4. RESULTS

In the first part of this chapter, findings on age-related differences in the dynamics of day-to-day positive affect (PA) and negative affect (NA) are presented. This is followed by findings on trait- and state-correlates of intraindividual variability in positive and negative affect. The final section is devoted to the results on age-related differences in the within-person, day-to-day coupling of affect and cognitive performance in a vigilance task (i.e., reaction times for correct responses).

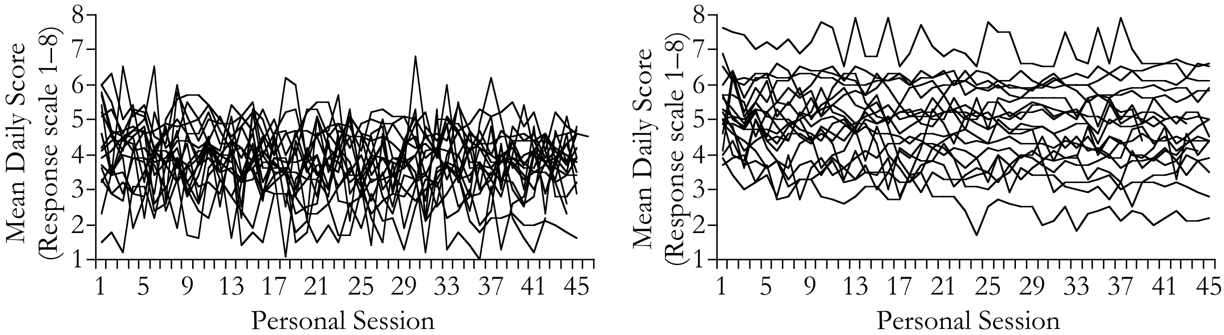
Analyses were carried out at several different to address each set of research questions (zero-order, analysis of variance, multilevel modeling analyses; see Section 3.4.4 in the Method chapter for more details). The first set of questions was about age-related differences in intraindividual mean levels, time-related trends in PA and NA across the daily assessment phase, as well as in day-to-day variability (fluctuation) of PA and NA. These questions were addressed using multilevel modeling as well as repeated measures of variance. The second set of research questions was about the role of age and personality in explaining individual differences in affect fluctuation, age-related differences in couplings of daily affect with stress and events, as well as about the association between variability in PA and NA with trait psychological well-being. Analyses carried out to address these questions included hierarchical regression analyses, zero-order correlations as well as multilevel modeling analyses. The third set of research questions dealt with the within-person relationships between cognitive performance and PA as well as NA. The main analyses for this last set of questions involved a series of multilevel modeling analyses. Throughout the three sets of research questions, some of the analyses were conducted on the raw data. For others it was important to control for time-related trends in the intraindividual trajectories, and therefore the data were residualized prior to or within a given analysis. In the following presentation of results, it will be clearly stated whether raw or residualized data were subjected to each analysis.

4.1 Age-Related Differences in Stable and Dynamic Characteristics of Day-to-Day Self-Reports of Positive and Negative Affect

The first set of questions addressed in this dissertation is whether there are age-related differences in the static and dynamic characteristics of daily reports of positive affect (PA) and negative affect (NA). In particular, three such aspects are (1) the average level of PA and NA across the daily assessment period (i.e., 45 days), (2) time-related trends in self-reported PA and

NA across the daily assessment period, and (3) the magnitude of intraindividual variability (i.e., within-person fluctuations) of PA and NA across the daily assessment period. For illustrative purposes, Figure 4.1 gives an overview of the descriptive trajectories of reported PA and NA separately for all young and all older adults (see Appendix C, Tables C1–C3 for each participant's descriptives of day-to-day PA and NA as well as day-to-day hedonic balance, including the intraindividual mean level, the minimum and maximum, the intraindividual standard deviation, and the number of sessions provided). Inspection of Figure 4.1 indicates individual differences in mean levels of day-to-day affect, domain-specific differences in variability in PA versus NA as well as differences in variability between young and older adults.

A) Trajectories of PA: Young Adults (left) and Older Adults (right)



B) Trajectories of NA: Young Adults (left) and Older Adults (right)

