Supplement D: Resilience among Older Individuals in the Face of Adversity: How Demographic and Trait Factors Impact Mental Health Constructs and their Temporal Dynamics

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Methods

Statistical analyses

Multiple linear regression models were used to analyze the predictive value of several *between-subject factors* of the overall average (all timepoint taken together) of our main outcome variables, where the main focus was on evaluating the interactions among predictors that could not be done with the network models. The *lm* function of the R-package *stats* was used (R Core Team, 2020), allowing for the inclusion of BRS and PAS scores as continuous fixed-effect predictors, and age, education, and urbanization grade as categorical fixed-effect predictors. Continuous variables were z-scored prior to model estimations. All possible interaction terms were included, and type III ANOVA tables, including p-values for F-tests, were computed using Satterthwaite's method for denominator degrees of freedom (Satterthwaite, 1941). The proportion of variance of the mental health indicators that is explained by its corresponding model, adjusted for the number of predictors in the model (i.e., adjusted R^2), was used estimated, and partial eta-squared (η^2) was subsequently used as effect size measure for each fixed effect included in the model.

In case of a significant higher-order (3 or more predictors) interaction term, data was split based on age group, urbanization grade, and/or education level categories, depending on the involvement of each of these factors in the interaction term. Subsequently, data of these subgroups was evaluated by adopting multiple linear regression models including all remaining predictors for each subgroup separately. This allowed for the extraction of possible subgroup differences from the data.

The *plot_model* function (*sjPlot* package; Lüdecke, 2021) was used to visualize the interaction terms. Interactions involving solely categorical variables were evaluated by looking at the estimated marginal means (EMMs), using the *emmeans* function (*emmeans* package; Lenth, 2021). Two-way interactions involving a categorical (e.g., age) and a continuous predictor were evaluated by looking at the simple slopes for each level (e.g., young-old, old-old) with the *emtrends* function (also *emmeans* package). When evaluating interactions among two continuous predictors (i.e., BRS and PAS), the mean value of the continuous variable (i.e., the moderator; 0), as well as one standard deviation below (-1) and above (+1) the mean value, were used to distinguish hypothetical subgroups (i.e., low, medium, high). Again, the Satterthwaite's method for denominator degrees of freedom was used when comparing simple slopes or EMMs to determine pairwise differences ($\alpha = 0.05$).

Results

An overview of all significant fixed-effects of the main analyses, including their corresponding F-statistics and p-values, is shown in Table SD1. The effects are numbered and will be referred to in text. Statistics of all main effects and significant interaction effects of the additional regression models are numbered and reported in Table SD2 – 5, and those number will be used to refer to the appropriate test in text as well.

Main effects

Most certainly, it has been confirmed that the ability to bounce back or recover from stress (BRS) and positive appraisal style (PAS) are *protective factors*, as we observed *better* mental health indicators for *most* individuals scoring high on these constructs (1,2). Only for anxiety scores, no main effect of PAS was observed (2). Moreover, the old-old reported higher mental well-being than the young-old (3). Surprisingly, low/medium education levels were associated with higher mental well-being than high education levels (5). No age or education level main effects were found for the other mental health indicators. Urbanization grade did not seem to affect overall mental well-being, depression, anxiety and loneliness scores (4). Since we found subgroup differences when evaluating the role of most of these factors in isolation from the other predictors (see Panel Models), this suggests that the role of PAS, age, education level and urbanization grade on the mental health indicators was most likely influenced by other predictors that were included in the regression models and thus involved in (several) interactions. Indeed, we observed some interesting subgroup patterns, often involving the predictors for which main effects were not found. These are discussed below.

Interaction effects

While no interaction effects were observed for mental well-being, multiple subgroup patterns were found for anxiety, depression and loneliness. The protective effect of BRS on anxiety was stronger among those with low to medium education levels, than those with high education levels (6). Moreover, anxiety complaints were lower for the young-old living in rural areas, as compared to their peers living in high urban areas (SD3-11II-A), but no main environment differences were found for the old-old (SD3-11II-B). Accordingly, in urban settings, anxiety complaints were higher for the young-old than the old-old (SD3-11I-A). Yet, a high PAS among the young-old living in urban areas was associated with lower anxiety complaints (SD3-11I-C1), while no such protective effect was found for the old-old living in urban areas (SD3-11I-C2). Interestingly, among the old-old living in mid urban areas, the protective effect of BRS on anxiety complaints (SD3-11I-B2), was stronger when PAS was relatively low. Conversely, only for those having low BRS, a significant effect of PAS on anxiety complaints was found. This suggests there might be a certain limit to the extent that PAS and BRS can

collectively increase resilience against aversive effects on anxiety in this particular age-environment group.

