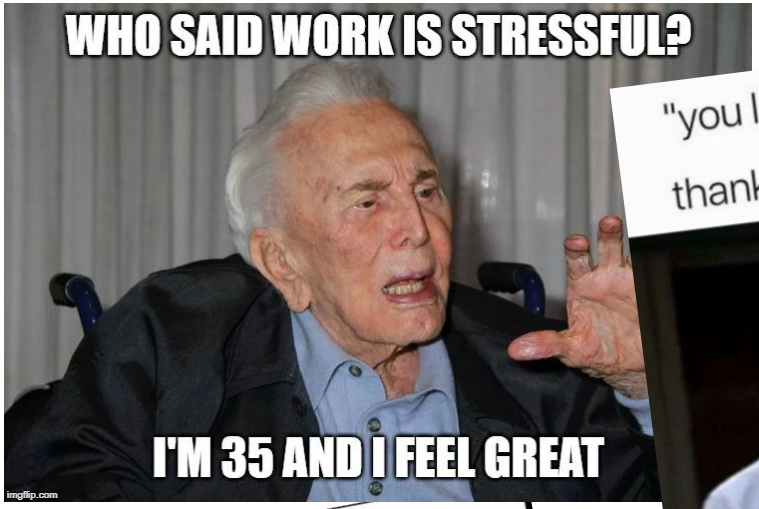
The stressor reactivity (SR) score: Basic methods and two use cases

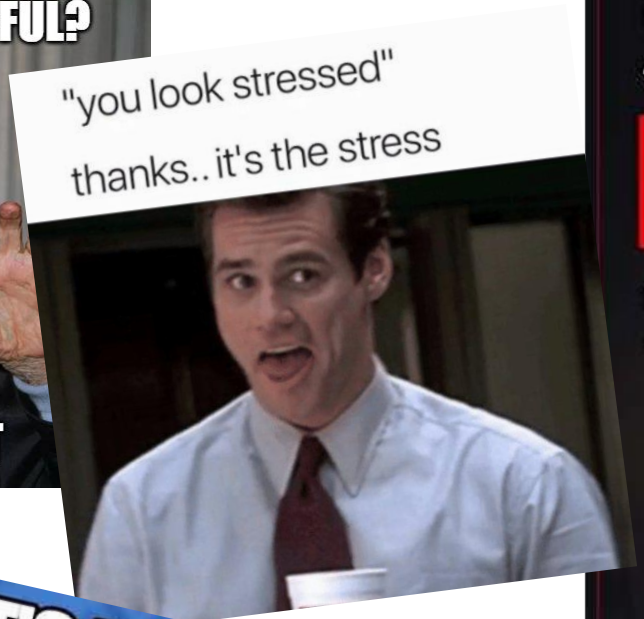
Lara Puhlmann
Leibniz Institute for Resilience Research

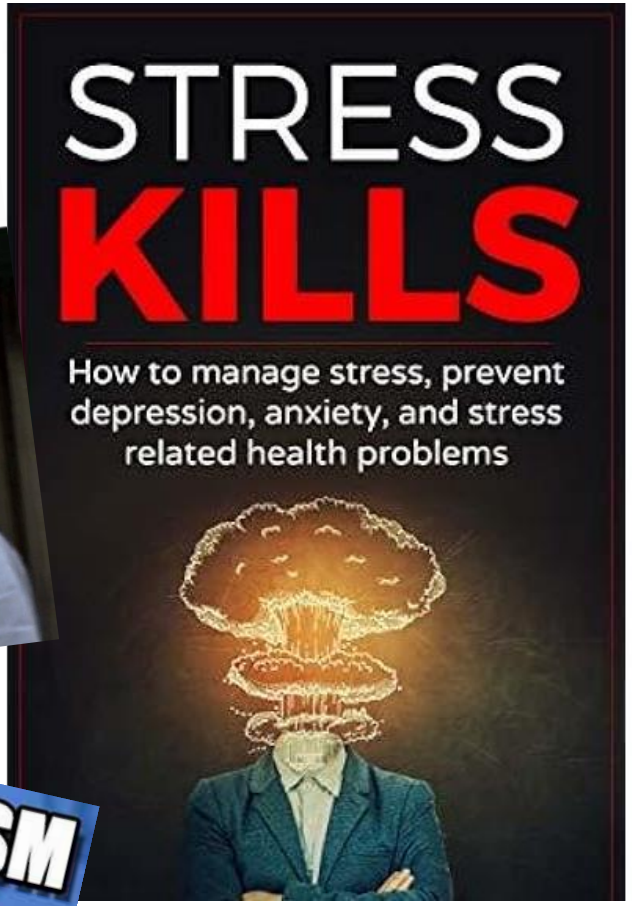
DynaMORE

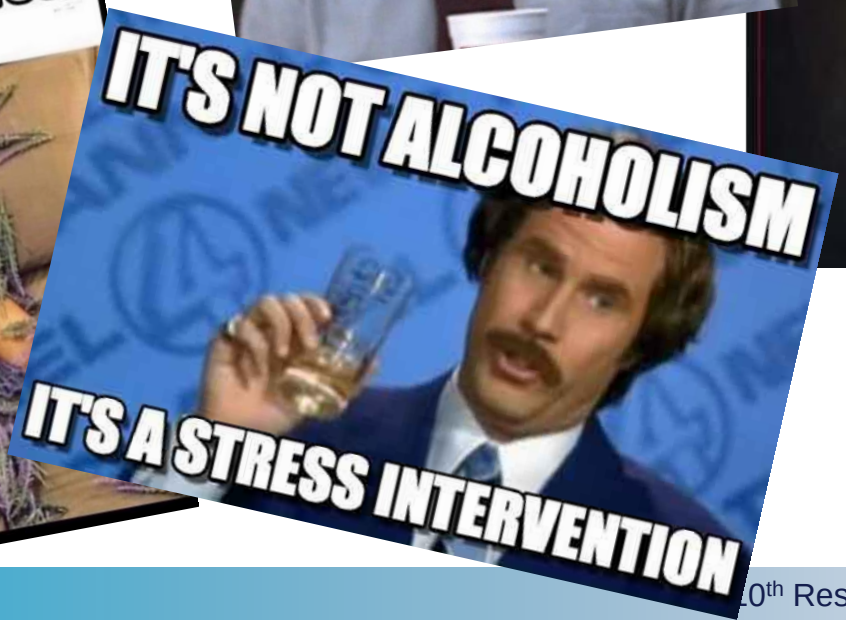
European Commission
Horizon 2020
European Union funding
for Research & Innovation

Lets talk about stress

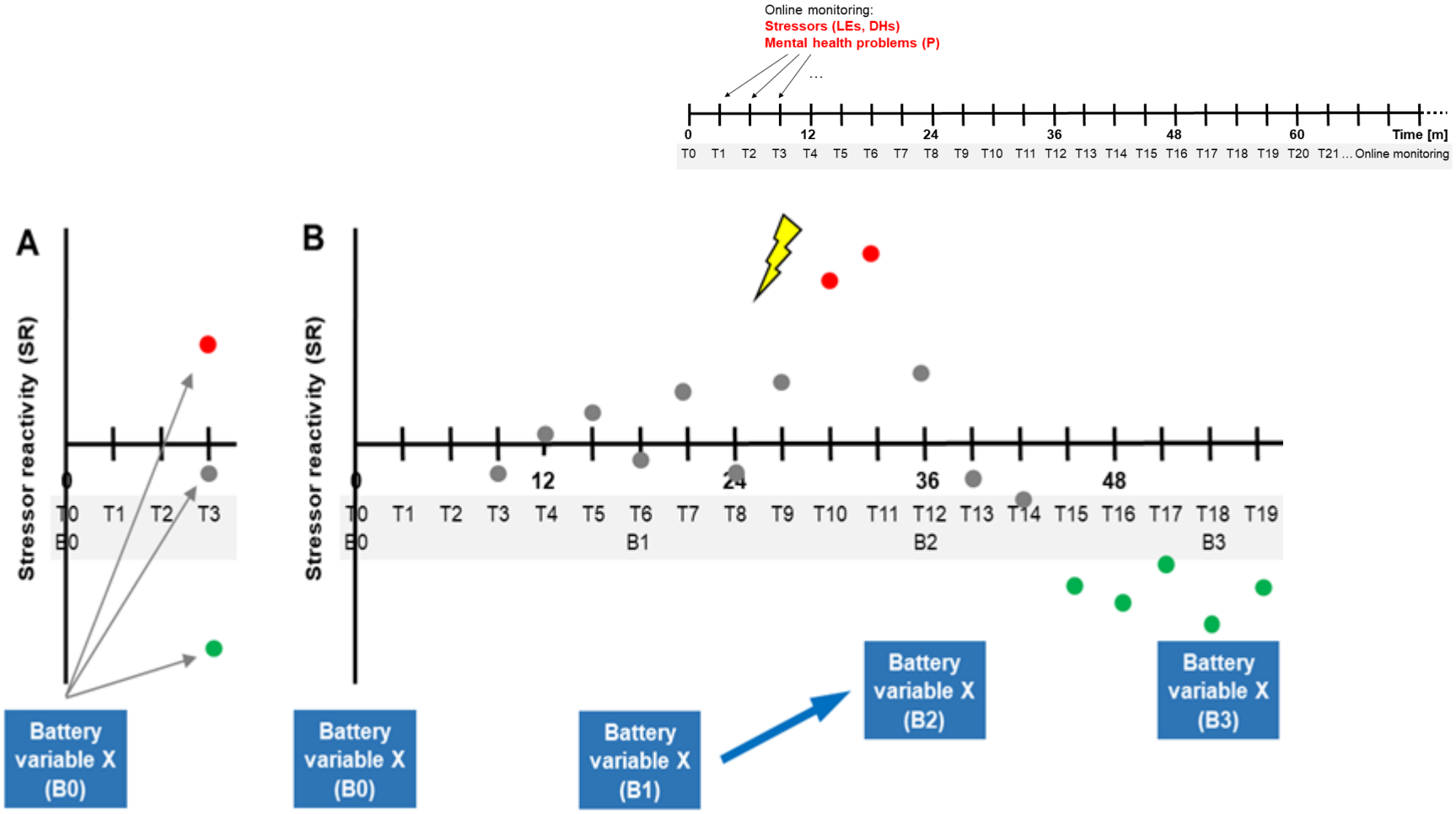








Capturing Resilience Dynamics



Kalisch et al., 2021, Front Psych

Resilience – outcome-based operationalization

Possibility 1: identify resilience factors

Possibility 2: identify resilience processes

Possibility 3: quantify resilience to life events

Possibility 4: quantify effects of resilience interventions

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Possibility 2: identify resilience processes

Possibility 3: quantify resilience to life events

Possibility 4: quantify effects of resilience interventions

Basic methods

- E & P assessments (in different study designs)
- E-P-line building
- Different SR versions (for different analyses)

