**Supplementary Material**

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***Supplementary Methods*: Practice frequency and liking of training**

*Data collection and processing.* After completing each module, participants rated how much they liked practicing the two core exercises of the respective module on a 5-point Likert scale from 1 (“not at all”) to 5 (“very much”) (see also Singer et al. 2016; Appendix H). Practice frequency was tracked online through a custom-made ReSource training platform and is reported here as the average number of times participants practiced each exercise per week. To limit the number of exploratory analyses, and to improve variable stability, we averaged liking and practice scores across the two core exercises of each module.

By nature, liking and practice scores were only available from training cohort (TC) participants, and not collected at baseline (T0). To be able to model change in our dependent variables directly as a function of liking and practice scores, we thus had to generate change scores. These were calculated by taking the difference between raw measurements from each set of consecutive timepoints (T1-T0, T2-T1 and T3-T2). HC and HE change scores were calculated from the log-transformed data; PSS and TICS change scores were calculated from the raw summary scores (for available samples and raw data used in the exploratory analyses see supplements, Table S3). Outliers in the data were identified and winsorized following the same procedure as described in the main methods section.

*Significance testing.* In line with our main analyses, we used linear mixed models (LMMs) and full-to-reduced model comparisons to assess whether the addition of liking or practice scores to the model significantly improved explained variance in HC, HE, PSS, or TICS change. We additionally assessed the influence of an interaction term, liking x module, to examine whether liking of the Perspective module in particular was implicated in the reduction of subjective stress. In the latter analysis, we combined data from the different training cohorts and grouped them by training module.

# *Supplementary Results A*: Baseline analyses.

At baseline (T0), age significantly positively correlated with HC (Pearson *r* = .165, *p* = .039) and HC/DHEA ratios (*r*=.271, *p*=.001), and positively but non-significantly with HE levels (Pearson *r* = 0.123, *p* = 0.102). T-tests revealed no significant sex difference between in HC or HE levels, but women had significantly higher HC/DHEA ratios (mean [SD] = 1.58 [1.13]) than men (mean [SD] = 0.98 [0.98]) (*t*(141)=3.13, *p*=.002). Because the literature suggests an influence of sex on HC (Stalder et al., 2017), we nonetheless controlled for both sex and age in our models. We also explored the influence of hormonal status (male, female: naturally cycling, female: hormonal contraceptives, female: menopause) on steroid hormones through linear mixed models controlling for age, and found no effect on HC, HE or HC/DHEA ratios (all ps > .1). Although women’s menstrual cycle phase was not assessed, the impact of current cycle phases on cumulative indices of glucocorticoid exposure should be limited.

Finally, we did not include BMI in our models, as a previous publications with the ReSource sample already revealed its limited influence on HC and HE (Engert et al., 2018). Similarly, a linear mixed model analysis controlling for age and sex demonstrated no association between BMI and HC/DHEA ratios (p > .5).

Further baseline exploratory analyses showed that concentrations of HC and HE were highly positively correlated (*r*=.608, *p*<.001). The same was true for T0 questionnaire scores of PSS and TICS (*r*=.692, *p*<.001). HC and HE were not related to PSS scores at baseline, but, surprisingly, significantly negatively associated with baseline TICS scores (HC: *r*=-.204, *p*=.011; HE: *r*=-0.151, *p*=.046). As expected, HC/DHEA ratios correlated positively with HE (*r*=.360, *p* < .001) and HC (*r*=.768, *p*<.001) and negatively with DHEA (*r*=-.658, *p*<.001), but no correlations with self-reported stress were observed.

# *Supplementary Results B*: Model residual checks.

All models’ residuals displayed satisfactory approximation to normal distribution, with the exception of the analysis of HE change data in relation to practice frequency, in which residual distribution had unusually light tails owing to the high kurtosis in HE change. Variance inflation factors of all models’ main effects indicated uncritical levels of multicollinearity (Hair Jr., Black, Babin, & Anderson, 1998). Estimates of cook’s distances showed no evidence of highly influential observations in HC or HE models, but 1 and 3 influential case(s) in models of PSS and TICS, respectively (indicated through cook’s d > 1 and/or visual inspection; Fox, 1991). Re-calculating models and contrast estimates after removal of these cases did not alter any of the previous results.