This also seems to be the case for depression complaints among the old-old, although here specifically for those who were highly educated, irrespective from urbanization grade (SD4-12-B2). Again, the protective effect of BRS on depression was found for all levels of PAS, with stronger effects for those having lower PAS than medium or high PAS (low > medium > high). Only for those having low BRS, a significant effect of PAS on depression was found (SD4-12-B2). No such effects were found for the highly educated young-old (SD4-12B1), or all other individuals (both young-old and old-old) with lower education levels (SD4-12A). Finally, among those living in high urban areas, there was only an effect of PAS on depression among the young-old, but not the old-old (SD4-10C).

Similarly, but irrespective from urbanization grade, the effect of PAS on loneliness was stronger among the young-old than old-old (7). Finally, in line with earlier findings on anxiety, loneliness scores were similar across urbanization grade categories among the old-old, but significantly lower in rural areas as compared to mid to high urban areas for the young-old (8).

In sum, we found that most mental health indicators were positively affected by BRS and PAS. The effect of PAS on depression (only in urban areas) and loneliness was stronger among the young-old than old-old. Moreover, for some specific subgroups, the protective effect of BRS on depression and anxiety was stronger if PAS was relatively low; whereas PAS only had an effect on anxiety and depression scores if BRS was low. A protective effect of PAS on anxiety was only found for the young-old living in urban areas. In line with this, urbanization grade had no effect on the outcome variables among the old-old, but anxiety and loneliness scores were affected by living environment among the young-old, with rural areas being associated with better mental health indicators in this subgroup.

References

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R Core Team. (2020). *R: A Language and Environment for Statistical Computing* (4.0.0). R Foundation for Statistical Computing. https://www.r-project.org/

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Table SD1. F-statistics, p-values and effect sizes for the fixed effects of the mental health multiple regression models

	Mental well-being	**Anxiety**	**Depression**	**Loneliness**
	$F(47, 1222) = 16.71$, $p < .001$, adjusted $R^2 = 0.37$	$F(47, 1222) = 11.27$, $p < .001$, adjusted $R^2 = 0.28$	$F(47,1222) = 9.6$, $p < .001$, adjusted $R^2 = 0.24$	$F(47, 1222) = 5.52$, $p < .001$, adjusted $R^2 = 0.14$
Main effects				
1. BRS	$F(1,1222) = 209.8$, $p < .001$, $\eta^2 = 0.15$	$F(1,1222) = 231.8$, $p < .001$, $\eta^2 = 0.16$	$F(1,1222) = 195.2$, $p < .001$, $\eta^2 = 0.14$	$F(1,1222) = 58.9$, p < .001, $\eta^2 = 0.05$
2. PAS	F(1,1222) = 91.3, $p < .001$, $\eta^2 = 0.07$		$F(1,1222) = 3.91$, $p = .048$, $\eta^2 = 0.003$	$F(1,1222) = 23.5$, $p < .001$, $\eta^2 = 0.02$
3. AGE (< 67, >= 67)	F(1,1222) = 11.68, $p < .001$, $\eta^2 = 0.009$			
4. URB (R, S, U)	$F(2, 1222) = 2.86$, $p = .057$	$F(2, 1222) = 2.97$, $p = .054$	$F(2, 1222) = 2.97$, $p = .052$	
5. EDU (L/M, H)	$F(1,1222) = 13.81$, $p < .001$, $\eta^2 = 0.01$			
Lower order interactions				
6. BRS:EDU		$F(1,1222) = 5.37$, $p = .021$, $\eta^2 = 0.004$		
7. PAS:AGE				$F(1, 1222) = 4.16$, $p = .042$, $\eta^2 = 0.003$
8. AGE:URB				$F(2, 1222) = 3.13$, $p = .044$, $\eta^2 = 0.005$
Higher order interactions				
9. BRS:PAS:URB		$F(2, 1222) = 4.11$, $p = .017$, $\eta^2 = 0.007$		
10. PAS:AGE:URB			$F(2, 1222) = 4.81$, $p = .008$, $\eta^2 = 0.008$	
11. BRS:PAS:AGE:URB		$F(2, 1222) = 4.53$, $p = .011$, $\eta^2 = 0.007$		
12. BRS:PAS:AGE:EDU			$F(1, 1222) = 5.81$, $p = .016$, $\eta^2 = 0.004$	

Note. Marginal significant p-values for main-effects ($.05 > p < .09$) are shown in red.