Prospective longitudinal studies

And a generic solution for E and P monitoring

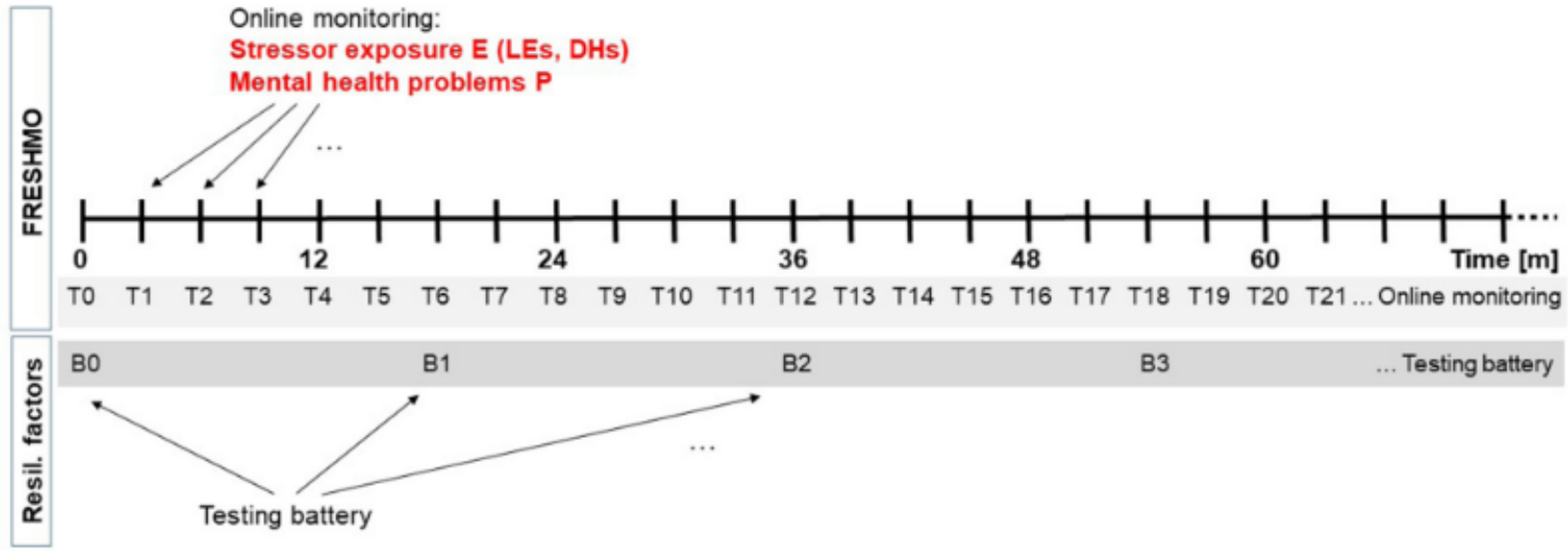

FIGURE 1 | Example design scheme employing the FRESHMO paradigm in combination with repeated assessment of resilience factors. Every 3 months (T1, T2, ...), exposure to macrostressors (life events, LEs) and microstressors (daily hassles, DHs) is assessed via self-report using online questionnaires. At the same online monitoring surveys, mental health problems P are reported. Every 1.5 years (B0, B1, B2, ...), subjects complete a testing battery for resilience factors.

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Our studies

- **LORA** (Kalisch et al., 2021; Chmitorz et al., 2021)
- **MARP** (Kalisch et al., 2021)
- **COVID samples**
  - MARP-COVID
  - LORA-COVID (Ahrens et al., 2021)
  - DynaCORE-L (Bögemann et al., 2023)
  - DynaCORE-C (https://osf.io/5xq9p/#!), N=15790 (Veer et al., 2021)
  - HEROES (Petri-Romão, *preprint*)
- **DynaMORE**
  - DynaM-OBS (Wackerhagen et al., 2022)
  - DynaM-INT (Bögemann et al., 2023)

References

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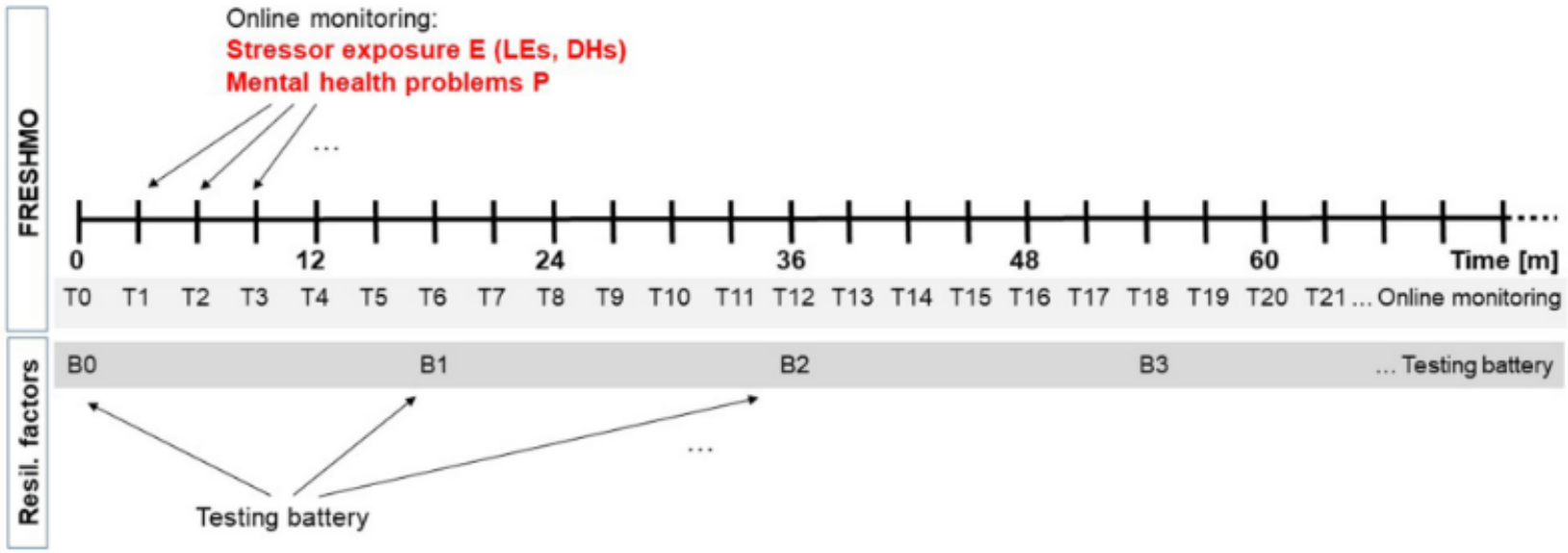
The longitudinal resilience assessment (LORA) study

LORA RESILIENZ STUDIE

Resilience in the general population
- Inclusion age: 18-50 yrs
- N=1191 healthy participants
- N=738 complete datasets at year 3



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Basic methods

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- E-P-line building
- Different SR versions

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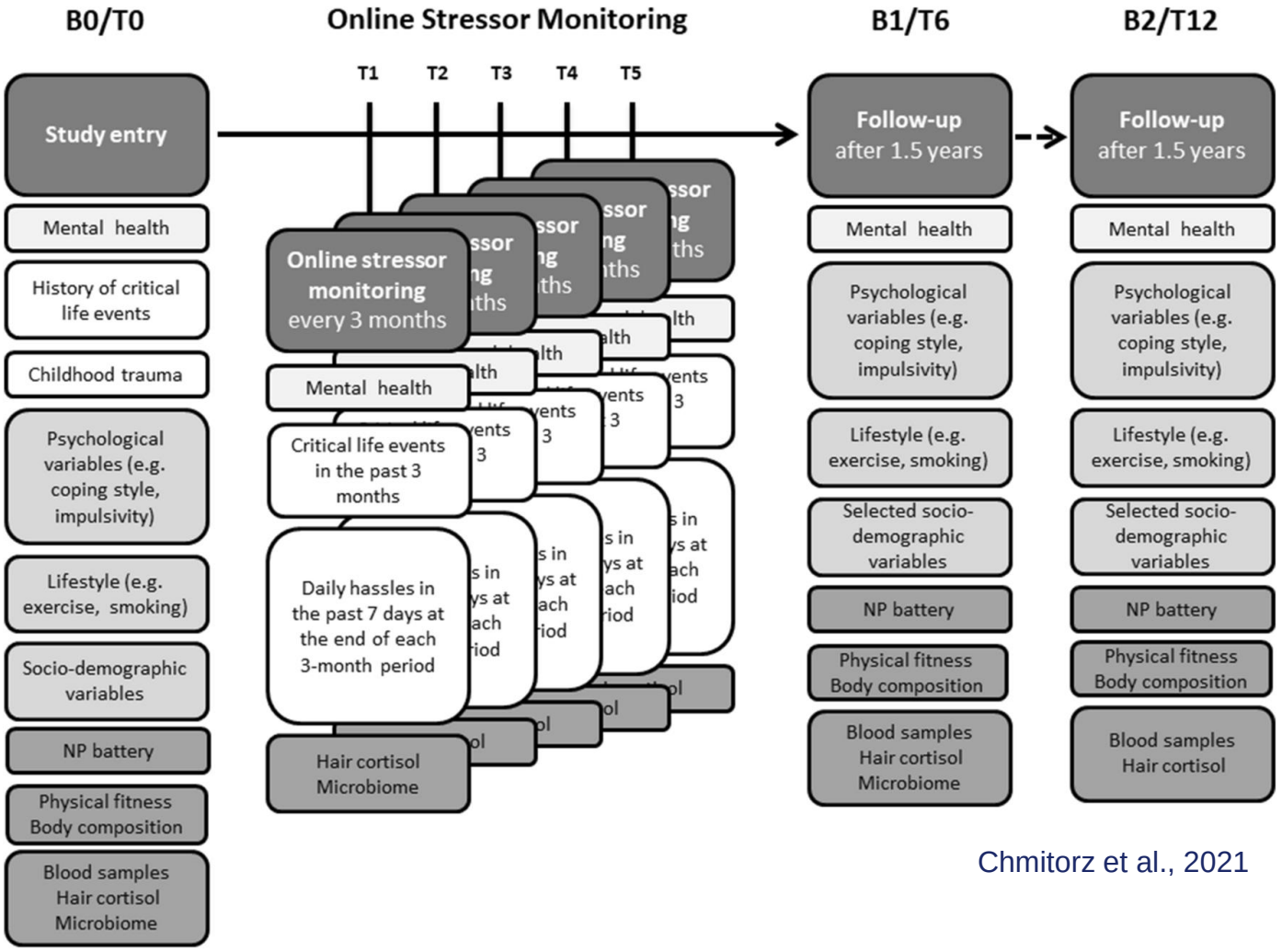

Chmitorz et al., 2021

Note. NP battery: neuropsychological testing battery.

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Table 1 (a) Questionnaires and (b) neuropsychological tests used in the LORA study

(a) Questionnaires

Topic	Questionnaire	*B*	*F*	3m	*#I*
Mental health	General health questionnaire-28 (GHQ-28) [18, 19]	x	x	x	28
	Health questionnaire for patients (PHQ-D) [20, 21]	x	x		16
	Mini international neuropsychiatric interview (M.I.N.I.) [16, 17]	x	x		
Micro- and macrostressors					
History of critical life events	Life events checklist from LHC (adapted from Canli et al. [22])	x	x	x	27
Daily hassles	Mainz Inventory of Microstressors (MIMS) [23, 24]	x	x	x	58
Childhood Trauma	Childhood trauma questionnaire (CTQ) [26, 27]	x	x		25
Perceived stress	Perceived stress scale (PSS) [28]; unpublished translation by A. Büssing, University of Witten/Herdecke	x	x	x	10
Maltreatment and abuse	Maltreatment and abuse chronology of exposure (MACE) [29]		x		18
Trauma	Harvard trauma questionnaire (HTQ) [30]		x		35
Psychological variables					

...

