Online Supplemental Materials (OSM)

Developmental Regulation Across the Life Span: Towards a New Synthesis

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**Method**

**Statistical Analyses**

Data were analyzed separately for Study 1 (S1) and Study 2 (S2) using structural equation modeling (SEM) ([Kline, 2005](#_ENREF_6)) in AMOS 17.0.

To examine the first study aim, we tested whether an integrative model of goal engagement, goal disengagement, and meta-regulation would show reasonable fit to the theory-specific measures. We modeled goal engagement and goal disengagement as second-order factors with loadings on the respective theory-specific measures as first-order factors as presented in Table 1. Meta-regulation was modeled as a first-order factor (because this process was postulated by only one theory and represented by one measure). Goal engagement, goal disengagement, and meta-regulation were correlated. We evaluated model fit using two approaches. First, we examined the χ2 statistic (known to be affected by sample size and therefore not of primary interest), CFI (using a cut-off value of > .90 as a guideline), and RMSEA ([using < .08 as an indicator of reasonable fit; Browne & Cudeck, 1993](#_ENREF_1)). We note that Hu and Bentler ([1999](#_ENREF_5)) recommended stricter cut-off values. However, Marsh, Hau, and Wen ([2004](#_ENREF_7)) pointed out problems underlying their approach and cautioned against overgeneralizing their rules. Second, we compared the fit of the integrative model to the fit of several alternative integrative models as recommended ([e.g., Marsh et al., 2004](#_ENREF_7)) using χ2 difference tests. The following alternative models were examined: (1) All developmental regulation processes load on one single second-order factor; (2) Goal engagement processes and optimization (MTD) load on one second-order factor; goal disengagement processes load on another second-order factor; (3) Goal disengagement processes and optimization (MTD) load on one second-order factor; goal engagement processes load on another second-order factor; and (4) Elective selection loads on the meta-regulation factor (otherwise, the model is like our integrative model).

To examine the second aim, we introduced age as a predictor in the integrative model and examined regression paths from age to goal engagement, goal disengagement, and meta-regulation.

To examine the third aim, we tested the model shown in Figure 1 and examined its model fit (CFI > .90; RMSEA < .08) and path coefficients (*p* < .05). Separate structural equation models were examined for each aspect of well-being. To test whether goal engagement and goal disengagement mediated effects of meta-regulation on well-being, we used BC bootstrapping ([Preacher & Hayes, 2008](#_ENREF_8)). To test whether age moderated associations between goal engagement or disengagement and well-being, we employed multi-group modeling. Specifically, building on recommended procedures ([e.g., Byrne & Stewart, 2006](#_ENREF_2)) we compared an unconstrained model to a model with the regression paths between goal engagement or goal disengagement and well-being constrained to be equal across age groups (for goal disengagement predicting purpose in life constrained for young and old adults) using χ2 difference tests. To prepare these multi-group analyses, we established equivalence of all first-order measurement weights across age groups (S1: Δχ2 (28) = 36.69, *p* = .126; S2: Δχ2 (40) = 39.91, *p* = .474, residuals set equal for goal disengagement factor and compensation).

Items were parceled into three indicators for each theory-specific measure of developmental regulation. When repeating the analyses using two item parcels per latent variable, the results remained essentially stable (note that for S2 the CFI for the integrative three-process model was .091). Across analyses, a few negative and nonsignificant residual variances were constrained to zero as recommended ([Hox, 2002](#_ENREF_4)). In S1, all participants and in S2 almost all participants (*n* = 211) provided complete data. AMOS uses a Full Information Maximum Likelihood Algorithm for estimating missing data.

**Participants and Procedure**

 S1 examined 262 participants (52.7% females) from three age groups, young adults (*n* = 86; 32.8%; age in years: *M* = 29.06, *SD* = 4.00, range: 20-35), middle-aged adults (*n* = 88; 33.6%; age in years: *M* = 47.41, *SD* = 5.06, range: 40-55), and older adults (*n* = 88; 33.6%; age in years: *M* = 68.02, *SD* = 6.44, range: 60-85). 46.9% were married, 35.9% were single (with or without romantic partner), 11.5% were divorced, and 5.7% were widowed. 48.1% had completed 12 years of education (range: 8-15).