# *Table S1*. Availability of raw data and reasons for missing cases

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **N** | **Reasons for missingness** | |
| **Age** | 332 | N/A | |
| **Sex** | 332 | N/A | |
| **HC** | **T0**  *Available:*179  *Usable:*156 | Study dropout (n = 4)  Study exclusion (n = 2)  No hair sampling throughout (n = 99)a  No hair sample (missing) (n = 48)  < dl (n = 23) | |
| **T1**  *Available:*157  *Usable:*130 | Study dropout (n = 11)  No hair sample (missing) (n = 58)  < dl (n = 27) | |
| **T2**  *Available:*136  *Usable:*112 | Study dropout (n = 5)  TC3 Study completed (n = 49)b  No hair sample (missing) (n = 25)  < dl (n = 24) | |
| **T3**  *Available:*150  *Usable:*124 | Study dropout (n = 8)  No hair sample (missing) (n = 3)  < dl (n = 26) | |
| **HE** | **T0**  *Available:*179  *Usable:*177 | Study dropout (n = 4)  Study exclusion (n = 2)  No hair sampling throughout (n = 99)a  No hair sample (missing) (n = 48)  < dl (n = 2) | |
| **T1**  *Available:*157  *Usable:*155 | Study dropout (n = 11)  No hair sample (missing) (n = 58)  < dl (n = 2) | |
| **T2**  *Available:*136  *Usable:*131 | Study dropout (n = 5)  TC3 Study completed (n = 49)b  No hair sample (missing) (n = 25)  < dl (n = 5) | |
| **T3**  *Available:*150  *Usable:*146 | Study dropout (N = 8)  No hair sample (missing) (n = 3)  < dl (n = 4) | |
| **TICS, PSS** | **T0**  N = 322 | Study dropout (n = 4)  Study exclusion (n = 2)  No questionnaire data (missing) (n = 4) | |
| **T1**  N = 311 | Study dropout (n = 11)  No questionnaire data (missing) (n = 4) | |
| **T2**  N = 232 (TICS)  N = 233 (PSS) | Study dropout (n = 5)  TC3 Study completed (n = 76)b  No questionnaire data (missing) (TICS: n =2, PSS: n = 1) | |
| **Practice frequencyc** | **T0 to T1**  N = 225 | | **Only assessed in TCs (N = 242)**  TCs Study dropout (n = 11)  TCs Study exclusion (n = 0)  No practice data (missing) (n = 3) |
| **T1 to T2**  N = 149 | | TCs Study dropout (n = 3)  TC3 Study completed (n = 76)b  No practice data (missing) (n = 3) |
| **T2 to T3**  N = 144 | | TCs Study dropout (n = 5)  No practice data (missing) (n = 3) |
| **Likingc** | **T0 to T1**  N = 217 | | **Only assessed in TCs (N = 242)**  TCs Study dropout (n = 11)  TCs Study exclusion (n = 0)  No liking ratings (missing) (n = 14) |
| **T1 to T2**  N = 144 | | TCs Study dropout (N = 3)  TC3 Study completed (N = 76)b  No liking ratings (missing) (N = 8) |
| **T2 to T3**  N = 139 | | TCs Study dropout (N = 5)  No liking ratings (missing) (N = 8) |

*Notes:*dl: detection limit; HC: hair cortisol; HE: hair cortisone; PSS: Perceived Stress Scale (Cohen, S., Kamarck, T. & Mermelstein, 1983); TICS: Trier Inventory for Chronic Stress (Schulz & Schlotz, 1999).

a Reasons for no hair sampling throughout were baldness or opting-out

b from the total 81 TC3 participants, n = 5 were study dropouts before T2 and an additional n = 27 had no hair sampling throughout

c not including data from dropouts of the present study (i.e. participants without HC, HE, TICS and PSS data)