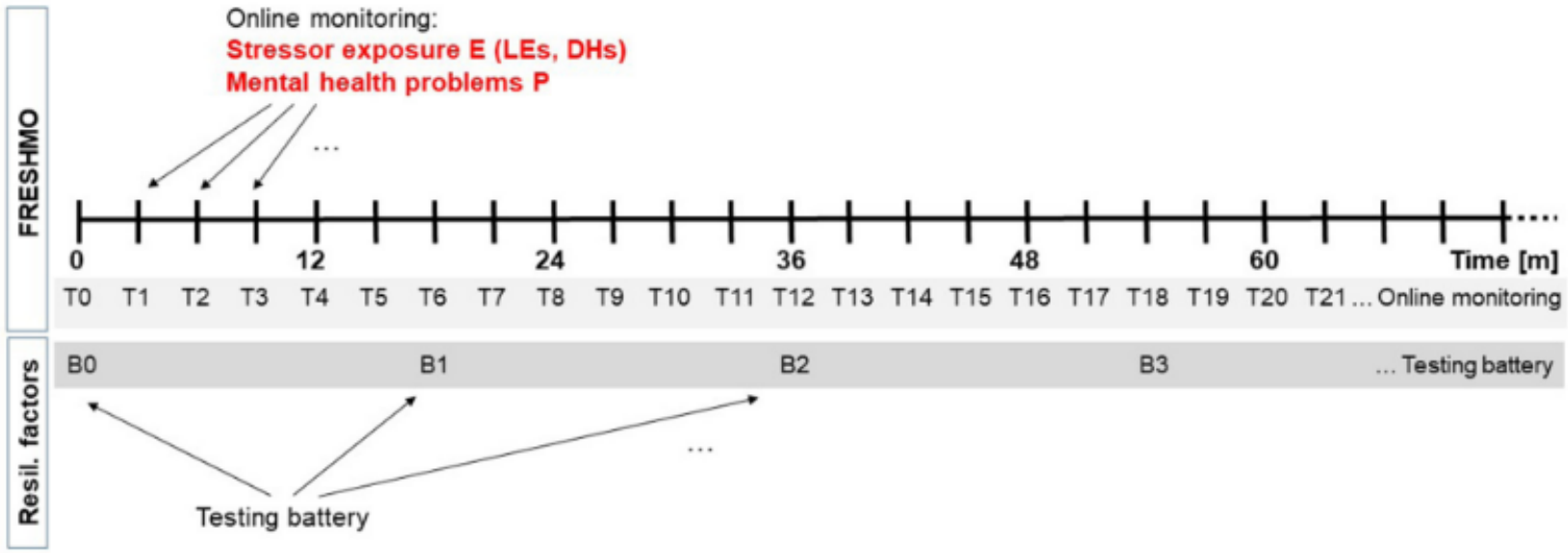
Chmitorz et al., 2021

Mainz Resilience Project (MARP)

MARP RESILIENZ STUDIE

Transition from adolescence (school, family life) to adulthood (work life)

- Inclusion age: 18 – 19 yrs
- Significant past adverse life events (>=3)
- N=167



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Kalisch et al., 2021, Front Psych

MARP COVID

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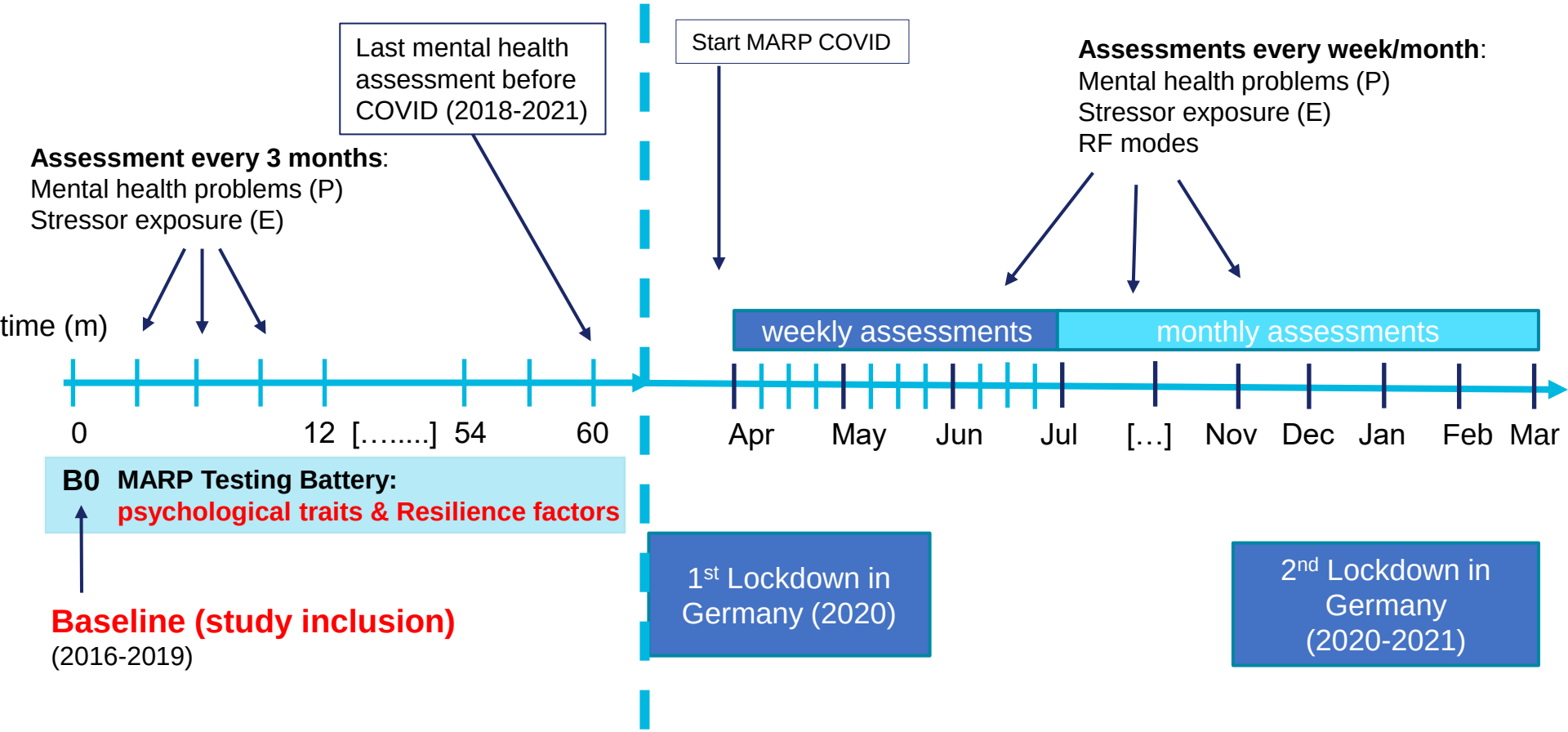
MARP study

MARP-COVID study extension



MARP COVID

Outcome

- Mental health problems (P):
  - General Health Questionnaire-28
- Stressor exposure (E)
  - Daily hassles
  - Corona hassles

combined in the **Stressor Reactivity (SR)** score

MARP RESILIENZ STUDIE

Deep phenotyping N=200

COVID monitoring N=89

Types of stressor exposure (E)

Daily hassles

Discrimination or mobbing by another person (including social media)
Problem with a pet (eg, diseases, bad behavior)

Covid hassles

Corona-related media coverage
Not being able to perform leisure activities.

Data variance

E (DHs)

	Mean + SD	ICC	SD (within)	Range (within)
DynaC ORE-L	43.8 ± 20.4	0.65	11.0	-42.5 - 44.7
Lora COVID	45.6 ± 23.6	0.75	10.6	-41 - 114
MARP	52.9± 27	0.52	16.6	-59.5 - 69.3
LORA	61.5± 29.0	0.38	16.3	-119 - 262

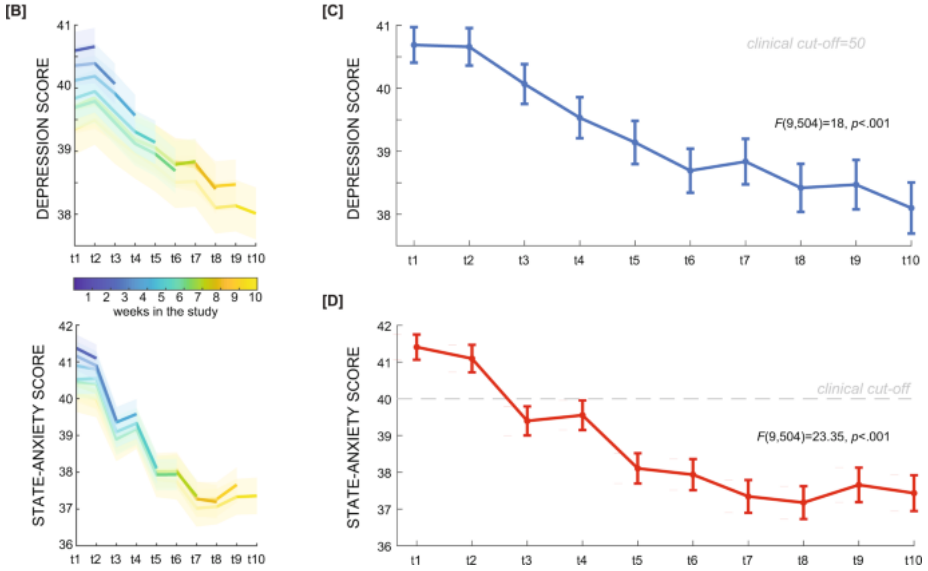
P (GHQ)

	Mean + SD	ICC	SD (within)	Range (within)
DynaC ORE-L	14.4 ± 5.9	0.69	2.97	-13.3- 13.3
Lora COVID	16.6 ± 8.66	0.54	5.30	-24.5 – 33-7
MARP	23.14 ± 11.8	0.35	8.53	-29.6 - 32.8
LORA	19.6 ± 9.67	0.33	7.18	-27.1 - 54.3

LORA COVID

[A]

	t1	t2	t3	t4	t5	t6	t7	t8	t9	t10
Data collection date	Apr 2	Apr 9	Apr 16	Apr 23	Apr 30	May 7	May 14	May 21	May 28	June 4
Not complete	31	153	131	83	76	65	75	59	47	29
Duplicate responses	20	2	2	1	0	3	0	0	1	0
Failed attention	35	18	19	11	15	12	12	7	5	6
n of valid observations	1426	1285	1156	1081	1001	936	866	812	766	737



Ahrens et al., 2021

DynaCORE-L

	Assessment	T0	Follow-Up 1	Follow-Up 2	Follow-Up 3	Follow-Up 4	Follow-Up 5
	Weeks since BL	0	1	2	3	4	5
	Resilience Factor measures						
RF Types	**RF Style (RF_S)** **RF Trait (RF_T)** **RF Mode (RF_M)**	PA_S OPT_T REC_S PSS_S CSS_M BC_S NEU_T	PAC_M GSE_M PSS_M	PA_M PAC_M GSE_M PSS_M BC_M	PA_M PAC_M GSE_M PSS_M BC_M	PA_M PAC_M GSE_M PSS_M BC_M	PA_M PAC_M GSE_M PSS_M BC_M
				Average weekly mode			

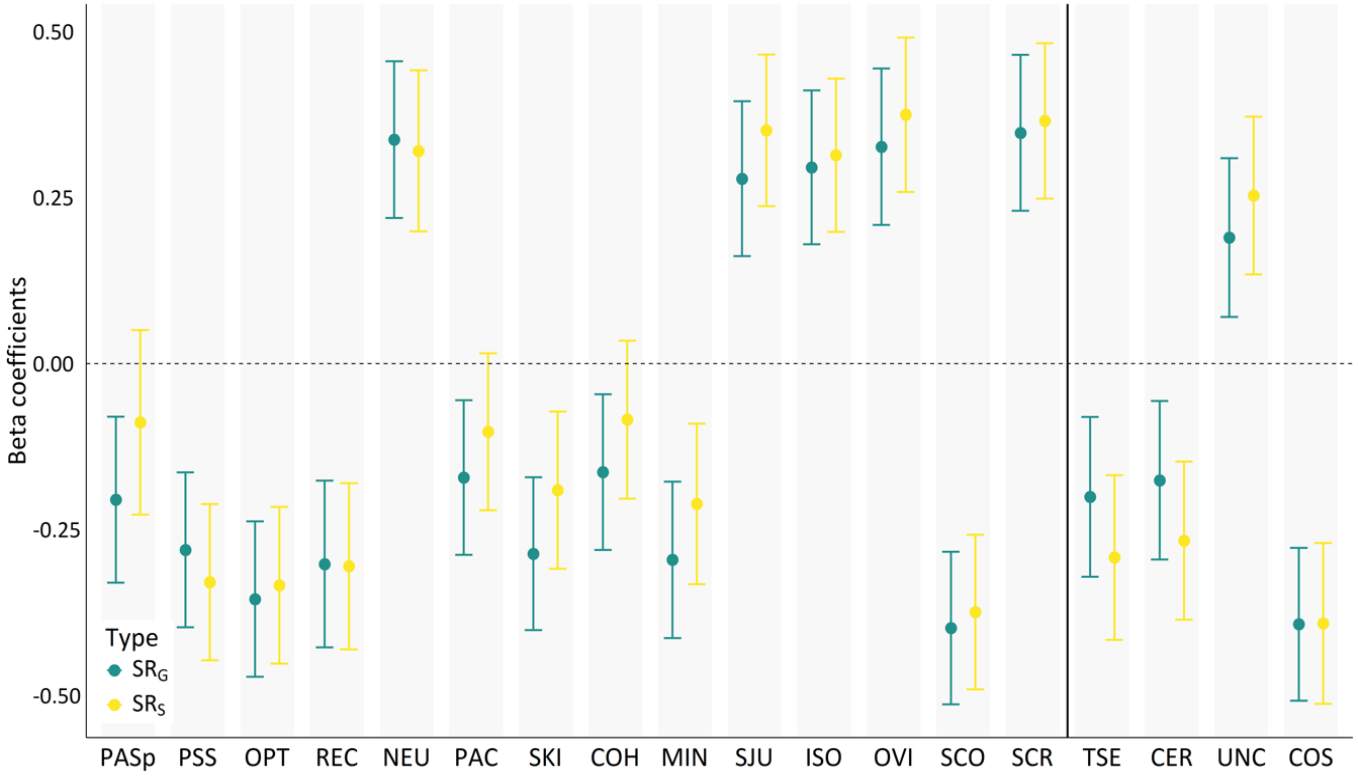
Bögemann et al., 2023

SR score based on other symptom measures

PCA Component loadings		Component
	STS	.61
	ProQoL: CF/STS	.59
	ProQoL: CF/Burnout	.53