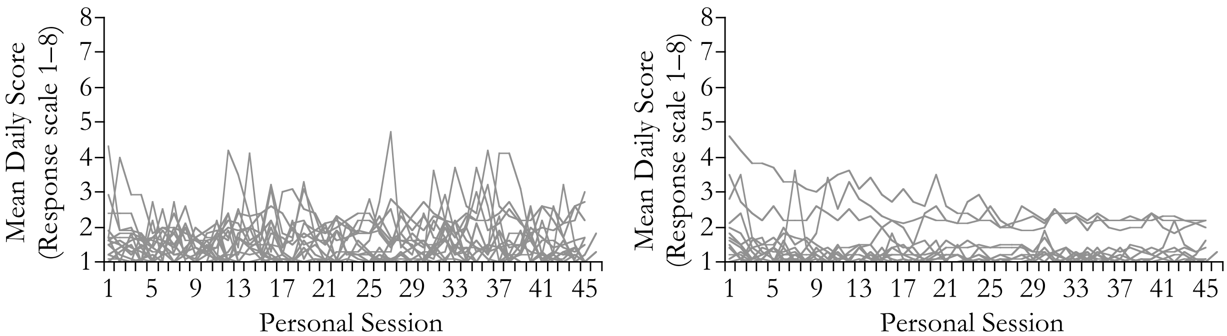


Figure 4.1. Nine-Week Trajectories of Positive Affect (PA) and Negative Affect (NA) for 18 Young and 19 Older Adults (PANAS-Items)

Note that the terms positive affect and negative affect refer to constructs assessed by the PANAS (Watson et al., 1988) and represent a standard measure of the two central dimensions of emotional well-being that are relatively high on the dimension of arousal. Positive affect (PA) is a composite of ten items as is negative affect (NA). In addition to the two standard PANAS constructs, I also examined the constructs pleasantness and unpleasantness, each derived from three items characterized by lower levels of arousal (PANAS-X, Watson & Clark, 1994; circumplex models of emotion, e.g., Larsen & Diener, 1992; Watson & Tellegen, 1985). These were used to build a hedonic balance index (pleasantness score – unpleasantness score; see also the beginning of Section 1 and Section 3.2.2 for a more detailed description). The presentation of results is primarily focused on analyses using the measures of positive and negative affect (i.e., PANAS). Central analyses were repeated with the alternative hedonic balance index, and this will always be explicitly stated in the following presentation of results. Before outlining the empirical findings of the central analyses, the adequacy of the data, particularly with respect to the question of intraindividual variability in self-reported affect, will be presented and discussed.

4.1.1 *Inspection of Adequacy of Daily Affect Data*

In a first step of inspecting the daily affect data with regard to whether individuals fluctuated sufficiently from one day to the next, the relative magnitude of within-person and between-person variance in both affect domains was examined following a procedure suggested by Nesselroade and Salthouse (2004). Figure 4.2 illustrates the different levels of variability that are characteristic of any longitudinal study.

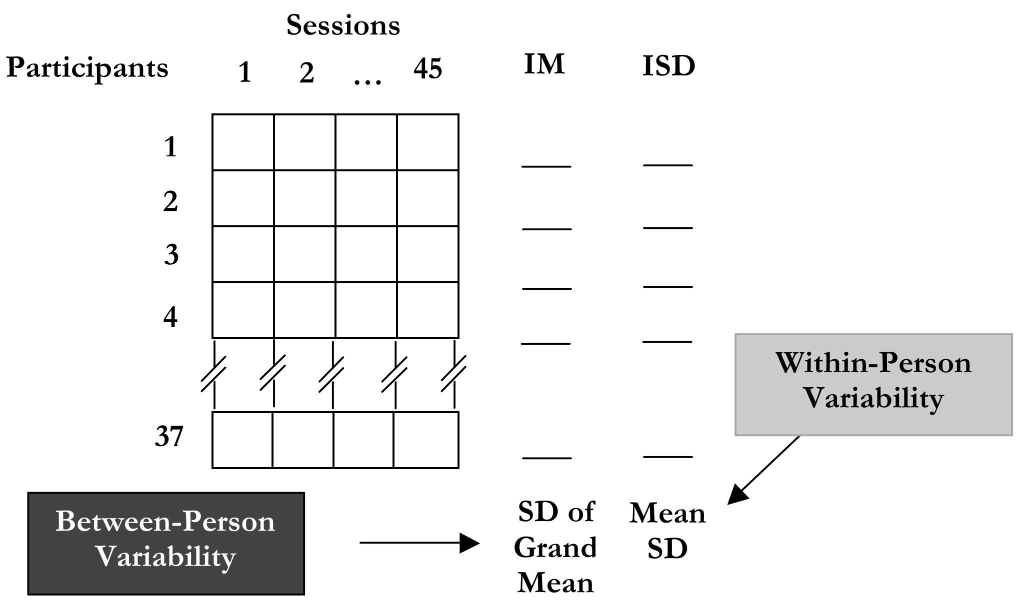


Figure 4.2. Schematic Representation of Variability Between and Within Individuals
(Figure adapted from Nesselroade and Salthouse, 2004. IM and ISD = Intraindividual Mean and SD.)

Each participant's time-series data can be summarized with an intraindividual mean (IM) and an intraindividual standard deviation (ISD). The intraindividual means can be averaged, and the standard deviation of this grand-mean is considered to be an indicator of the between-person variance. Likewise, the intraindividual SDs can be averaged, and this pooled SD is an indicator of the average within-person variance.