# *Table S2.* Final N and drop-outs per cohort.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | **RCC** | **TC1** | **TC2** | **TC3** |
| **HC/HE sample** | Usable N1) (% female) | 68  (61.8% f) | 48  (60.4% f) | 62  (66.1% f) | 49  (75.5% f) |
| Dropouts, N (% total; % female) | 22  (24.4%; 50.0% f) | 32 (40.0%; 56.3% f) | 19 (23.5%;  36.8% f) | 32 (39.5)  (37.5% f) |
| **PSS/TICS sample** | Usable N2) | 87  (59.8% f) | 79  (58.2% f) | 81  (59.3% f) | 79  (60.8% f) |
| Dropouts, N (% total; % female) | 3 (3.33%; 33.3% f) | 1 (1.25%;  100% f) | 0 (0.00%; 0.00% f) | 2 (2.47%;  50.0% f) |

*Notes:* Final sample sizes for analyses and total drop-out rates per cohort. Drop-out numbers are the sum of drop-outs from the entire study and drop-outs specific to the respective measurements (see Table S1 for further details on reasons for missing data). Less females than males dropped out of the HC/HE sample, presumably because men were more likely to have short hair or be bald, such that the proportion of females in the HC/HE analysis sample was increased relative to 59.3% females in the complete randomized sample.

1) includes participants with at least one usable sample of either HC or HE

2) includes participants with at least one usable sample of either PSS or TICS

# *Table S3.* Descriptives of change scores used in exploratory analyses.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **T0 to T1** | **T1 to T2** | **T2 to T3** |
| **HC** | sample n | 98 | 103 | 92 |
| mean (SD) | -0.286 (0.83) | -0.196 (0.80) | -0.002 (0.62) |
| **HE** | sample n | 126 | 132 | 118 |
| mean (SD) | -0.247 (0.90) | -0.138 (0.96) | 0.062 (0.85) |
| **PSS** | sample n | 309 | 271 | 225 |
| mean (SD) | -0.616 (5.21) | -0.193 (5.33) | -0.71 (5.33) |
| **TICS** | sample n | 309 | 270 | 224 |
| mean (SD) | -1.29 (5.20) | 0.118 (5.21) | -0.747 (5.05) |
| **practice**a  (n/week) | sample n | 225 | 149 | 144 |
| mean (SD) | 4.38 (1.09) | 3.80 (0.77) | 3.51 (0.84) |
| **liking**a  (rating) | sample n | 217 | 144 | 139 |
| mean (SD) | 3.99 (0.68) | 3.60 (0.83) | 3.72 (0.83) |

*Notes:* Hair cortisol (HC) and hair cortisone (HE) change scores were calculated from the ln-transformed data. T0 to T1 etc. refer to the change intervals between two timepoints of data sampling (see Figure 1 B, study design). PSS: Perceived Stress Scale (Cohen, Kamarch, & Mermelstein, 1983); TICS: Trier Inventory for Chronic Stress (Schulz & Schlotz, 1999).

a not including data from dropouts of the present study (i.e. participants without HC, HE, TICS and PSS data)