N= 569 psychotherapists during the COVID pandemic

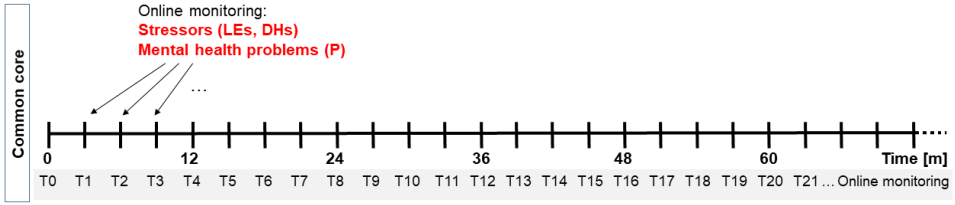
Abbreviations: STS, Secondary Trauma Stress Scale; CF/STS, Compassion Fatigue/Secondary Trauma Stress Scale; ProQoL marks scales of the Professional Quality of Life Questionnaire

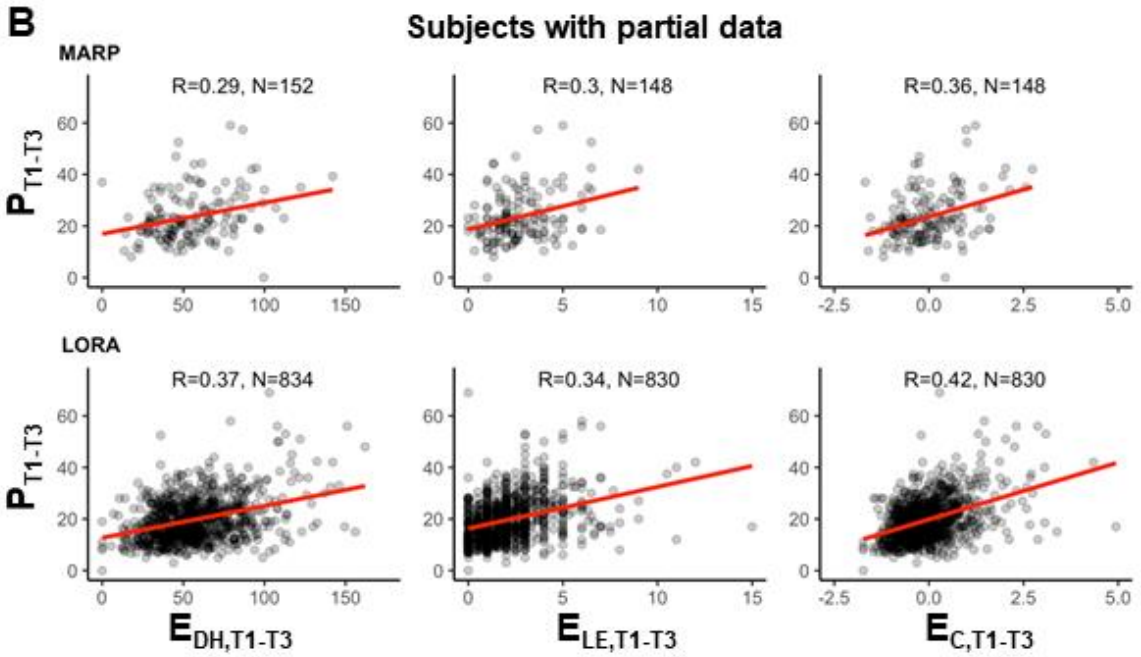


Zerban, Puhlmann et al., 2024

Key: relationship between stressor exposure and mental health

FRESHMO paradigm: frequent stressor and menta





→ **Stressors affect mental**

Basic methods

- **E & P assessments (in different study designs)**
  - E & P measures (according to sample)
  - Measurement spacing (feasibility, research question)

- E-P-line building
- Different SR versions

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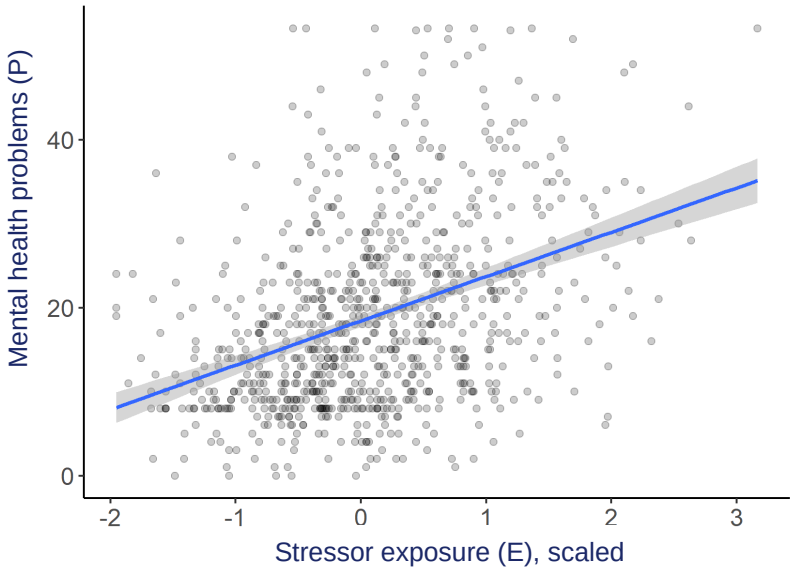
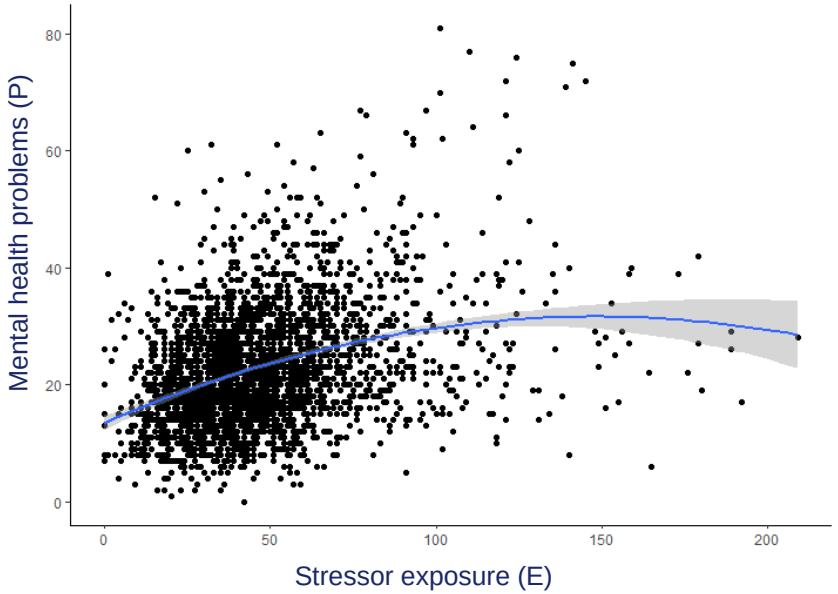
Linear vs non-linear line

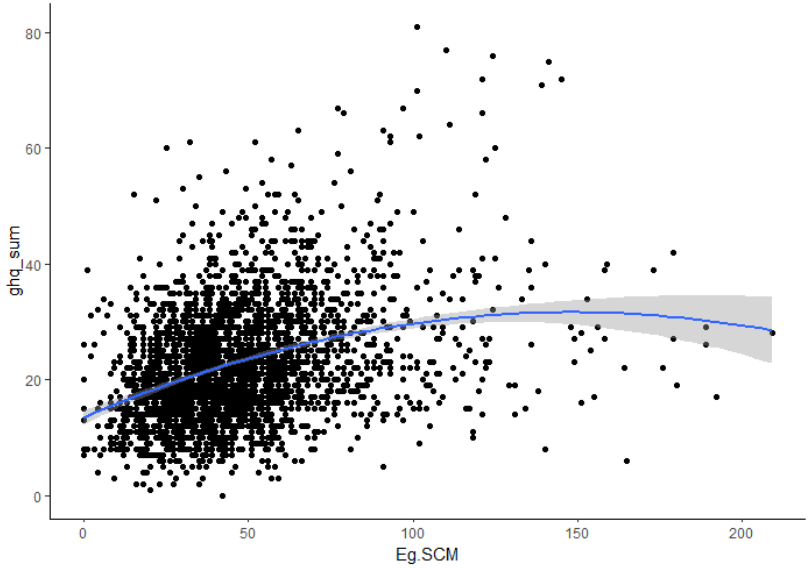
- Choose the best fitting line (based on model comparison)

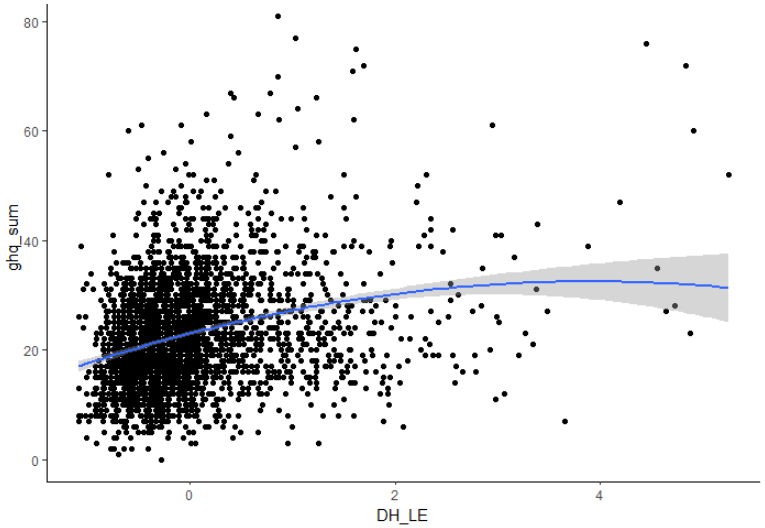


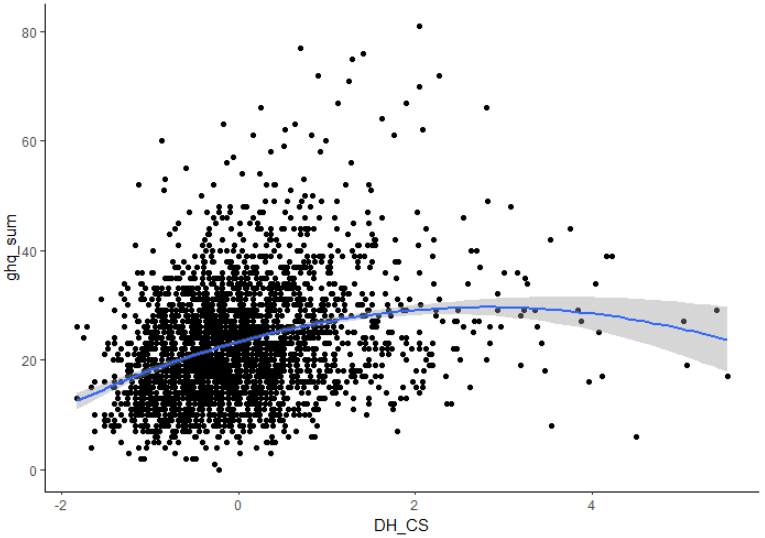


Contribution of different stressors?