Table SD2. F-statistics and p-values of Mental Well-being Multiple Mixed-Effects Regression Models

		Mental Wellbeing (adjusted R^2 = 0.368)		
		Statistics	*p-value*	*Contrasts/Slopes*
Main effects				
1	BRS	$F(1,1222) = 209.8$, $B = 1.58$, $SE = 0.11$	$p < .001$	-
2	PAS	$F(1,1222) = 91.3$, $B = 1.07$, $SE = 0.11$	$p < .001$	-
3	AGE	$F(1,1222) = 11.68$	$p < .001$	Old-old > Young-Old
4	URB	$F(2, 1222) = 2.86$	**$p = 0.057$**	
5	EDU	$F(1,1222) = 13.81$	$p < .001$	Low/Medium > High

All contrast are reported that had a $p < .05$.

Table SD3. F-statistics and p-values of Anxiety Multiple Mixed-Effects Regression Models

			Anxiety			
			Statistics	*p-value*	*Contrasts*	
Main effects						
1		BRS	$F(1,1222) = 231.8$, $B = -0.33$, $SE = 0.02$	$p < .001$	-	
2		PAS	$F(1,1222) = 1.83$	$p = .176$	-	
3		AGE	$F(1,1222) = 2.41$	$p = .121$	-	
4		URB	$F(2, 1222) = 2.97$	$\mathbf{p = 0.055}$	-	
5		EDU	$F(1,1222) = 1.13$	$p = .288$	-	
Lower order interactions						
6		BRS:EDU	$F(1,1222) = 5.37$	$p = .021$	*Low/Medium* $B = -0.38$, $SE = 0.03$, $p < .001$	*High* $B = -0.28$, $SE = 0.03$, $p < .001$
					Slope: Low/Medium < High	
Higher order interactions						
9	-	BRS:PAS:URB	$F(2, 1222) = 4.11$	$p = .017$	-	
11	I	BRS:PAS:AGE:URB	$F(2, 1222) = 4.53$	$p = .011$	-	
	A	*URB: Rural*	*n = 364*			
		BRS	$F(1,348) = 61.07$, $B = -0.30$, $SE = 0.04$	$p < .001$	-	
		PAS	$F(1,348) = 1.29$	$p = .257$	-	
		AGE	$F(1,348) = 0.06$	$p = .811$	-	
	B	*URB: Suburban*	*n = 587*			
		BRS	$F(1,571) = 96.7$, $B = -0.34$, $SE = 0.03$	$p < .001$	-	
		PAS	$F(1,571) = 3.47$	$p = .063$	-	
		AGE	*F(1,571) = 0.57*	*p = .451*	-	
		BRS:PAS	$F(1,571) = 11.98$	$p = .001$	-	
		BRS:PAS:AGE	$F(1,571) = 4.71$	*p = .030*		
	B1	*Young-Old*	*n = 298*			
		BRS	$F(1,290) = 44.5$, $B = -0.32$, $SE = 0.05$	$p < .001$	-	
		PAS	$F(1,290) = 0.27$	$p = .601$	-	
	B2	*Old-Old*	*n = 289*			
		BRS	$F(1,281) = 52.2$, $B = -0.34$, $SE = 0.05$	$p < .001$		
		PAS	$F(1,281) = 4.14$, $B = -0.1$, $SE = 0.05$	$p = .043$		