 S2 included an independent sample previously analyzed by Freund & Baltes ([2002; Study 1](#_ENREF_3)). Participants who had answered only one measure of developmental regulation or had not reported their age were not included. The resulting sample consisted of 223 participants (58.3% females) who (for multi-group analyses) were categorized into three age groups, adolescents and young adults (*n* = 90; 40.4%; age in years: *M* = 24.48, *SD* = 6.07, range: 14-35), middle-aged adults (*n* = 67; 30.0%; age in years: *M* = 46.31, *SD* = 5.63, range: 36-55), and older adults (*n* = 66; 29.6%; age in years: *M* = 63.30, *SD* = 5.64, range: 56-87). 43.5% were married, 37.7% were single (with or without romantic partner), 10.8% were divorced, and 8.1% were widowed. On average, participants had completed 12 years of education (range: 8-16).

S1 and S2 used different recruitment procedures and there was no indication for overlap in participants. Participants completed sessions at the Max Planck Institute for Human Development in Berlin and were compensated with about $13 (S1) and $33 (S2).

Table OSM 1

*Measures of Developmental Regulation: Example Items, Number of Items, Internal Consistencies*

|  |  |
| --- | --- |
| Measure | Items |
| Examples | Study 1 | Study 2 |
| N | α | N | α |
| Dual-Process Model |
| AS | I can be very stubborn in pursuing my goals. |  6 | .81 |  4 | .75 |
| AC | I usually find something positive even in giving up something I cherish. | 11 | .81 |  9 | .76 |
| Motivational Theory of Lifespan Development (MDT) |
| OPT (MTD) | Many life goals become important to me because it is the right time for them. (Match goals to opportunities)I choose goals that have more long-term as opposed to short-term benefits. (Consequences)It is important for me to be active not just in one area of life, but in several different ones. (Diversity) | 22 | .78 | 10 | .75 |
| SPC | When something really matters to me, I invest as much time as I can in it. | 16 | .91 |  8 | .87 |
| CPC | When obstacles get in my way, I try to get help from others. | 16 | .89 |  8 | .81 |
| SSC | When I have decided on a goal, I always keep in mind its benefits. | 10 | .83 |  8 | .83 |
| CSC | When it turns out that I cannot attain a goal in any way I let go of it. | 16 | .84 |  8 | .73 |
| Model of Selection, Optimization, and Compensation (SOC) |
| ES  | When I decide upon a goal, I stick to it. (vs. I can change a goal again at any time.)  | - | - | 12 | .74 |
| OPT (SOC) | I do everything I can to realize my plans. (vs. I wait a while first to see if my plans don’t realize themselves.) | - | - | 12 | .68 |
| COM | When things aren’t going so well, I accept help from others. (vs. Even in difficult situations, I don’t burden others.) | - | - | 12 | .68 |

*Note*. AS = Assimilation (i.e., tenaciousness). AC = Accommodation (i.e., flexibility). SPC = Selective primary control. CPC = Compensatory primary control. SSC = Selective secondary control. CSC = Compensatory secondary control. OPT (MTD) = Optimization (MTD). ES = Elective selection. OPT (SOC) = Optimization (SOC). COM = Compensation. N = Number.

Table OSM 2

*Measures of Developmental Regulation: Model Fit of SEM Measurement Models*

|  |  |  |
| --- | --- | --- |
|  | Study 1 | Study 2 |
| χ2(df) | CFI | RMSEA | χ2(df) | CFI | RMSEA |
| Dual-Process Model |
| Tenflex (original) a | 1369.75(404)\*\*\* | .57 | .096 | 483.11 (169)\*\*\* | .71 | .091 |
| Tenflex (revised) b | 25.41(8)\*\*\* | .97 | .091 | 21.81(8)\*\* | .96 | .088 |
| Motivational Theory of Lifespan Development (MDT) |
| OPS c | 138.57 (80)\*\*\* | .98 | .053 | 194.49(80)\*\*\* | .93 | .080 |
| Model of Selection, Optimization, and Compensation (SOC) |
| SOC | - | - | - | 49.20(24)\*\* | .95 | .069 |

*Note*. Tenflex = Tenacious Goal Pursuit and Flexible Goal Adjustment Scale. OPS = Optimization in Primary and Secondary Control (OPS) Scales. a The original Tenflex scale contained all Tenflex items and did not use parceled items. b The revised Tenflex scale (used in further analyses) excluded reverse-coded items and used parceled items. c Two items were excluded from the original optimization (MDT) subscale because of conceptual overlap with goal disengagement (“If something takes up time I need for other important activities, I ask myself whether I should keep doing it.”; “I don’t waste my time struggling with problems if it uses up energy I need for more important things.”).