DynaM-OBS data







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  - non-linearity (quadratic)
  - conceptual / data driven

- Different SR versions

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- **Different SR versions**

Resilience Processes independent of life events

The **Lo**ngitudinal **R**esilience **A**ssessment (LORA) Study

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Resilience in the general population
- Inclusion age: 18-50 yrs
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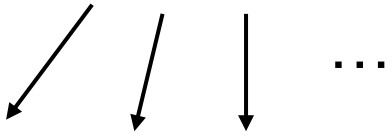
Online monitoring:
Mental health problems
Stressors (major life events, daily hassles)



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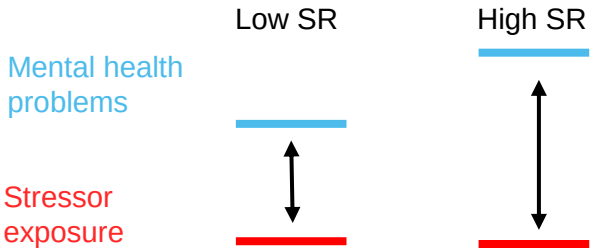

M = month

B0

SR
- **long-term**
- **sliding window**
- **single timpoint**

Data variance

SR sliding window

	ICC	SD (within)	Range (within)
DynaCORE-L	0.89	0.38	-1.61 - 1.76
Lora COVID	0.74	0.46	- 2.6 – 2.53
MARP	0.70	0.48	-1.81 - 2.53
LORA	0.67	0.53	-3.13 - 3.69

SR single TP

	ICC	SD (within)	Range (within)
DynaCORE-L	0.65	0.54	-2.14 - 2.62
Lora COVID	0.51	0.63	-2.96- 4.46

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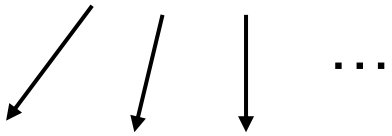

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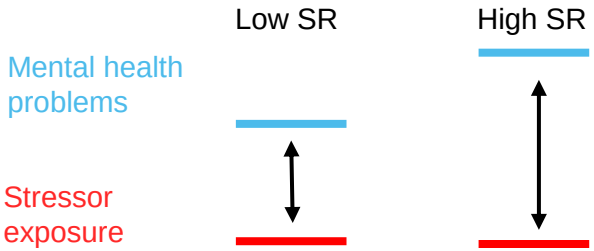
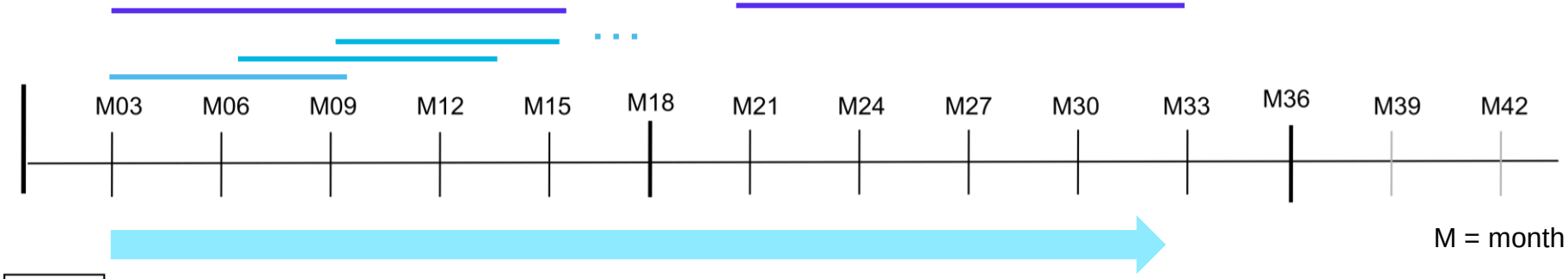




B0

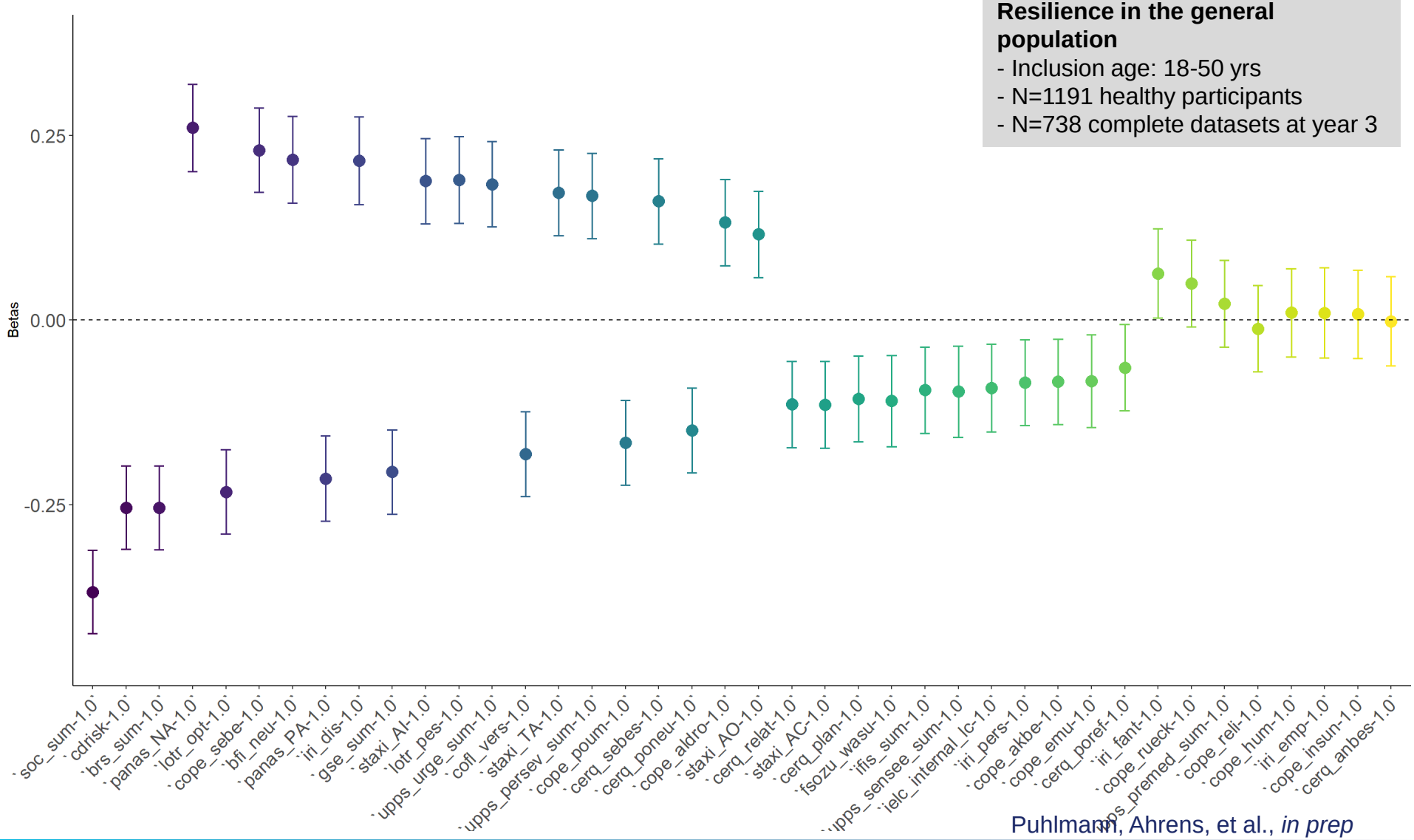
SR
- **long-term → long term RFs**
- **sliding window → smoothed time series**
- **single timpoint → time series, covariance**

Which factors are Resilience Factors (RFs)?

Baseline RF predicting SR over 3 years

LORA RESILIENZ STUDIE

Resilience in the general population
- Inclusion age: 18-50 yrs
- N=1191 healthy participants
- N=738 complete datasets at year 3



Puhlmann, Ahrens, et al., *in prep*

Resilience Processes independent of life events

The **Lo**ngitudinal **R**esilience **A**ssessment (LORA) Study

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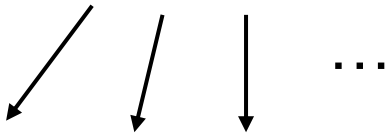
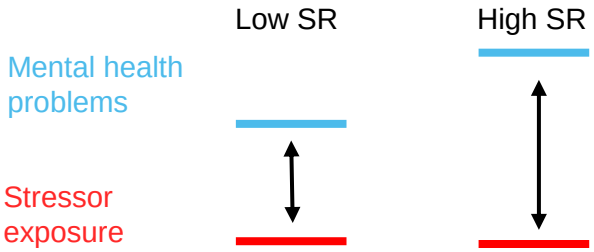
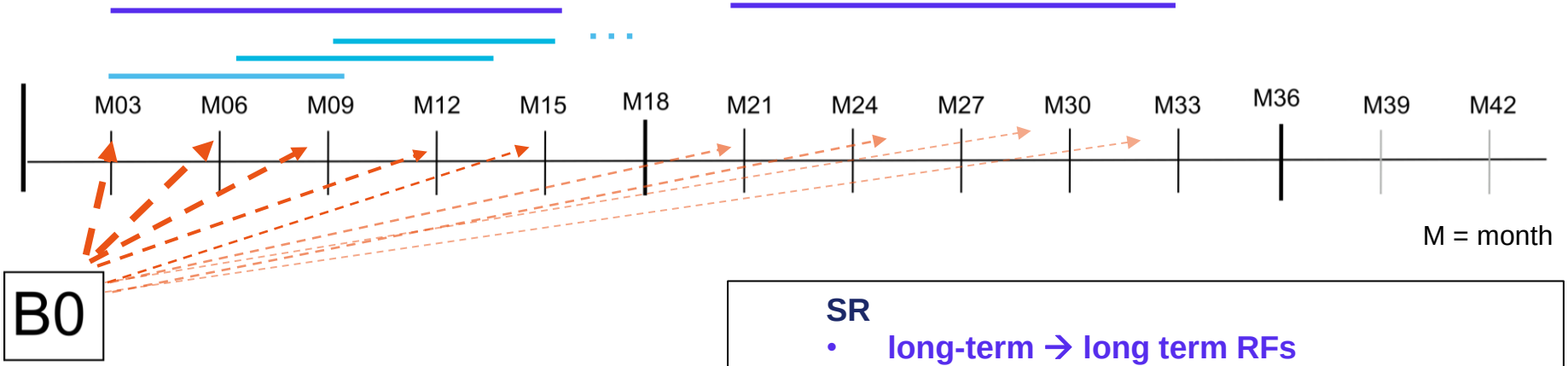
Stressors (major life events, daily hassles)



Stressor reactivity (SR) score

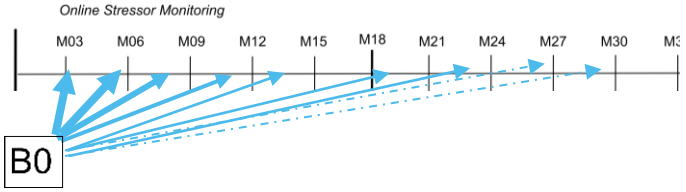




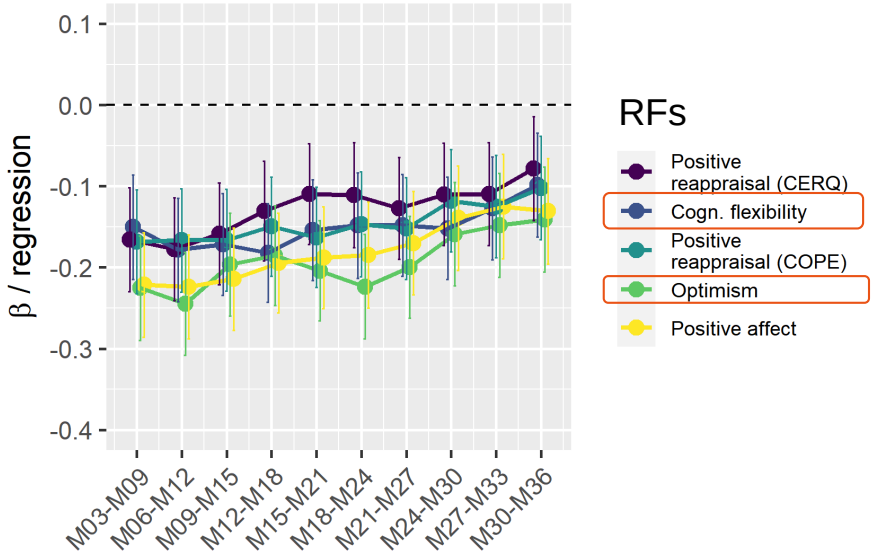
M = month

SR
- **long-term → long term RFs**
- **sliding window → smoothed time series**
- **single timpoint → time series, covariance**

RF → SR: Stable or variable association?