In a next step, Nesselroade and Salthouse (2004) proposed that researchers compute the ratio of the within-person to the between-person SD to arrive at an index of how much within-person relative to observed between-person variance there is in the variable of interest. Table 4.1 illustrates that for the sample as a whole, there is substantial within-person variance for PA (average *ISD* = 0.58) and for NA (average *ISD* = 0.31), amounting to 56.0% and 69.0% of the between-person variance in PA and NA, respectively. In other words, the variation for a given individual from one day to the next is more than half as much as the observed variation from one person to another. Likewise, follow-up analyses with the alternative hedonic balance score yielded an average ISD of 1.08 compared to a between-person SD of 0.61, indicating that the amount of within-person variability was almost twice as large as the between-person variance (177.0%).

Table 4.1
Characteristics of Within-Person and Observed Between-Person Variability in Daily Affect

	Positive Affect	Negative Affect
Between-person variance[27]	1.03	0.45
Within-person variance	0.58	0.31
Ratio of within- to between-person variance	0.56	0.69

For comparison, the between-person standard deviations for habitual (i.e., trait-like) PA and NA assessed at baseline were 0.57 and 0.92, respectively. In addition, the between-person standard deviations for the total sample in the Big Five personality factors ranged from 0.44 for Extraversion to 0.51 for Neuroticism. If one thus compares the magnitude of such

[27] An alternative way of calculating the average between-person variability would be to determine the between-person standard deviation for each session, namely 45 times, and then to average across these separate standard deviations. The results of this alternative analysis yielded similar results about the within-/between-variance ratio: This alternative value of the between-person variance was 1.18 for PA and 0.57 for NA, resulting in a within- to between-person variance ratio of .49 and .54 for PA and NA, respectively (for the total sample). These ratios, albeit smaller than the ones obtained from within the originally proposed procedure, still indicate that the within-person variability in both PA and NA is quite substantial, amounting to about half of the between-person variability. See Appendix C, Table C4, for an overview of these altered variability characteristics.

interindividual differences in prototypical trait measures of affect and personality with the indicators of average within-person variability, it becomes evident that the amount of within-person fluctuation in day-to-day affective experience is quite substantial.

A second common procedure used to examine the proportion of within-person and between-person variance in the total variance is to compute the intraclass correlation (ρ). In hierarchical data, in which repeated measurement occasions are nested within individuals, this statistic can be obtained using multilevel modeling analyses, which can account both for the hierarchical nature of the data as well as for the dependency across repeated measurement occasions (e.g., Raudenbush & Bryk, 2002). This coefficient denotes the proportion of variance in time-series data that exists on the between-person level relative to the total amount of variance, with the remainder of the variance being located at the within-person level. Figure 4.3 denotes the amounts of between-person and within-person variance on the total variance for positive and negative affect.

In the domain of PA, 72.0% of the total variance resides between individuals, whereas only slightly more than half (57.0%) of the variance in day-to-day negative affect is located at the between-person level. In other words, between 30–40% of the variance in daily PA and NA can be found within individuals, indicating that there is substantial day-to-day variability that can be further explored according to the research questions of the present dissertation.

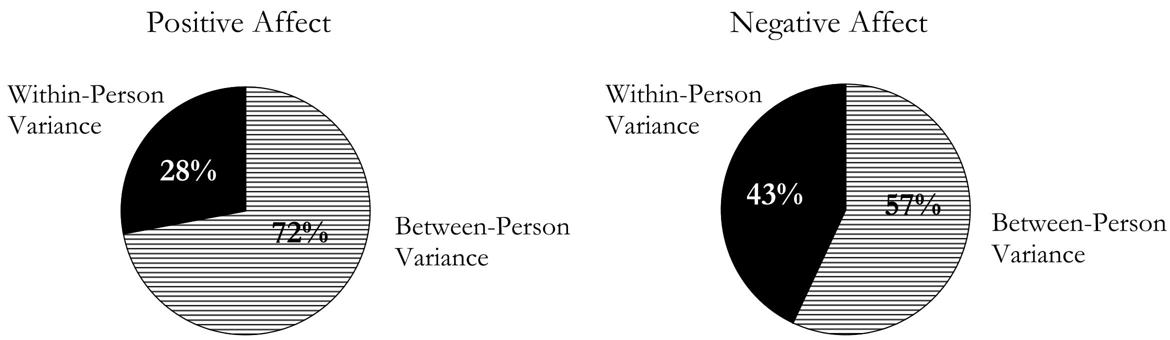


Figure 4.3. Proportions of Within-Person and Between-Person Variance in Day-to-Day Positive and Negative Affect (based on the Intraclass Correlation Coefficient obtained from the Random Coefficient Results of Multilevel Modeling Analyses)

For daily hedonic balance, the intraclass correlation coefficient was .63, suggesting that 63.0% of the total variance in day-to-day hedonic tone was between individuals and 37.0% within individuals.