# *Table S4.* Results of power analysis

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Effects simulated** | **HCa**  (min.*ß*s*)* | **HEa**  (min.*ß*s*)* | **PSSb**  (min.*ßs)* | **TICSb**  (min.*ßs)* |
| DV reduced after **Pres.** | -0.45 (TC1&TC2)  -0.5 (TC1/TC2) | -0.4 (TC1&TC2)  -0.45 (TC1/TC2) | -2.0 (TC1&TC2)  -2.4 (TC1/TC2) | -2.1 (TC1&TC2)  -2.4 (TC1/TC2) |
| DV reduced after **Affect** | -0.3 (all TCs)  -0.35 (TC1&TC2)  -0.55 (TC1/TC2)  -0.6 (TC3) | -0.25 (all TCs)  -0.30 (TC1&TC2)  -0.45 (TC1/TC2)  -0.50 (TC3) | -1.4 (all TCs)  -1.6 (TC1&TC2)  -2.4 (TC1/TC2)  -2.7 (TC3) | -1.5 (all TCs)  -1.7 (TC1&TC2)  -2.5 (TC1/TC2)  -2.8 (TC3) |
| DV reduced after **Pres.**  **& Affect** | -0.3 (all TCs)  -0.3 (TC1&TC2)  -0.5 (TC1/TC2) | -0.25 (all TCs)  -0.25 (TC1&TC2)  -0.45 (TC1/TC2) | -1.4 (all TCs)  -1.5 (TC1&TC2)  -2.1 (TC1/TC2) | -1.5 (all TCs)  -1.4 (TC1&TC2)  -2.1 (TC1/TC2) |
| DV reduced after **Pres., Affect & Persp.** | -0.45 (all TCs)  -0.45 (TC1&TC2)  -0.5 (TC1/TC2) | -0.45 (all TCs)  -0.40 (TC1&TC2)  -0.45 (TC1/TC2) | -2.3 (all TCs)  -2.1 (TC1&TC2)  -2.4 (TC1/TC2) | -2.4 (all TCs)  -2.2 (TC1&TC2)  -2.3 (TC1/TC2) |

a approximated in steps of 0.05

b approximated in steps of 0.1

*Notes:* For four possible effects of training, we calculated approximate minimum *ß* sizes required to achieve at least 80% power to detect a significant group by time interaction in the planned linear mixed models. Displayed are *ß*s for varying consistencies of the effects across training cohorts. Power was estimated based on simulations run 1000 times, and assuming no group differences at baseline and no effect of time. Lowest and highest *ß* values correspond to the following percentage change (relative to mean baseline values): HC, 0.3: 19%, 0.6: 37%; HE, 0.25: 11%; 0.5: 22%; PSS, 1.4: 10%, 2.7: 19%; TICS, 1.5: 10%, 2.8: 19%. HC denotes hair cortisol; HE, hair cortisone; PSS, perceived stress scale; TICS, Trier inventory for chronic stress; TC, training cohort.

# *Table S5*. Follow-up contrasts within LMM of HC levels

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Contrast** | **Estimate** | **SE** | **df** | **t-value** | **p-value** |
| **Against RCC, T1** | | | | | |
| RCC - TC1 | 0.017 | 0.176 | 472 | 0.097 | 0.923 |
| RCC - TC2 | 0.191 | 0.166 | 481 | 1.149 | 0.251 |
| RCC - TC3 | 0.270 | 0.166 | 445 | 1.621 | 0.106 |
| **Against RCC, T2** | | | | | |
| **RCC - TC1** | **0.449** | **0.163** | **435** | **2.748** | **0.006** |
| **RCC - TC2** | **0.429** | **0.155** | **453** | **2.766** | **0.006** |
| **Against RCC, T3** | | | | | |
| RCC - TC1 | 0.169 | 0.167 | 447 | 1.010 | 0.313 |
| RCC - TC2 | -0.057 | 0.146 | 419 | -0.389 | 0.697 |
| **Within RCC** | | | | | |
| T0 - T1 | -0.074 | 0.127 | 340 | -0.586 | 0.559 |
| T0 - T2 | -0.035 | 0.116 | 351 | -0.299 | 0.765 |
| T0 - T3 | 0.145 | 0.120 | 345 | 1.213 | 0.226 |
| T1 - T2 | 0.040 | 0.122 | 341 | 0.324 | 0.746 |
| T1 - T3 | 0.219 | 0.126 | 340 | 1.734 | 0.084 |
| T2 - T3 | 0.180 | 0.114 | 339 | 1.582 | 0.115 |
| **Within TC1** | | | | | |
| T0 - T1 | -0.019 | 0.139 | 352 | -0.136 | 0.892 |
| **T0 - T2** | **0.453** | **0.135** | **353** | **3.342** | **0.001** |
| **T0 - T3** | **0.352** | **0.136** | **355** | **2.591** | **0.010** |
| **T1 - T2** | **0.472** | **0.142** | **317** | **3.313** | **0.001** |
| **T1 - T3** | **0.371** | **0.144** | **323** | **2.581** | **0.010** |
| T2 - T3 | -0.101 | 0.141 | 327 | -0.711 | 0.478 |
| **Within TC2** | | | | | |
| **T0 - T1** | **0.513** | **0.135** | **360** | **3.803** | **<.001** |
| **T0 - T2** | **0.791** | **0.135** | **361** | **5.863** | **<.001** |
| **T0 - T3** | **0.484** | **0.119** | **363** | **4.060** | **<.001** |
| **T1 - T2** | **0.278** | **0.130** | **313** | **2.131** | **0.034** |
| T1 - T3 | -0.028 | 0.122 | 339 | -0.232 | 0.817 |
| **T2 - T3** | **-0.306** | **0.122** | **336** | **-2.514** | **0.012** |
| **Within TC3** | | | | | |
| **T0 - T1** | **0.413** | **0.130** | **368** | **3.178** | **0.002** |