β RF → SR in separate regressions



Puhlmann, Ahrens, et al., *in prep*

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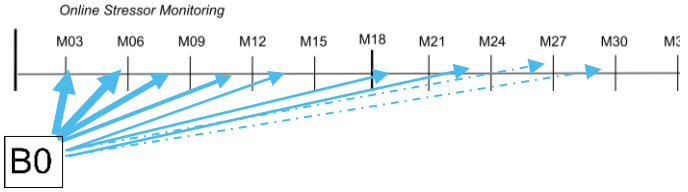
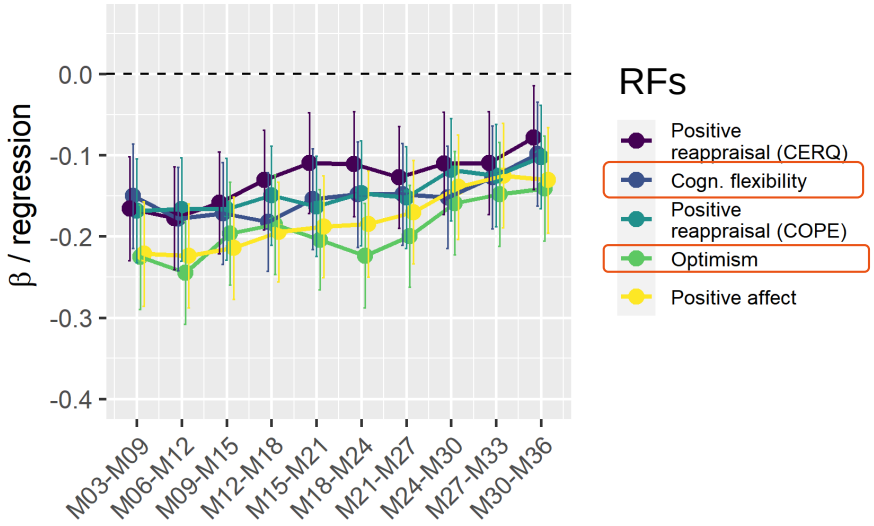
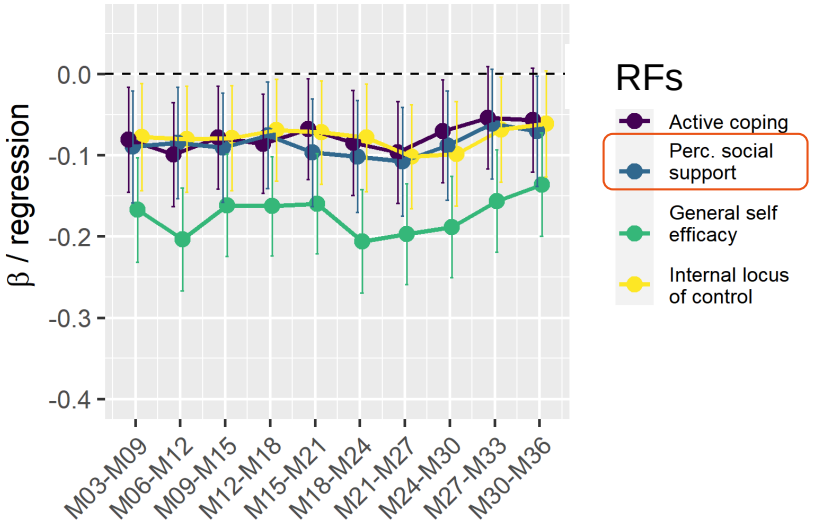


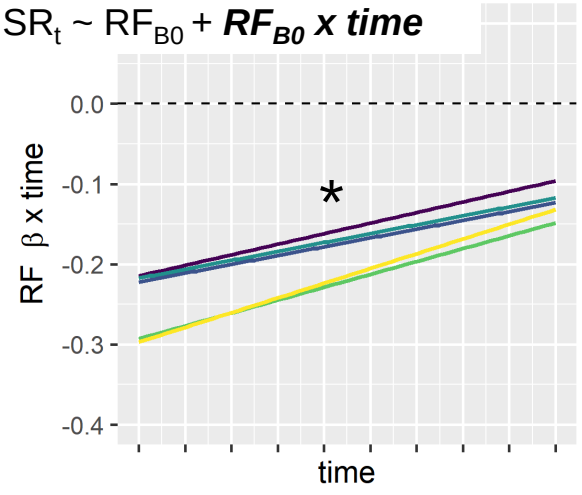
More variable RFs…

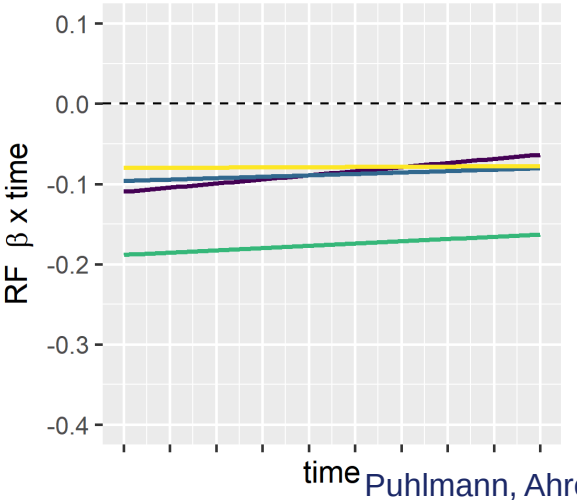


…to more stable RFs



$SR_t \sim RF_{B0} + \boldsymbol{RF_{B0}\ x\ time}$





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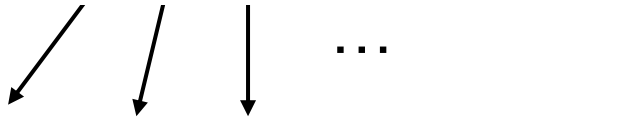

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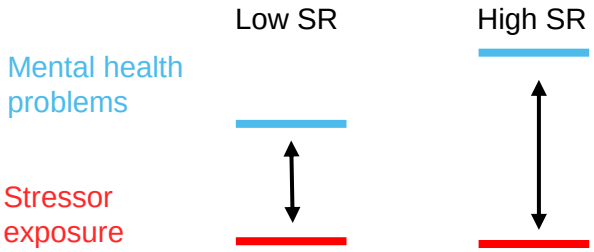
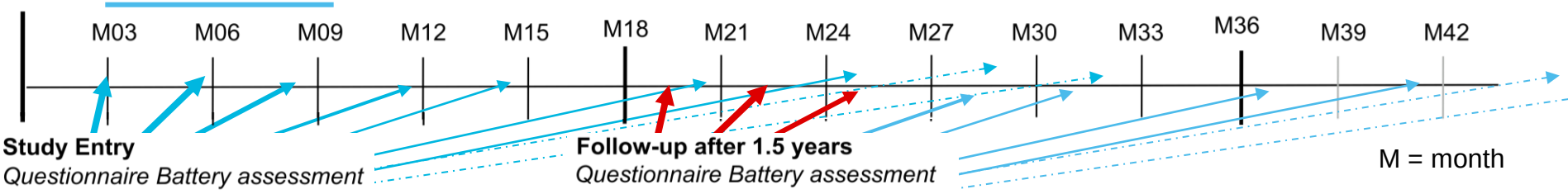


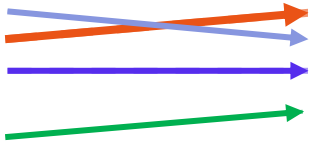


B0

B1

Resilience factors

- Personality
- **Cognitive flexibility**
- **Social support**
- Reappraisal
- **Optimism**
- Positive affect…



- **Cognitive flexibility**
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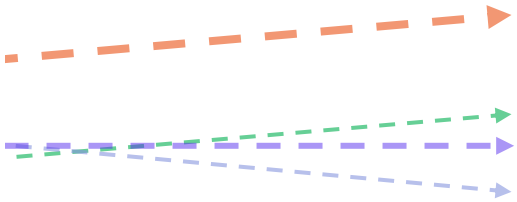
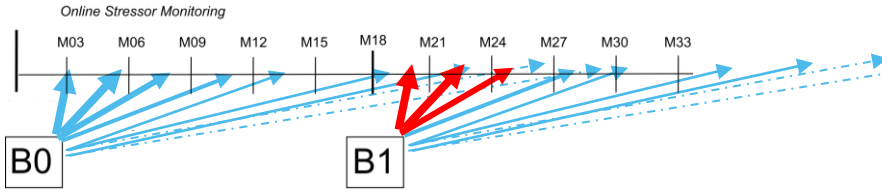
- Positive affect…



Updating RF measurements improves association



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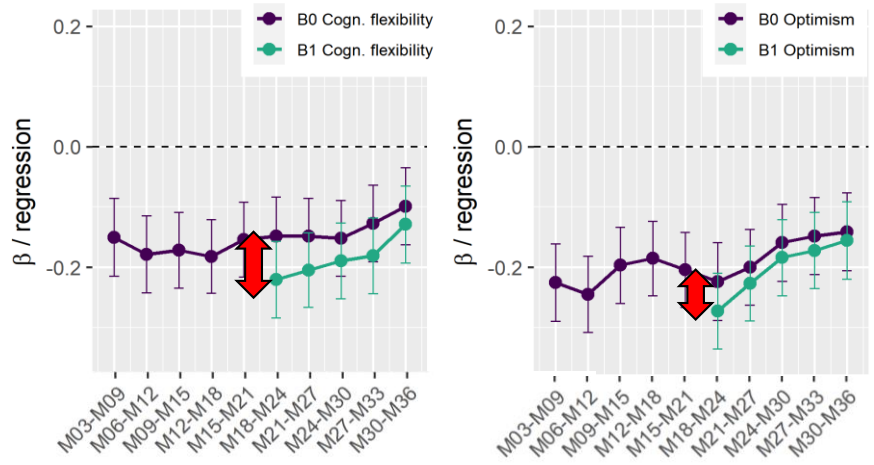
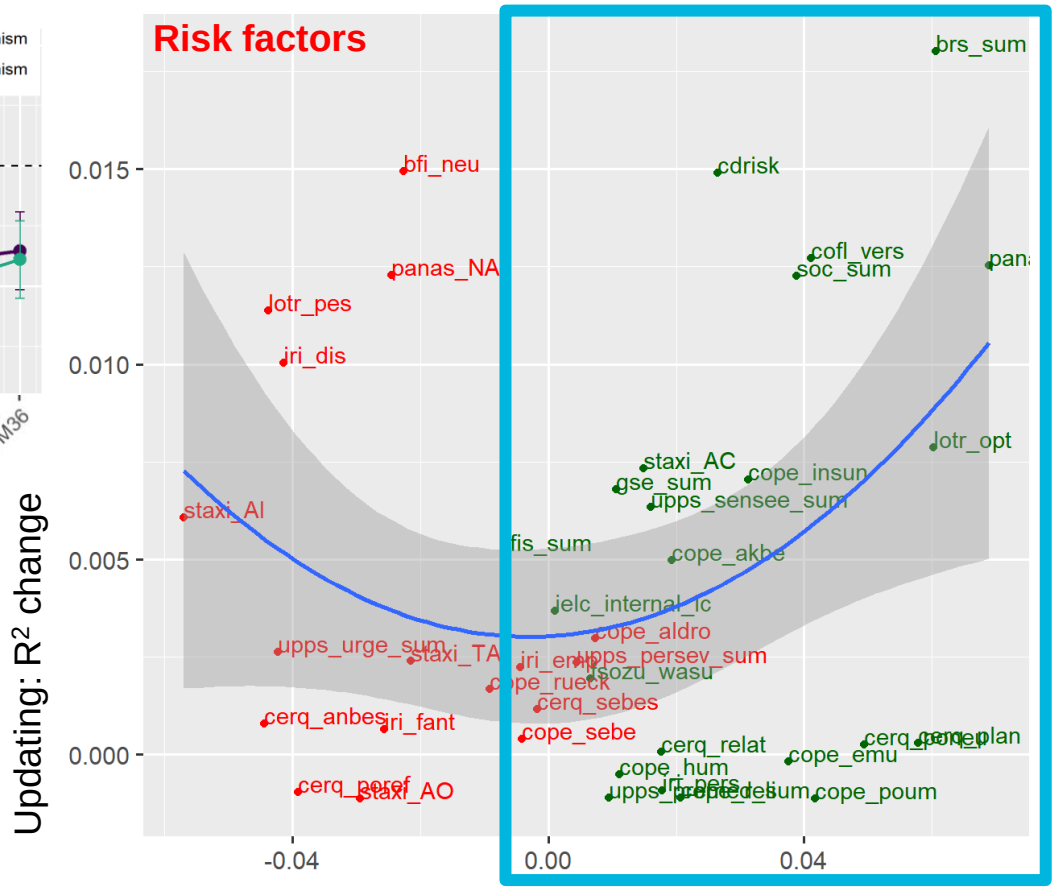