After establishing that in the sample as a whole, and at the level of aggregated scores of PA and NA substantial amounts of within-person variance was present, additional analyses explored variability at the level of single individuals and single items (see also Tables C1–C3 in

Appendix C for participant-based descriptives of the aggregated time-series data on PA and NA). To this end, response frequencies of the daily affect ratings were examined separately for each item and each person. Sufficient variability was defined rather conservatively as endorsing a specific rating on the 8-point response scale less than 90% of the time. For example, if a given individual provided a rating of "6" on more than 90% of the repeated assessment occasions for the item "happy", this person was considered to lack sufficient variability for that item. Table 4.2 summarizes the number of individuals who lack sufficient variability according to the 90%-criterion for each item, with items being grouped by affect domain and by age group.

Among young adults, only one person exhibited a substantial lack in day-to-day variability on one of the positively valenced items (enthusiastic), whereas among older adults, between one and five individuals did not exhibit sufficient fluctuation in nine out of 13 items of positive valence. The number of individuals with insufficient daily fluctuation was substantially larger for the negatively valenced items, particularly among older adults. Inspection of item-specific variability descriptives suggests that for older adults, negative affect fluctuations appeared to represent mainly fluctuations in feelings of nervousness and unrest, uneasiness.

Table 4.2
Daily Affect Data: Number of Participants with Lack of Variability Across the Daily Assessment Period

Positive Valence Items	Young Adults	Older Adults	Negative Valence Items	Young Adults	Older Adults
Positive Affect (PANAS)	*n* Lack of Variability		*Negative Affect (PANAS)*	*n* Lack of Variability	
Enthusiastic	1	3	Scared	11	14
Excited	0	2	Guilty	7	17
Inspired	0	1	Irritable	4	14
Determined	0	0	Afraid	11	17
Interested	0	0	Distressed	4	13
Strong	0	3	Jittery	3	7
Alert	0	1	Upset	5	14
Attentive	0	1	Nervous	4	8
Active	0	0	Hostile	11	19
Proud	0	5	Ashamed	12	18
Pleasantness			*Unpleasantness*		
Happy	0	1	Sad	7	13
Content	0	0	Downhearted	5	14
Cheerful	0	2	Frustrated	5	15

Note. Lack of sufficient variability was defined as proportion of same rating on rating scale across repeated measurement occasions for any given individual > 90% of the time.

In past work, the issue of floor effects in within-person variability in negative versus positive affect has rarely been discussed or specifically addressed with regard to older adults in particular (e.g., Carstensen et al., 2000). Some studies, however, have explicitly noted lack of sufficient variability, particularly in negative affect and other negative appraisal domains (e.g., Kim & Nesselroade, 2003; Kleban et al., 1992). Due to a lack of explicit discussion of this issue, past work has also not clearly addressed solutions to this problem. As one exception, some researchers (e.g., Kim & Nesselroade, 2003) have opted to delete individuals with lack of variability in specific items to avoid data-analytic problems (i.e., using dynamic factor analysis). Given the small group size in the present sample, deletion of participants was not feasible. In addition, deletion of specific items prior to scale composite aggregation would have impaired comparability across affect scores across participants. As an alternative way of dealing with such lack of variability in the negative (and to a lesser degree also the positive affect items), central analyses were repeated using the hedonic balance score between the pleasant and the unpleasant items.

4.1.2 Age-Related Differences in Aggregated Day-to-Day Mean Levels of Emotional Well-Being Across 45 Days

The role of age for aggregated day-to-day levels of positive and negative affect was explored first by calculating the zero-order correlations between chronological age and the aggregated day-to-day affect scores. These and the descriptives for each age group and affect domain are reported in Table 4.3.

Table 4.3
Descriptives of Aggregated Day-to-Day Positive Affect, Negative Affect, and Hedonic Balance for Young and Older Adults and Correlation with Chronological Age

		Young Adults $n = 18$		Older Adults $n = 19$	
	r_{Age}	*M*	*SD*	*M*	*SD*
Mean day-to-day Positive Affect	.51**	3.81	0.63	4.83	1.10
Mean day-to-day Negative Affect	–.22	1.52	0.37	1.32	0.51
Mean day-to-day Hedonic Balance	.14	2.83	1.19	3.30	1.98

Notes. Hedonic balance score = pleasantness score – unpleasantness score (Range of scores: –7 to +7, with a score of 0 indicating neutral hedonic tone). Correlation with age was also not significant for the separate pleasantness ($r = .15$) and unpleasantness ($r = –.10$) scores.
** $p < .01$

As expected, older adults' mean level of daily positive affect was higher than that of younger adults, and the zero-order correlation indicated that age was significantly positively related to mean daily positive affect (r = .51, p < .01). On the other hand, mean levels of daily negative affect were slightly lower in older than younger adults, but the negative correlation between age and mean daily negative affect did not reach statistical significance (r = –.22, p = .18). Mean daily hedonic balance and age were not reliably related (r = .14, p = .40).