*Notes*: Significant contrasts are highlighted in bold. Omitted are contrasts at baseline and across TCs, which to not address any of the study hypotheses. Effect estimates and SE refer to log-transformed data. LMM denotes linear mixed model; HC, hair cortisol; SE, standard error; df, degrees of freedom; RCC, retest control cohort; TC1-3, training cohort 1-3.

# *Table S6.* Follow-up contrasts within LMM of HE levels

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Contrast** | **Estimate** | **SE** | **df** | **t-value** | **p-value** |
| **Against RCC, T1** | | | | | |
| RCC - TC1 | 0.328 | 0.169 | 551 | 1.943 | 0.053 |
| RCC - TC2 | 0.102 | 0.168 | 572 | 0.608 | 0.544 |
| **RCC - TC3** | **0.408** | **0.165** | **545** | **2.479** | **0.013** |
| **Against RCC, T2** | | | | | |
| **RCC - TC1** | **0.376** | **0.157** | **516** | **2.396** | **0.017** |
| RCC - TC2 | 0.187 | 0.156 | 548 | 1.201 | 0.230 |
| **Against RCC, T3** | | | | | |
| **RCC - TC1** | **0.452** | **0.158** | **521** | **2.853** | **0.005** |
| RCC - TC2 | 0.038 | 0.144 | 514 | 0.260 | 0.795 |
| **Within RCC** | | | | | |
| T0 - T1 | -0.101 | 0.133 | 430 | -0.761 | 0.447 |
| T0 - T2 | 0.028 | 0.12 | 448 | 0.232 | 0.817 |
| T0 - T3 | -0.012 | 0.124 | 438 | -0.099 | 0.921 |
| T1 - T2 | 0.129 | 0.129 | 428 | 1.001 | 0.317 |
| T1 - T3 | 0.089 | 0.132 | 424 | 0.673 | 0.501 |
| T2 - T3 | -0.04 | 0.118 | 422 | -0.341 | 0.733 |
| **Within TC1** | | | | | |
| T0 - T1 | 0.233 | 0.139 | 436 | 1.670 | 0.096 |
| **T0 - T2** | **0.41** | **0.141** | **438** | **2.915** | **0.004** |
| **T0 - T3** | **0.446** | **0.138** | **435** | **3.229** | **0.001** |
| T1 - T2 | 0.177 | 0.139 | 396 | 1.275 | 0.203 |
| T1 - T3 | 0.213 | 0.138 | 406 | 1.544 | 0.123 |
| T2 - T3 | 0.036 | 0.139 | 404 | 0.261 | 0.794 |
| **Within TC2** | | | | | |
| **T0 - T1** | **0.3** | **0.142** | **458** | **2.117** | **0.035** |
| **T0 - T2** | **0.515** | **0.143** | **460** | **3.598** | **<.001** |
| **T0 - T3** | **0.325** | **0.125** | **442** | **2.591** | **0.010** |
| T1 - T2 | 0.215 | 0.141 | 396 | 1.524 | 0.128 |
| T1 - T3 | 0.025 | 0.132 | 438 | 0.187 | 0.852 |
| T2 - T3 | -0.19 | 0.133 | 436 | -1.428 | 0.154 |
| **Within TC3** | | | | | |
| **T0 - T1** | **0.566** | **0.135** | **446** | **4.18** | **<.001** |