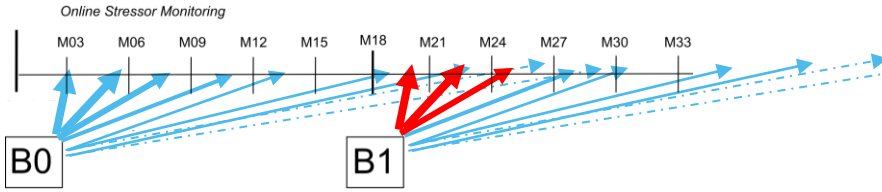
Resilience factors



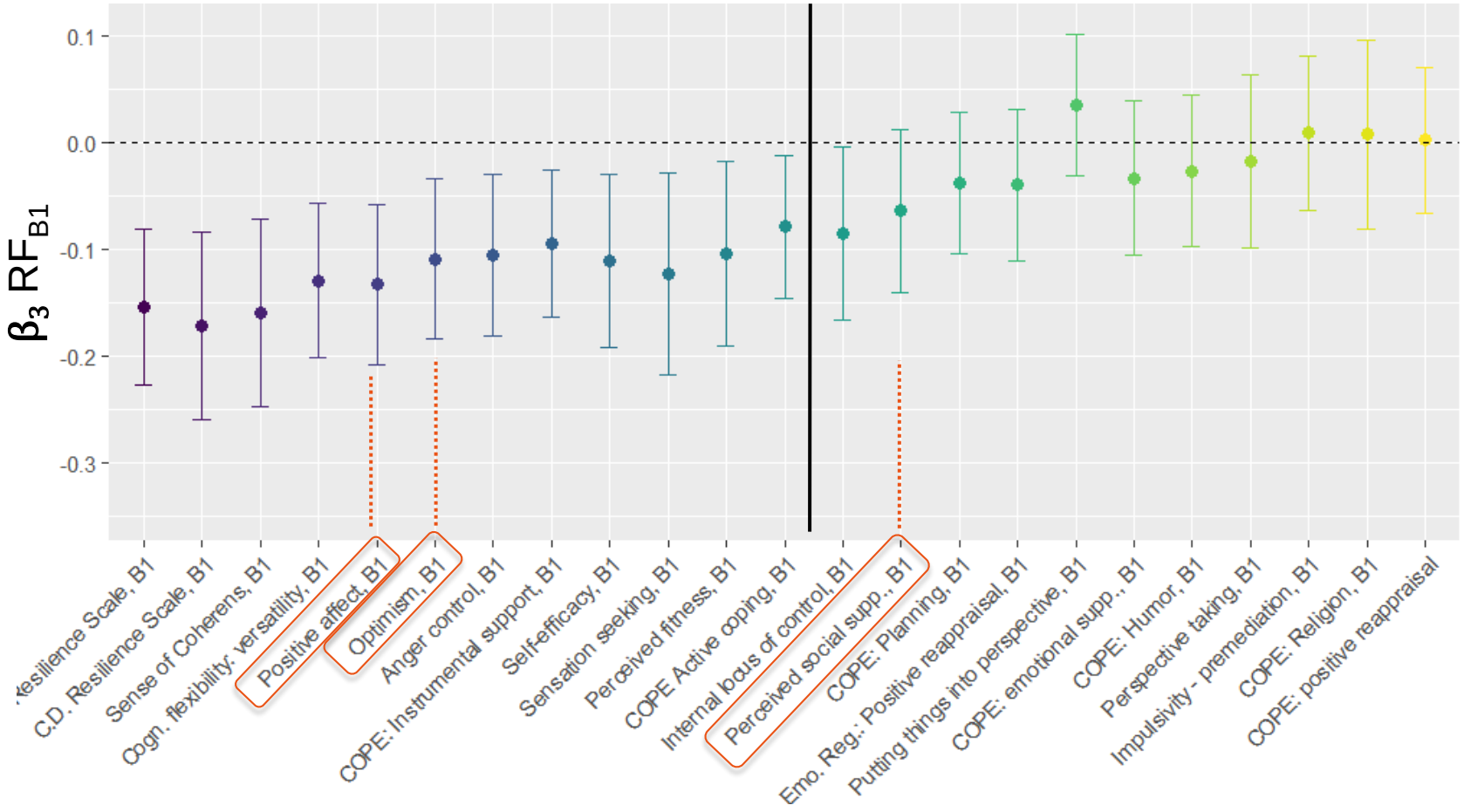
Weakening of RF → SR association *per sliding window*

Puhlmann, Ahrens, et al., *in prep*

Updating RF measurements improves association



Updating: $SR_{M21\text{-}M27} = \beta_1 SR_{M03\text{-}M09} + \beta_2 RF_{B0} + \beta_3 RF_{B1}$



Controlling for covariates age + gender + ctq + lifetime life events

Resilience – outcome-based operationalization

Possibility 1: identify resilience factors

Possibility 2: identify resilience processes

Possibility 3: quantify resilience to life events

Possibility 4: quantify effects of resilience interventions

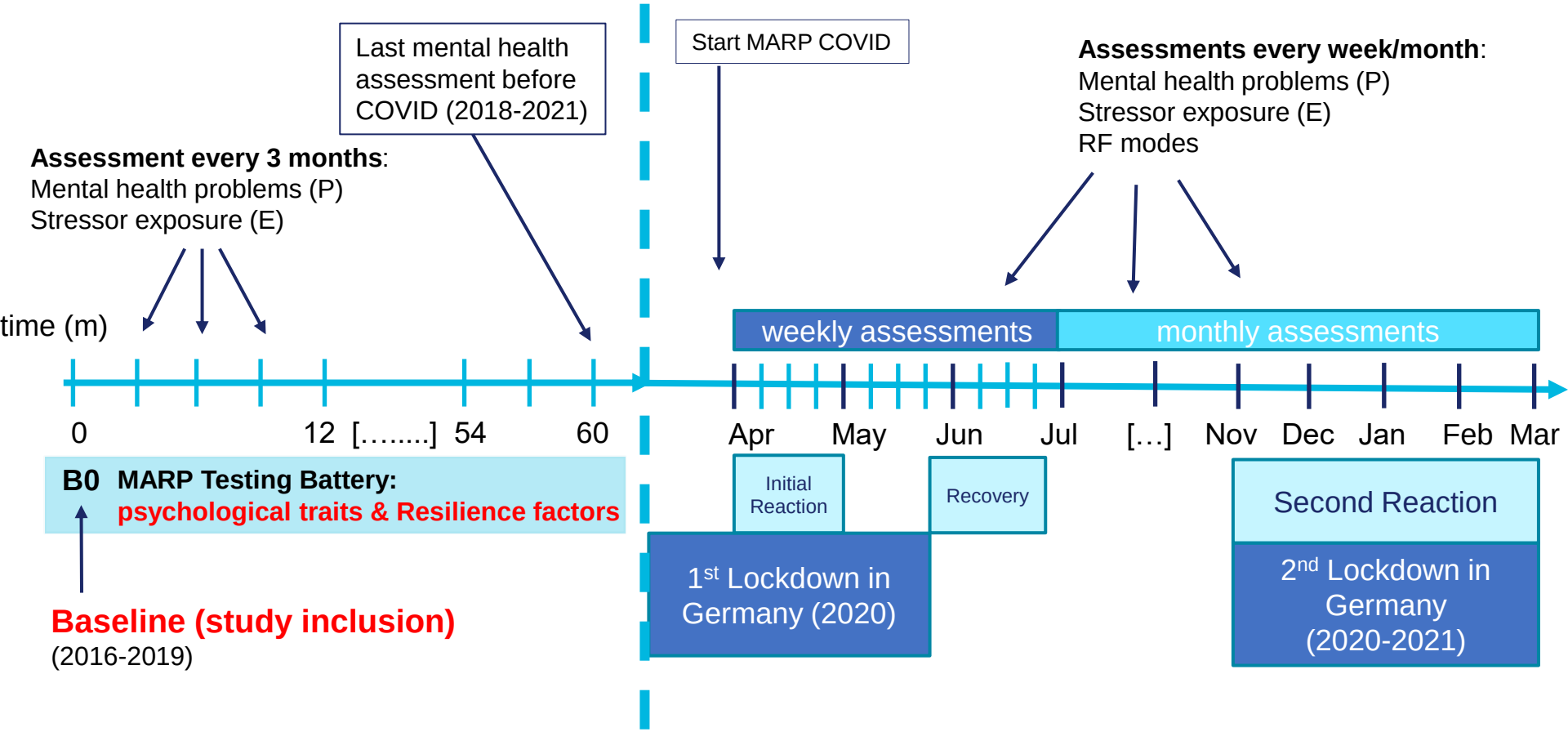
MARP COVID

MARP RESILIENZ STUDIE

Transition from adolescence (school, family life) to adulthood (work life)
- Inclusion age: 18 – 19 yrs
- Significant past adverse life events (>=3)
- N=167

MARP study

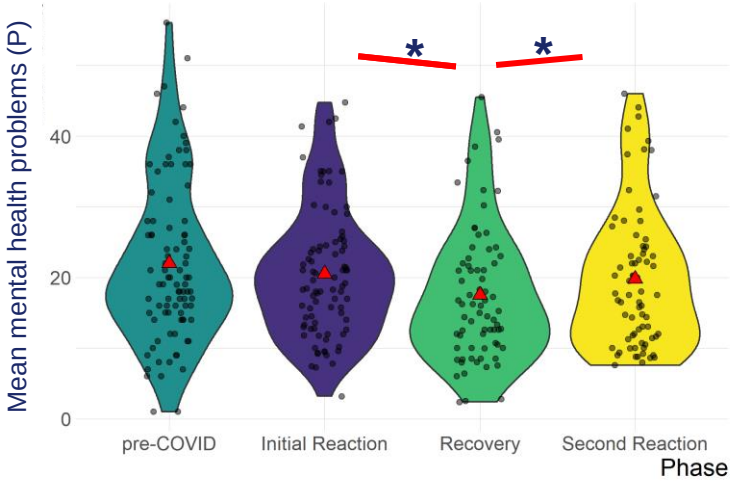
MARP-COVID study extension



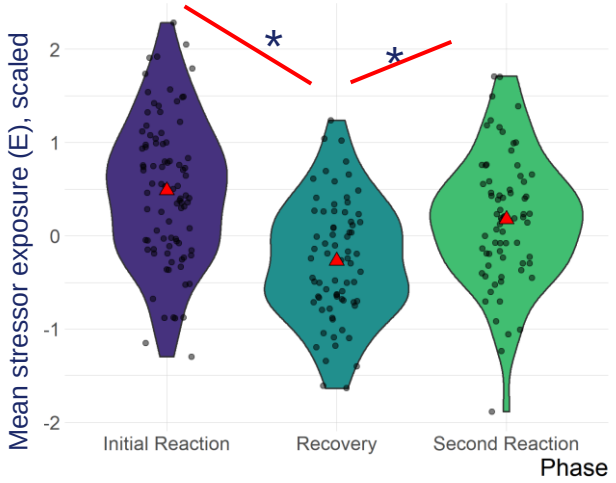
Baseline (study inclusion)
(2016-2019)