In a second step, age-related differences in mean levels of day-to-day positive and negative affect were analyzed using multilevel modeling. This analytic technique takes the specific structure of the intensive microgenetic data structure into account, in which measurement occasions are nested within individuals. As outlined in the Method chapter in more detail, multilevel modeling techniques, among other things, can account for the dependency in each individual's time-series and interindividual differences in reliability due to different numbers of overall provided sessions. These multilevel models consist of individual (within-)person models (Level 1) as well as between-person models (Level 2).

On the individual person level, which captures the within-person processes occurring from day-to-day, the model tested had the functional form γ_{ij} (Daily Affect) = β_{0j} + r_{ij}, where γ_{ij} represents daily affect (PA or NA) for a given person j on a given day i, β_{0j} represents the average level of affect across the nine weeks, and $r_{ij,}$ denotes a residual variance or error term representing the within-person variance in daily affect that remains after accounting for mean level affect.

At Level 2, a baseline model first tested whether the intra-person intercepts varied across individuals, a precondition for further testing of age-related differences in intercepts (i.e., 45-day mean levels). Thus, the following baseline person-level random coefficient model was fit to the data first: $\beta_{0j} = \gamma_{00} + u_{0j}$, where each person's intercept (β_{0j}) in affect was modeled as a function of the grand-mean of PA (NA, or Hedonic Balance) across individuals (γ_{00}) and a random component (u_{0j}) representing between-person variance in levels of emotional well-being that were unaccounted for by the respective PA, NA, or Hedonic Balance grand-mean. This model was then compared to one in which the Level 1 Model remained unchanged, but the Level 2 model took on the following form: $\beta_{0j} = \gamma_{00} + \gamma_{01}$ (Age group) + u_{0j}, thereby modeling each person's intercept (β_{0j}) in affect as a function of the grand-mean of PA (NA, or Hedonic Balance) across individuals (γ_{00}), age group (γ_{01}, coded as 0 for young adults and as 1 for older adults) and a random component (u_{0j}) representing between-person variance in levels of emotional well-being that was unaccounted for by the respective grand-mean and age group.

Table 4.4 gives an overview of the fixed and the random effects for the baseline and age group models for positive affect. Model fit and comparison in fit was determined via χ^2-

comparison of the difference in –2*LL* (i.e., deviance statistic) and the associated degrees of freedom across nested models. The average level of PA for all 37 participants across the 45 days was estimated to be 4.34, differing significantly from zero ($p < .0001$). The random effects part of the table indicates that individuals differed significantly in their intraindividual mean levels ($p < .0001$).

Table 4.4
Multilevel Modeling Results of Intraindividual Mean Levels of Day-to-Day Positive Affect (PA) as a Function of Age Group

	Baseline Model			Age Group Model		
	b	*SE*	*p*	*b*	*SE*	*p*
Fixed Effects						
Intercept (Mean Level)	4.34	0.17	< .0001	3.81	0.21	< .0001
Age group				1.02	0.29	< .001
Random Effects (Variance Components)						
Within-Person	0.3936	0.01	< .0001	0.3936	0.01	< .0001
Between-Person	1.0283	0.24	< .0001	0.7626	0.18	< .0001
Variance Explained[a]						
Pseudo-$R^2_{0 \text{ (Intercept)}}$		—			.25	
Goodness-of-fit						
Deviance (–2*LL*)		3322.1			3311.4.1	
χ^2 (*df*)[a]					10.7 (1), $p < .001$	

Notes. Range of response scale for daily positive affect: 1 (not at all) to 8 (extremely).
Age group was coded as young adults = 0 and older adults = 1.
[a] Variance explained, change in deviance and in model fit determined in reference to the baseline model, which does not include age group.

After including age group in the model, the pseudo-R^2 statistic suggests that age group accounts for 25.0% in the interindividual differences in mean levels. For young adults, the 45-day mean in PA was estimated to be 3.81, whereas the 45-day mean in PA for older adults was estimated to be 4.83 (i.e., 3.81 + 1.02), one scale point higher on the 8-point response scale. The single coefficient tests estimated this difference to be highly significant ($p < .001$). Comparison of model fit via χ^2-comparison of the difference in –2*LL* (i.e., deviance statistic) and the associated degrees of freedom between the baseline and the age group model corroborated the tests of the significance of single coefficients, indicating that the model including age group fit the data reliably better (p < .001). This finding supported the hypothesis of higher levels of day-to-day positive affect in older as opposed to younger adults.