*Notes*: Significant contrasts are highlighted in bold. Omitted are contrasts at baseline and across TCs, which do not address any of the study hypotheses. Effect estimates and SE refer to log-transformed data. LMM denotes linear mixed model; HE, hair cortisone; SE, standard error; df, degrees of freedom; RCC, retest control cohort; TC1-3, training cohort 1-3.

# *Table S7.* Follow-up contrasts within LMM of HC/DHEA ratios

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Contrast** | **Estimate** | **SE** | **df** | **t-value** | **p-value** |
| **Against RCC, T1** | | | | | |
| RCC - TC1 | -0.157 | 0.219 | 420 | -0.717 | 0.474 |
| RCC - TC2 | 0.106 | 0.205 | 428 | 0.515 | 0.607 |
| RCC - TC3 | 0.356 | 0.209 | 387 | 1.703 | 0.089 |
| **Against RCC, T2** | | | | | |
| RCC - TC1 | 0.158 | 0.206 | 379 | 0.765 | 0.445 |
| RCC - TC2 | 0.306 | 0.195 | 396 | 1.569 | 0.118 |
| **Against RCC, T3** | | | | | |
| RCC - TC1 | -0.072 | 0.208 | 386 | -0.346 | 0.730 |
| RCC - TC2 | -0.176 | 0.185 | 356 | -0.953 | 0.341 |
| **Within RCC** | | | | | |
| T0 - T1 | -0.154 | 0.150 | 306 | -1.026 | 0.306 |
| T0 - T2 | -0.114 | 0.141 | 317 | -0.808 | 0.420 |
| T0 - T3 | 0.013 | 0.142 | 311 | 0.090 | 0.928 |
| T1 - T2 | 0.040 | 0.139 | 305 | 0.285 | 0.776 |
| T1 - T3 | 0.166 | 0.142 | 304 | 1.173 | 0.242 |
| T2 - T3 | 0.127 | 0.132 | 312 | 0.962 | 0.337 |
| **Within TC1** | | | | | |
| T0 - T1 | -0.209 | 0.162 | 319 | -1.289 | 0.198 |
| T0 - T2 | 0.145 | 0.157 | 323 | 0.923 | 0.357 |
| T0 - T3 | 0.042 | 0.157 | 321 | 0.270 | 0.787 |
| **T1 - T2** | **0.354** | **0.161** | 286 | **2.207** | **0.028** |
| T1 - T3 | 0.251 | 0.163 | 291 | 1.547 | 0.123 |
| T2 - T3 | -0.103 | 0.158 | 292 | -0.651 | 0.516 |
| **Within TC2** | | | | | |
| **T0 - T1** | **0.351** | **0.154** | 315 | **2.278** | **0.023** |
| **T0 - T2** | **0.591** | **0.153** | 317 | **3.854** | **0.000** |
| T0 - T3 | 0.236 | 0.139 | 323 | 1.703 | 0.090 |
| T1 - T2 | 0.240 | 0.147 | 282 | 1.637 | 0.103 |
| T1 - T3 | -0.115 | 0.140 | 302 | -0.822 | 0.412 |
| **T2 - T3** | **-0.355** | **0.138** | 300 | **-2.575** | **0.011** |
| **Within TC3** | | | | | |
| **T0 - T1** | **0.474** | **0.151** | **334** | **3.141** | **0.002** |

*Notes*: Significant contrasts are highlighted in bold. Omitted are contrasts at baseline and across TCs, which do not address any of the study hypotheses. Effect estimates and SE refer to log-transformed data. LMM denotes linear mixed model; DHEA, dehydroepiandrosterone; SE, standard error; df, degrees of freedom; RCC, retest control cohort; TC1-3, training cohort 1-3.