E and P vary longitudinally across stressful phases

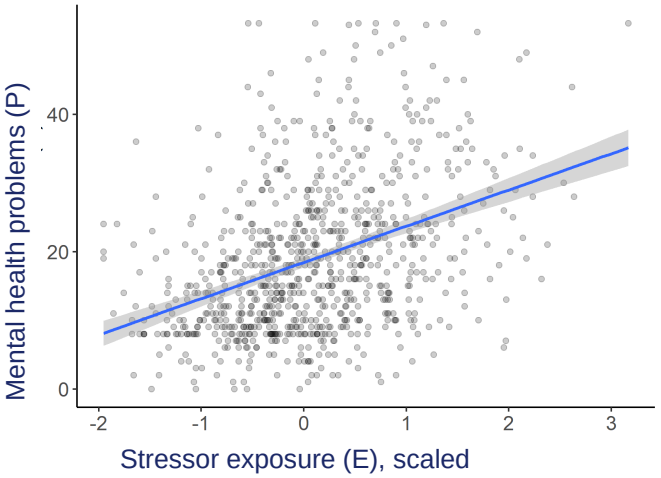
Mental health problems (P)



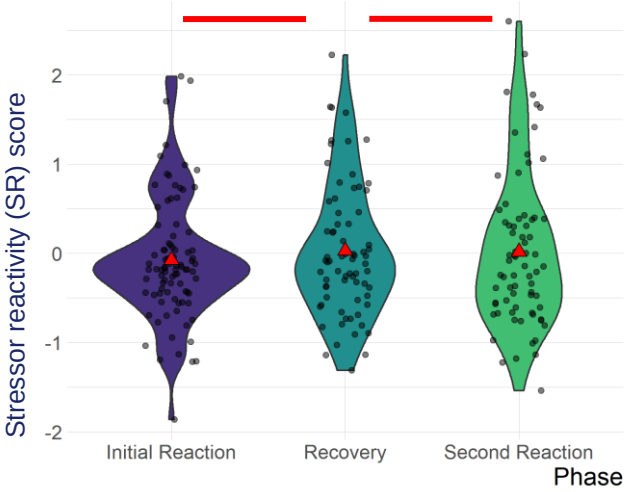
Stressor exposure (E)



P ~ E line



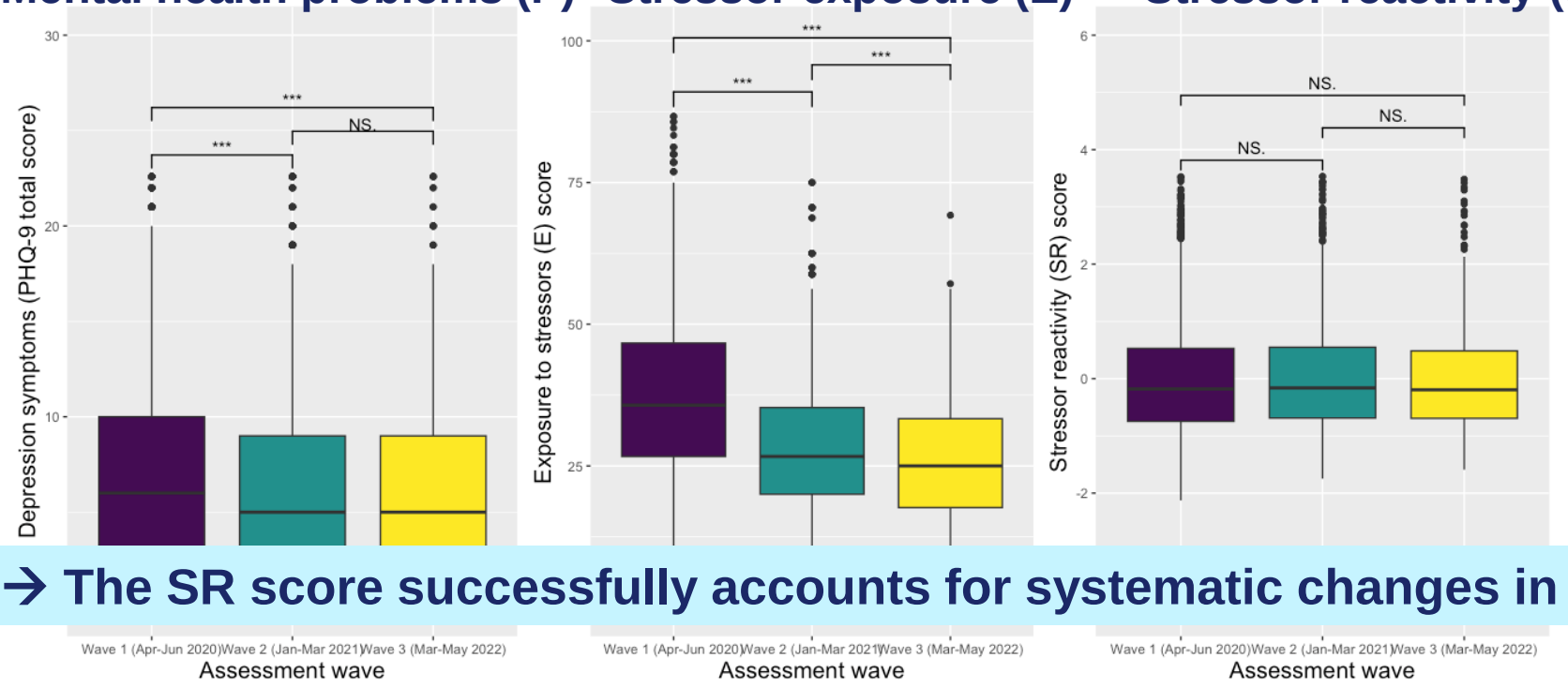
Stressor reactivity (SR)



E and P vary longitudinally across stressful phases

- **Design:** Prospective cohort study. Three waves: 2020, 2021, and 2022.
- **Participants:** HCWs aged 18 years or more working in Spain.
  - Wave 1 = 2,300 people; Wave 2 = 1,800 people; Wave 3 = 600 people. Participants with all assessment waves = 330.

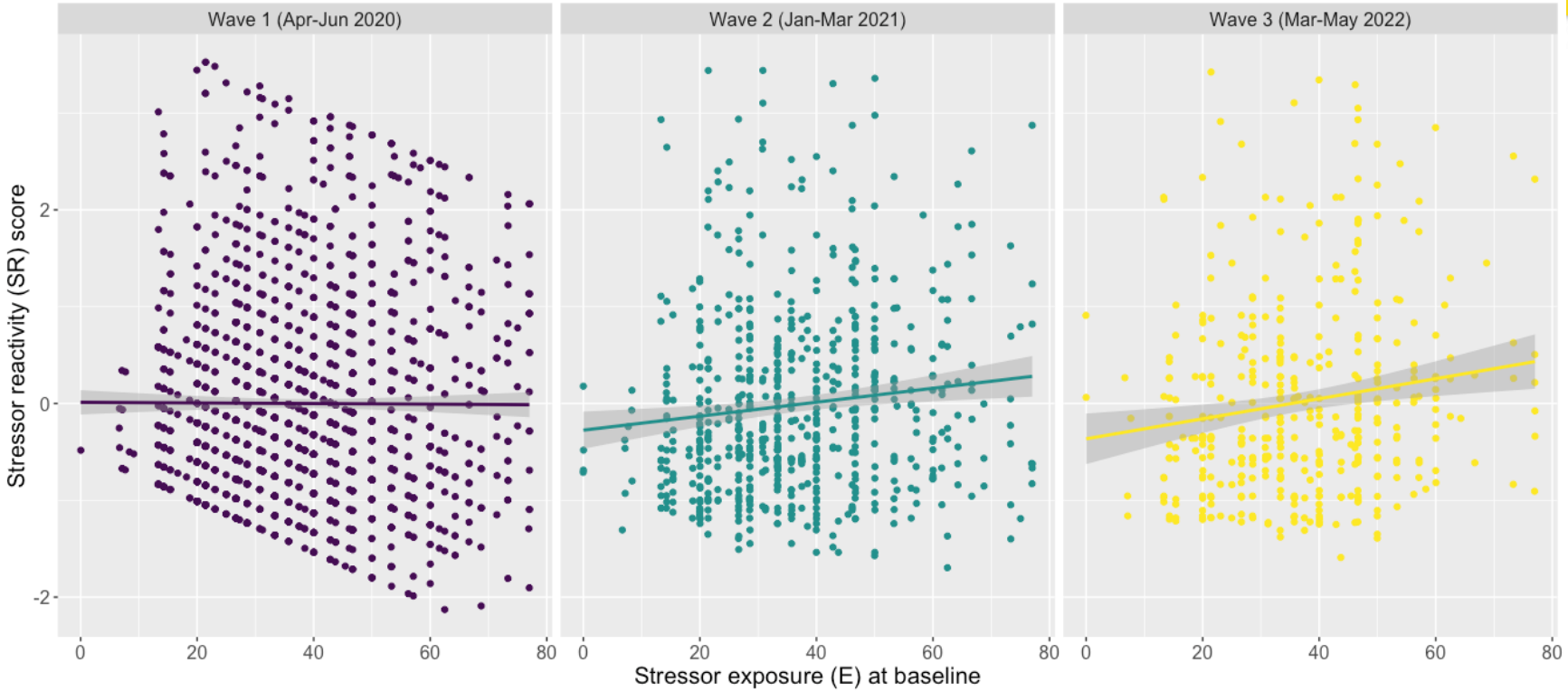
Mental health problems (P) **Stressor exposure (E)** **Stressor reactivity (SR)**



→ **The SR score successfully accounts for systematic changes in E**

Petri-Romão, Puhlmann, et al., 2023

E and P vary longitudinally across stressful phases



	Wave 2 (Jan-Mar 2021)		Wave 3 (Mar-May 2022)	
	Crude B (95% CI)	Adjusted B (95% CI)	Crude B (95% CI)	Adjusted B (95% CI)
Prioritization instructions	-0.03 (-0.28, 0.22)	0.02 (-0.23, 0.27)	0.06 (-0.29, 0.42)	0.08 (-0.29, 0.44)
Support from colleagues	**-0.24 (-0.35, -0.14)**	-0.25 (-0.35, -0.14)	-0.12 (-0.25, 0.02)	**-0.14 (-0.28, 0)**
Trust in the workplace	**-0.13 (-0.2, -0.05)**	-0.11 (-0.19, -0.03)	-0.12 (-0.22, -0.02)	**-0.15 (-0.25, -0.04)**

Note. Estimates were adjusted for age and gender (adjusted Bs)

Petri-Romão, Puhlmann, et al., 2023

Basic methods

- E & P assessments (in different study designs)
  - E & P measures (according to sample)
  - Measurement spacing (feasibility, research question)

- E-P-line building
  - non-linearity (quadratic)
  - conceptual / data driven

- **Different SR versions**
  - long-term / phases
  - sliding window
  - single timepoint

    → different analyses

Special thanks to:

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Anita Schick
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Martina Thiele
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CRC 1193 “Neurobiology of Resilience“ Mainz/Frankfurt

JGU UNIVERSITÄTSmedizin. MAINZ

NIC NeuroImaging Center

European Commission
Horizon 2020
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DynaMORE

Further references

Kalisch, R., Köber, G., Binder, H., Ahrens, K. F., Basten, U., Chmitorz, A., ... & Engen, H. (2021). The frequent stressor and mental health monitoring-paradigm: a proposal for the operationalization and measurement of resilience and the identification of resilience processes in longitudinal observational studies. *Frontiers in Psychology*, *12*, 710493.

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