The multilevel modeling results on age-related differences in day-to-day mean levels in negative affect are displayed in Table 4.5. For the sample as a whole, the average level of NA across the nine-week micro-longitudinal assessment period was estimated to be 1.42, differing significantly from zero (p < .0001). Inspection of the random effects associated with the between-person level demonstrates that there were reliable interindividual differences in intraindividual mean levels (p < .0001).

These differences, however, could not reliably be explained by age ($\beta_{0\ \text{Young Adults}} = 1.52$ and $\beta_{0\ \text{Older Adults}} = 1.32$; pseudo-$R^2$ = .05). Neither the single coefficient test was significant ($\gamma_{01} = -0.19$, p = .18), nor was there a reliable overall improvement in model fit after including age group in the model (p = .18). Thus, the hypothesis of lower mean levels of day-to-day negative affect could only be supported as a trend observable in the raw and estimated mean levels, but did not reach statistical significance.

Table 4.5
Multilevel Modeling Results of Intraindividual Mean Levels of Day-to-Day Negative Affect (NA) as a Function of Age Group

	Baseline Model			Age Group Model		
	b	*SE*	*p*	*b*	*SE*	*p*
Fixed Effects						
Intercept (Mean Level)	1.42	0.07	< .0001	1.52	0.10	< .0001
Age group				–0.19	0.14	.18
Random Effects (Variance Components)						
Within-Person	.1448	0.01	< .0001	.1448	0.01	< .0001
Between-Person	.1938	0.05	< .0001	.1847	0.04	< .0001
Variance Explained[a]						
Pseudo-$R^2_{0\ (\text{Intercept})}$		—			.05	
Goodness-of-fit						
Deviance (–2*LL*)		1646.7			1644.9	
χ^2 (*df*)[a]					1.8 (1), p = .18	

Notes. Range of response scale for daily positive affect: 1 (not at all) to 8 (extremely).
Age group was coded as young adults = 0 and older adults = 1.
[a] Variance explained, change in deviance and in model fit determined in reference to the baseline model, which does not include age group.

Follow-Up Analyses I: Age-Related Differences in Mean Levels of Daily Hedonic Balance

Age group differences in mean levels over nine weeks (i.e., the intercept in multilevel modeling analyses) were also examined in the index of hedonic balance. The multilevel model analysis indicated that the mean day-to-day hedonic balance score for young adults was 2.82 (this score had a theoretical range of –7 to +7, with 0 indicating hedonic neutrality and positive scores indicating an overall positive hedonic tone) and slightly but not reliably higher for older adults (γ_{01} = 0.47, χ^2 = 0.8, *df* = 1, *p* = .37; see Appendix C, Table C5, for complete overview of fixed and random effects for the baseline and the age group difference model).

Follow-Up Analyses II: Separating Intensity and Frequency in Self-Reported Affect

In order to be able to compare the present findings with other previous research on age differences in daily PA and NA (e.g., Carstensen et al., 2000), the momentary affect ratings were re-analyzed according to a frequency and an intensity dimension, following a procedure suggested in Schimmack and Diener (1997). A frequency score was computed for each individual as the ratio of sessions on which each affect received a rating greater than 1 (i.e., indicating that the affect was being experienced at all). These ratios were subsequently averaged separately across all positive and all negative items to yield a frequency score for positive affect and a frequency score for negative affect for each individual. An intensity score for each item was computed as the average rating on each affect item across all ratings that were greater than 1. These item-based intensity scores were then averaged for all items belonging to the PA-scale and for all items belonging to the NA-scale to obtain an intensity score each for PA and for NA for every individual. The descriptives for these derived scores can be found in Appendix C, Table C6.

Overall, these follow-up analyses extended and replicated the general pattern of significant age-related differences in the domain of PA but not NA. The two intensity scores (i.e., one for PA and one for NA) and the two frequency scores were each subjected to a repeated measures analysis of variance (ANOVA). The within-subjects factors were significant in both analyses, suggesting that in the domain of positive affect, intensity and frequency was reliably higher than in the negative affect domain. In both analyses, the affect domain × age group interactions were marginally significant (intensity: *p* = .059, frequency: *p* = .051). Inspection of the descriptives suggested that the domain difference was particularly pronounced for older adults, both for intensity and frequency. The between-person effect for age group was only significant with respect to the level of intensity (F (1, 35) = 7.01, $p < .05$, η_p^2 = .17), and follow-up ANOVAS suggested that this effect was driven by positive rather than negative affect (see Appendix C for the complete results).

Follow-Up Analyses III: Comparison of Aggregated State-Like Daily Affect with Trait Affect

Given that one of the advantages of diary or experience sampling studies of affect and other self-report measures (e.g., subjective coping) is the reduction of retrospective memory biases (e.g., Bolger et al., 2003), the third set of follow-up analyses sought to examine the relationship of the aggregated day-to-day affect ratings with trait ratings of PA and NA obtained at baseline. Most of the literature on age-related differences and changes in PA and NA is based on such single-assessment, retrospective affect ratings.