			BRS:PAS	$F(1,281) = 13.6$	$p < .001$	*Effect of BRS on PAS*		
						BRS[-1] $B = -0.24$, $SE = 0.07$, $p < .001$	*BRS[M]* $B = -0.10$, $SE = 0.05$, $p = .053$	*BRS[+1]* $B = 0.04$, $SE = 0.06$, $p = .534$
						Effect of PAS on BRS		
						PAS[-1] $B = -0.48$ $SE = 0.06$, $p < .001$	*PAS[M]* $B = -0.34$ $SE = 0.05$, $p < .001$	*PAS[1+]* $B = -0.21$ $SE = 0.06$, $p < .001$
						Slope: PAS[-1] > PAS[M] > PAS[+1]		
	C		*URB: Urban*	*n = 319*				
			BRS	$F(1,303) = 85.9$, $B = -0.36$, $SE = 0.04$	$p < .001$	-		
			PAS	$F(1,303) = 2.84$	$p = .093$	-		
			AGE	$F(1,303) = 4.48$	*p = .035*	*Young-Old > Old-Old*		
			BRS:PAS:AGE	$F(1,303) = 4.44$	*p = .036*			
		C1	*Young-Old*	*n = 163*				
			BRS	$F(1,155) = 45.9$, $B = -0.38$, $SE = 0.06$	$p < .001$	-		
			PAS	$F(1,155) = 4.38$, $B = -0.12$, $SE = 0.06$	$p = .038$	-		
		C2	*Old-Old*	*n = 156*				
			BRS	$F(1,148) = 41.5$, $B = -0.33$, $SE = 0.05$	$p < .001$	-		
			PAS	$F(1,148) = 0.04$	$p = .836$	-		
11	II		BRS:PAS:AGE:URB	$F(2, 1222) = 4.53$	$p = .011$			
	A		*AGE: Young-Old*					
			BRS	$F(1,619) = 124.7$, B = -0.35, Se = 0.03	$p < .001$	-		
			PAS	$F(1,619) = 2.00$	$p = .158$	-		
			URB	$F(2,619) = 4.10$	$p = .017$	Rural < Urban		
	B		*AGE: Old-Old*					
			BRS	$F(1, 603) = 107.4$, $B = -0.31$, $SE = 0.03$	$p < .001$	-		
			PAS	$F(1, 603) = 0.24$	$p = .622$	-		
			URB	$F(2, 603) = 0.17$	$p = .844$	-		

	BRS:PAS	*F*(1, 603) = 5.83	*p* = *.016*	-			
	BRS: PAS:URB	*F*(2,604) = 5.46	*p* = .004	-			
B1	*URB: Rural*						
	BRS	*F*(1,74) = 23.9, *B* = -0.27, *SE* = 0.05	*p* < .001	-			
	PAS	*F*(1,174) = 1.77	*p* = .185	-			
B2	*URB: Suburban*						
	BRS	*F*(1,281) = 52.3, *B* = -0.34, *SE* = 0.05	*p* < .001	-			
	PAS	*F*(1,281) = 4.14, *B* = -0.1, *SE* = 0.05	*p* = .043	-			
	BRS:PAS	*F*(1,281) = 13.6	*p* < .001	Effect of BRS on PAS			
				BRS[-1] *B* = -0.24, *SE* = 0.07, *p* < .001	*BRS[M]* *B* = -0.10, *SE* = 0.05, *p* = .053	*BRS[+1]* *B* = 0.04, *SE* = 0.06, *p* = .534	
				Effect of PAS on BRS			
				PAS[-1] *B* = -0.48 *SE* = 0.06, *p* < .001	*PAS[-1]* *B* = -0.34 *SE* = 0.05, *p* < .001	*PAS[-1]* *B* = -0.21 *SE* = 0.06, *p* < .001	
				Slope: PAS[-1] > PAS[M] > PAS[+1]			
B3	*URB: Urban*						
	BRS	F(1,148) = 41.5, *B* = -0.34, *SE* = 0.05	*p* < .001	-			
	PAS	*F*(1,148) = 0.04	*p* = .836	-			

Table SD4. F-statistics and p-values of Depression Multiple Mixed-Effects Regression Models