\*\**p* < .01. \*\*\**p* < .001.

Table OSM 3

*Measures of Well-Being: Example Items, Number of Items, Internal Consistencies*

|  |  |
| --- | --- |
| Measure | Items |
| Examples | Study 1 | Study 2 |
| N | α | N | α |
| Life satisfaction |
| Life satisfaction | How satisfied are you with your life at the moment? | 4 | .82 | - | - |
| Psychological well-being |
| Autonomy a | I judge myself by what I think is important, not by the values of what others think is important. | 3 | .52 | 9 | .81 |
| Environmental mastery a | I am quite good at managing the many responsibilities of my daily life. | 3 | .64 | 9 | .86 |
| Personal growth a | For me, life has been a continuous process of learning, changing, and growth. | 3 | .51 | 9 | .71 |
| Positive relations a | People would describe me as a giving person, willing to share my time with others. | 3 | .58 | 9 | .75 |
| Purpose in life a | Some people wander aimlessly through life, but I am not one of them. | 3 | .37 | 9 | .75 |
| Self-acceptance a | When I look at the story of my life, I am pleased with how things have turned out. | 3 | .77 | 9 | .87 |

*Note*. N = Number. a In Study 2, the data set we had access to included scores for all six scales of psychological well-being, but not the individual items. We thus report their internal consistencies as in Freund and Baltes (2002).

Table OSM 4

*Measures of Well-Being: Model Fit of SEM Measurement Models*

|  |  |  |
| --- | --- | --- |
|  | Study 1 | Study 2 |
| χ2(df) | CFI | RMSEA | χ2(df) | CFI | RMSEA |
| Life Satisfaction | 3.14(2) | 1.00 | .047 | - | - | - |
| Psychological Well-Being a | 195.26(120)\*\*\* | .92 | .049 | - | - | - |

*Note*. a In Study 2, the data set we had access to included scores for all six scales of psychological well-being, but not the individual items. Thus, a measurement model was not analyzed.

\*\**p* < .01.

Table OSM 5

*Means, Standard Deviations, and Intercorrelations of Manifest Variables (Study 1)*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. |
| *M* (*SD*) | 3.62(.71) | 3.66(.59) | 3.74 (.45) | 4.14 (.58) | 3.68 (.64) | 3.98(.61) | 3.24(.59) | .00(.81) | 3.81 (.65) | 3.87 (.69) | 4.28 (.63) | 3.61 (.86) | 4.05 (.74) | 3.67 (.82) |
| 1. AS | - |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. AC | .32\*\*\* | - |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. OPT (MTD) | .26\*\*\* | .50\*\*\* | - |  |  |  |  |  |  |  |  |  |  |  |
| 4. SPC | .63\*\*\* | .36\*\*\* | .50\*\*\* | - |  |  |  |  |  |  |  |  |  |  |
| 5. CPC | .29\*\*\* | .25\*\*\* | .38\*\*\* | .29\*\*\* | - |  |  |  |  |  |  |  |  |  |
| 6. SSC | .51\*\*\* | .37\*\*\* | .44\*\*\* | .72\*\*\* | .19\*\* | - |  |  |  |  |  |  |  |  |
| 7. CSC | .04 | .50\*\*\* | .52\*\*\* | .24\*\*\* | .19\*\* | .41\*\*\* | - |  |  |  |  |  |  |  |
| 8. LSA | .11 | .34\*\*\* | .19\*\* | .10 | .21\*\* | .14\* | .23\*\*\* | - |  |  |  |  |  |  |
| 9. AUT | .24\*\*\* | .22\*\*\* | .15\* | .24\*\*\* | -.10 | .33\*\*\* | .12\* | .19\*\* | - |  |  |  |  |  |
| 10. EMA  | .26\*\*\* | .38\*\*\* | .18\*\* | .36\*\*\* | .07 | .37\*\*\* | .28\*\*\* | .54\*\*\* | .41\*\*\* | - |  |  |  |  |
| 11. PGR | .15\* | .18\*\* | .20\*\* | .20\*\* | .28\*\*\* | .05 | .00 | .23\*\*\* | .06 | .13\* | - |  |  |  |
| 12. PRE | .23\*\*\* | .27\*\*\* | .19\*\* | .29\*\*\* | .29\*\*\* | .21\*\* | .15\* | .28\*\*\* | .03 | .34\*\*\* | .20\*\* | - |  |  |
| 13. PIL | .20\*\*  | .02 | .03 | .22\*\*\* | .09 | .17\*\* | -.11 | .19\*\* | .19\*\* | .21\*\* | .24\*\*\* | .18\*\* | - |  |
| 14. SAC | .22\*\*\* | .43\*\*\* | .23\*\*\* | .24\*\*\* | .17\*\* | .30\*\*\* | .31\*\*\* | .68\*\*\* | .32\*\*\* | .62\*\*\* | .14\* | .39\*\*\* | .14\* | - |