Following a procedure proposed by Nezlek and Plesko (2001), the association of individuals' mean daily PA and NA with their trait measure of PA and NA (as assessed at baseline) was determined by modeling daily PA (NA) as a function of a grand mean and the trait PA (NA) score plus a random component. The fixed estimates of this analysis indicated that the aggregated state and the trait measures were related for both affect domains. For each unit increase in trait PA, mean daily PA increased by 0.86 (i.e., almost one scale point on the 8-point response scale; $p < .001$), and for each unit increase in trait NA, mean daily NA increased by 0.24 ($p < .001$).

The strength of the relationship between mean daily and trait measures can be operationalized as the amount of variance in mean daily affect accounted for by trait affect. The residual intercept variance for PA was reduced by 23.0% when trait PA was included in the model. The square root of .23 represents the person-level correlation between mean daily and trait PA, and it has a value of .48. For NA, inclusion of trait NA into a totally unconditional model led to a reduction in residual intercept variance of 24.0%, which corresponds to a person-level correlation of mean daily and trait NA of .49. In sum, after considering the specific nested data structure, there were significant positive relationships between average daily and trait affect ratings. These suggest an acceptable level of agreement between aggregated daily and trait measures, but both types of affect scores appear to capture slightly different aspects of affective experience.

4.1.3 Age-Related Differences in the Time-Related Trends of Day-to-Day Positive and Negative Affect Across 45 Days

Affect and mood tend to be regarded as fluctuating states that are not characterized by "learning" or other less reversible change-like processes. On the other hand, intensive repeated assessment of self-reported mood may lead to small shifts in mean levels over the assessment period due to reactivity and regression to the mean. In order to examine whether such slight time-related trends were observable in the daily affect data, and whether young and older adults differed in these trends, a sequence of models was tested. This sequence consisted of a baseline no change model (i.e., the same baseline models for PA and NA as used to examine age group differences in the average day-to-day levels of affect), and a series of polynomial change models that were nested in one another (see Method chapter, Section 3.4.4, for details). The best fitting change model was then extended to include age group as a covariate to examine age-related differences in nine-week trends.

Estimating the Time-Related Trends in the Daily Affect Data

The first polynomial model fit to the data was a linear change model, as represented in the following occasion-level (Level 1) equation: γ_{ij} (Daily Affect)= β_{0j} + β_{1j} (Session) + r_{ij}, where γ_{ij} represents daily affect (PA or NA) for a given person j on a given day i, β_{0j} represents the level of affect at the beginning of the daily assessment period, because the session term was centered at the first session, β_{1j} represents the slope of the personal session number, and $r_{ij,}$ denotes the residual within-person variance in daily affect that remains after accounting for mean level affect and a linear change component. At the between-person level (Level 2), intra-person intercepts ($\beta_{0j} = \gamma_{00} + u_{0j}$) and slopes ($\beta_{1j} = \gamma_{10} + u_{0j}$) were expected to vary across individuals as a function of a grand mean (of level of affect and of the session slope) and an error term.

The single coefficient tests for this model yielded a significant average negative slope of session for PA ($\gamma_{10} = -0.01$, $p < .01$), with a significant random component associated with it, and a non-significant fixed effect for the session slope for NA ($\gamma_{10} = -0.002$, *n.s.*), associated with significant variance around it. In other words, on average, PA was estimated to decrease by 0.01 (i.e., 1/10 of a scale point on the 8-point response scale) from one occasion to the next, and there were reliable individual differences in this trend across individuals. On average, daily NA remained stable, but the reliable individual differences predicted by the model suggest that some participants also reported time-related trends in daily NA across nine weeks (see Appendix C, Tables C9 and C10 for a complete overview of fixed and random effects of these models).

In addition, the intercept-slope covariances indicated that greater initial levels of reported affect were associated with a slightly steeper decline in level over time, but this association was very small and only reached statistical significance for the domain of NA ($\sigma = -0.0028$). Inspection of the raw data suggests that this effect was mainly driven by a few older participants initially reporting elevated levels of negative affect. Comparison of this model to the baseline no-growth model on the basis of the deviance statistic suggests that the linear growth model fits the data significantly better both for PA ($\chi^2 = 214.8$, $df = 3$, $p < .001$) and for NA ($\chi^2 = 132.9$, $df = 3$,

$p < .0001$). As a measure of effect size, the pseudo-R^2 statistics indicate that the linear session slope explained 16.0% of the within-person variance in PA, and 12.0% of the within-person variance in NA.