			Depression (adjusted R^2 = 0.242)		
			Statistics	*p-value*	*Contrasts or subgroup results*
Main effects					
1	BRS		$F(1,1222) = 195.2$, $B = -0.33$, $SE = 0.02$	$p < .001$	
2	PAS		$F(1,1222) = 3.91$, $B = -0.05$, $SE = 0.02$	$p = .048$	
3	AGE		$F(1,1222) = 1.99$	$p = .159$	-
4	URB		$F(2, 1222) = 2.97$	$\mathbf{p = 0.052}$	-
5	EDU		$F(1,1222) = 1.15$	$p = .284$	-
Higher order interactions					
10	PAS:AGE:URB		$F(2, 1222) = 4.81$	$p = .008$	
	A	*URB: Rural*	n = 364		
		PAS	$F(1,360) = 23.19$	$p = .756$	-
		AGE	$F(1,348) = 0.130$	$p = .719$	-
	B	*URB: Suburban*	n = 587		
		PAS	$F(1,571) = 3.32$	$p = .069$	-
		AGE	$F(1,571) = 1.94$	$p = .164$	-
	C	*URB: Urban*	n = 319		
		PAS	$F(1,303) = 1.91$	$p = .168$	-
		AGE	$F(1,303) = 2.13$	$p = .145$	-
		PAS:AGE	$F(1,303) = 6.30$	$p = .013$	*Young-old* $B = -0.17$, $SE = 0.06$, $p = .005$ / *Old-old* $B = 0.05$, $SE = 0.07$, $p = .448$
12	BRS:PAS:AGE:EDU		$F(1, 1222) = 5.81$	$p = .016$	
	A	*EDU: Low/Medium*	n = 811		
		BRS	$F(1,787) = 146.9$, $B = -0.35$, $SE = 0.03$	$p < .001$	-
		PAS	$F(1,787) = 1.77$	$p = .184$	-
		AGE	$F(1,787) = 2.21$	$p = .137$	-
	B	*EDU: High*	n = 459		
		BRS	$F(1, 435) = 72.9$, $B = -0.32$, $SE = 0.04$	$p < .001$	-
		PAS	$F(1,435) = 2.33$	$p = .127$	-
		AGE	$F(1,435) = 0.45$	$p = .520$	-
		BRS:PAS:AGE	$F(1, 435) = 7.80$	$p = .005$	-
	B1	*AGE: Young-Old*	n = 223		
		BRS	$F(1,211) = 42.9$, $B = -0.35$, $SE = 0.05$	$p < .001$	-
		PAS	$F(1,211) = 1.32$	$p = .252$	-
	B2	*AGE: Old-Old*	n = 236		

BRS	$F(1,224) = 30.2$, $B = -0.28$, $SE = 0.05$	$p < .001$	
PAS	$F(1,224) = 1.03$	$p = .312$	
BRS:PAS	$F(1,224) = 6.71$	$p = .010$	*Effect of BRS on PAS* *BRS[-1]*: $B = -0.14$, $SE = 0.06$, $p = .031$ *BRS[M]*: $B = -0.03$, $SE = 0.06$, $p = .536$ *BRS[+1]*: $B = 0.07$, $SE = 0.07$, $p = .325$ *Effect of PAS on BRS* *PAS[-1]*: $B = -0.38$, $SE = 0.06$, $p < .001$ *PAS[M]*: $B = -0.28$, $SE = 0.05$, $p < .001$ *PAS[+1]*: $B = -0.19$, $SE = 0.06$, $p = .004$ Slope: PAS[-1] > PAS[M] > PAS[+1]

Table SD5. F-statistics and p-values of Loneliness Multiple Mixed-Effects Regression Models

	Loneliness		
	Statistics	*p-value*	
Main effects			
1. BRS	$F(1,1222) = 58.9$, $B = -0.18$, $SE = 0.02$	$p < .001$	
2. PAS	$F(1,1222) = 23.5$, $B = -0.11$, $SE = 0.02$	$p < .001$	
3. AGE	$F(1,1222) = 2.74$	$p = .098$	-
4. URB	$F(2,1222) = 2.34$	$p = .096$	-
5. EDU	$F(1,1222) = 0.96$	$p = .326$	
Lower order interactions			
7. PAS:AGE	$F(1, 1222) = 4.16$	$p = .042$	*Young-Old*: $B = -0.16$, $SE = 0.03$, $p < .001$ *Old-Old*: $B = -0.07$, $SE = 0.03$, $p = .048$ Slope: young-old > old-old
8. AGE:URB	$F(2, 1222) = 3.13$	$p = .044$	*Young-Old*: *Rural < Suburban, Urban* *Old-Old*: -