*Note*. AS = Assimilation (i.e., tenaciousness). AC = Accommodation (i.e., flexibility). OPT (MTD) = Optimization (MTD). SPC = Selective primary control. CPC = Compensatory primary control. SSC = Selective secondary control. CSC = Compensatory secondary control. LSA = Life satisfaction. AUT = Autonomy. EMA = Environmental mastery. PGR = Personal growth. PRE = Positive relations. PIL = Purpose in life. SAC = Self-acceptance.

\**p* < .05. \*\**p* < .01. \*\*\**p* < .001.

Table OSM 6

*Means, Standard Deviations, and Intercorrelations of Manifest Variables (Study 2)*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. | 16. |
| *M* (*SD*) | 3.80 (.72) | 3.65 (.58) | 3.72 (.50) | 4.06 (.59) | 3.83 (.58) | 3.73 (.63) | 3.29 (.58) | .48 (.25) | .71 (.21) | .71 (.20) | 3.63 (.56) | 3.82 (.62) | 3.98 (.56) | 3.93 (.56) | 3.97 (.53) | 3.69 (.46) |
| 1. AS | - |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. AC | .27\*\*\* | - |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. OPT (MTD) | .27\*\*\* | .35\*\*\* | - |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. SPC  | .57\*\*\* | .35\*\*\* | .41\*\*\* | - |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. CPC | .30\*\*\* | .26\*\*\* | .36\*\*\* | .46\*\*\* | - |  |  |  |  |  |  |  |  |  |  |  |
| 6. SSC | .55\*\*\* | .26\*\*\* | .39\*\*\* | .68\*\*\* | .27\*\*\* | - |  |  |  |  |  |  |  |  |  |  |
| 7. CSC | .14\* | .19\*\* | .39\*\*\* | .09 | .17\* | .27\*\*\* | - |  |  |  |  |  |  |  |  |  |
| 8. ES | .24\*\*\* | .04 | -.06 | .38\*\*\* | .05 | .44\*\*\* | -.06 | - |  |  |  |  |  |  |  |  |
| 9. OPT (SOC) | .50\*\*\* | .17\* | .22\*\* | .56\*\*\* | .29\*\*\* | .31\*\*\* | -.14\* | .36\*\*\* | - |  |  |  |  |  |  |  |
| 10. COM | .35\*\*\* | .10 | .24\*\* | .44\*\*\* | .56\*\*\* | .24\*\*\* | -.04 | .21\*\* | .50\*\*\* | - |  |  |  |  |  |  |
| 11. AUT | .25\*\*\* | .37\*\*\* | .15\* | .14\* | .05 | .14 | -.01 | .15\* | .19\*\* | -.03 | - |  |  |  |  |  |
| 12. EMA | .25\*\*\* | .28\*\*\* | .18\*\* | .23\*\* | .10 | .28\*\*\* | .13 | .27\*\*\* | .16\* | .04 | .34\*\*\* | - |  |  |  |  |
| 13. PGR | .11 | .40\*\*\* | .19\*\* | .21\*\* | .20\*\* | -.02 | -.14\* | -.14\* | .18\*\* | .19\*\* | .21\*\* | .10 | - |  |  |  |
| 14. PRE | .24\*\*\* | .29\*\*\* | .15\* | .29\*\*\* | .28\*\*\* | .29\*\*\* | .04 | .09 | .29\*\*\* | .21\*\* | .13 | .34\*\*\* | .34\*\*\* | - |  |  |
| 15. PIL | .40\*\*\* | .27\*\*\* | .32\*\*\* | .48\*\*\* | .22\*\* | .38\*\*\* | .02 | .25\*\*\* | .38\*\*\* | .30\*\*\* | .21\*\* | .48\*\*\* | .32\*\*\* | .33\*\*\* | - |  |
| 16. SAC | .27\*\*\* | .37\*\*\* | .19\*\* | .24\*\*\* | .14\* | .17\* | .11 | .10 | .15\* | .07 | .29\*\*\* | .59\*\*\* | .28\*\*\* | .40\*\*\* | .44\*\*\* | - |

*Note*. AS = Assimilation (i.e., tenaciousness). AC = Accommodation (i.e., flexibility). OPT (MTD) = Optimization (MTD). SPC = Selective primary control. CPC = Compensatory primary control. SSC = Selective secondary control. CSC = Compensatory secondary control. ES = Elective selection. OPT (SOC) = Optimization (SOC). COM = Compensation. AUT = Autonomy. EMA = Environmental mastery. PGR = Personal growth. PRE = Positive relations. PIL = Purpose in life. SAC = Self-acceptance.

\**p* < .05. \*\**p* < .01. \*\*\**p* < .001.

Table OSM 7

*Comparing the Integrative Model against Alternative Models*

|  |  |
| --- | --- |
| Comparing fit of integrative model with fit of alternative…  | ∆χ2(df) |
| Study 1  | Study 2 |
| Model 1All developmental regulation processes load on one single second-order factor. | 97.92(2)\*\*\* | 21.16(2)\*\*\* |
| Model 2Goal engagement processes and optimization (MTD) load on one second-order factor; goal disengagement processes load on another second-order factor. | 50.34(1)\*\*\* | 16.01(1)\*\*\* |
| Model 3Goal disengagement processes and optimization (MTD) load on one second-order factor; goal engagement processes load on another second-order factor.  | 7.73(1)\*\* | .26(1) |
| Model 4 aElective selection loads on the meta-regulation factor. | -  | 843.55 (393)\*\*\*  |

*Note*. A significant χ2 difference test indicated that the alternative model showed worse fit. A nonsignificant χ2 difference test indicated that the integrative and the alternative model showed similar fit. a Alternative model 4 was not tested in Study 1 because SOC was not assessed in Study 1; for Study 2, a χ2 difference test was not performed because the degrees of freedom were similar for both models [instead we present χ2 (df) for model 4]. The meta-regulation factor did not load on elective selection, β = .04, *p* = .694).

\*\**p* < .01. \*\*\**p* < .001.

Table OSM 8

*Developmental Regulation and Well-being: Model Fit*

|  |  |  |
| --- | --- | --- |
| Model for develop-mental regulation and… | Study 1 | Study 2 |
| χ2(df) | CFI | RMSEA | χ2 (df = 422) | CFI | RMSEA |
| Life satisfaction | 511.87(265)\*\*\*  | .94 | .060 | - |
| Autonomy | 522.26(242)\*\*\* | .92 | .067 | 882.45\*\*\* | .84 | .070 |
| Environmental mastery | 497.81(242)\*\*\* | .93 | .064 | 867.33\*\*\* | .85 | .069 |
| Personal growth | 512.66(242)\*\*\* | .93 | .065 | 880.53\*\*\* | .84 | .070 |
| Positive relations | 510.53(242)\*\*\* | .93 | .065 | 856.30\*\*\* | .85 | .068 |
| Purpose in life | 493.37(242)\*\*\* | .93 | .063 | 854.05\*\*\* | .85 | .068 |
| Self-acceptance | 467.75(242)\*\*\* | .94 | .060 | 860.60\*\*\* | .85 | .068 |

*Note*. \*\*\**p* < .001.

References

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen & J. S. Long (Eds.), *Testing structural equation models* (pp. 136-162). Newbury Park, CA: Sage.

Byrne, B. M., & Stewart, S. M. (2006). The MACS approach to testing for multigroup invariance of a second-order structure: A walk through the process. *Structural Equation Modeling, 13*, 287-321. doi: 10.1207/s15328007sem1302\_7

Freund, A. M., & Baltes, P. B. (2002). Life-management strategies of selection, optimization and compensation: Measurement by self-report and construct validity. *Journal of Personality and Social Psychology, 82*, 642-662. doi: 10.1037/0022-3514.82.4.642

Hox, J. (2002). *Multilevel analysis techniques and applications*. Mahwah, NJ: Lawrence Erlbaum.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling 6* 1-55. doi: 10.1080/10705519909540118

Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York, NY: Guilford Press.

Marsh, H. W., Hau, K.-T., & Wen, Z. (2004). In search of golden rules: Comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Structural Equation Modeling, 11*, 320-344. doi: 10.1207/s15328007sem1103\_2

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*, 879-891. doi: 10.3758/BRM.40.3.879