The second polynomial model estimated assumed daily affect to be a function of not only the average level of affect and a linear change component, but also of an additional quadratic change component: γ_{ij} (Daily Affect) = β_{0j} + β_{1j} (Session) + β_{2j} (Session^2) + r_{ij}. The intra-person intercepts and linear slopes (in general form: $\beta_{aj} = \gamma_{a0} + u_{aj}$) were expected to vary across individuals as a function of a grand mean and an error term. The quadratic session term was estimated as fixed across participants ($\beta_{2j} = \gamma_{20}$) because otherwise neither the PA-model nor the NA-model converged.

On average, there was a significant but very small effect for the quadratic term of session for PA, suggesting that the overall pattern of decrease was attenuated over time. For the daily NA data, there was no significant quadratic change component. In comparison to the linear growth model, the quadratic trend model resulted in a significantly smaller deviance statistic for PA ($\chi^2 = 8.9$, $df = 1$, $p < .01$) but not for NA ($\chi^2 = 3.4$, $df = 1$, $p = .07$). However, the pseudo-R^2 for the within-person residual variance associated with the addition of the quadratic term was very small for both PA and NA, indicating that the quadratic term only explained an additional 0.4% of the within-person variance in PA and an additional 0.2% of the variance in NA. Therefore, a model assuming linear change and interindividual differences in this change pattern was judged to be the best fitting and the most parsimonious in representing the observed day-to-day trajectories of PA and NA (see Tables C9 and C10, Appendix C).[28]

Age-Related Differences in the Time-Related Trends in PA and NA across 45 Days

As a further extension to the multilevel modeling analyses in Section 4.1.2, in which age-related differences in the day-to-day levels (intercepts) in PA and NA were examined, a subsequent set of analyses modeled the linear slopes as a function of a grand-mean, age group (with the younger group as the reference category), and an error term as well ($\beta_{1j} = \gamma_{10} + \gamma_{11}$ (Age group) + u_{0j}). Table 4.6 outlines the fixed effect results of this analysis. The age group differences in the intercept have been presented already in the previous section and will not be repeated here,

[28] For exploratory reasons, the fit of a model that included a cubic term of session was also evaluated. For PA, this model did not fit the data better than the quadratic model ($\chi^2 = 2.2$, $df = 1$, $p = .14$). For NA, this model fit the data slightly better than the quadratic model ($\chi^2 = 10.9$, $df = 1$, $p < .001$). However, the within-person variance explained in addition to the quadratic model was only 0.6%. Therefore, the linear model was selected to be the best fitting and most parsimonious in representing the observed day-to-day reports of NA.

they remained unchanged after controlling for the linear change component at the within-person level. The coefficients are listed in the following table for information only.

Patterns of age group differences in the linear slopes differed somewhat from the age group differences obtained for the intercepts. Age group explained none of the variance in slopes for PA, but it did explain about 11.0% of the variance in the linear slopes of NA. The fixed effects indicated that even though on average, younger adults' NA displayed no change across nine weeks, there was a small decrease in older adults' day-to-day reports of NA. Furthermore, the random effects (i.e., variance components) associated with the linear slopes of both affect domains were estimated to be significantly different from zero (both *p*s < .001, see Table C11 in Appendix C for a complete overview of all random effects results). Thus, there were individual differences in patterns of change trajectories, which could not be explained by age group.

Table 4.6
Fixed Effects Results from Multilevel Modeling on Age-Related Differences in Time-Related Trends of Day-to-Day PA and NA

Fixed Effects		Positive Affect	Negative Affect
Initial Status, Intercept, β_0	γ_{00}	4.03***	1.50***
Intercept × Age Group[a]	γ_{01}	0.99***	–0.06
Linear Change Slope, β_1	γ_{10}	–0.01*	0.001
Linear Change Slope × Age Group	γ_{11}	0.002	–0.01[#]

Notes. Range of response scale for daily positive affect (PA) and negative affect (NA): 1 (not at all) to 8 (extremely).
Age group was coded as young = 0, old = 1.
Coefficients shown are unstandardized coefficients.
[a] The session variable to estimate the linear trend was centered at the first session, so that unlike in Tables 4.4 and 4.5, the intercept in this model does not represent the average level of day-to-day affect and age group differences in it. Rather, the intercept represents the average level of affect across individuals at the first session.
[#] $p < .10$; * < .05; *** $p < .001$

Comparison of the deviance statistics of the linear change model with no individual difference variables predicting intercepts and slopes with the models including age group in the between-person level model indicated that the inclusion of age group into the prediction of interindividual differences of levels and slopes improved the model fit significantly for both PA (χ^2 = 11.2, *df* = 2, *p* < .01) and NA (χ^2 = 6.2, *df* = 2, *p* < .05). [29]

In sum, both day-to-day PA and NA appeared to show slight time-related trends in the sense of decrease across the nine weeks, even though the magnitude of this decrease was very small. Whereas the two age groups, on average, did not differ in this linear trend for PA, only older but not younger adults' NA was estimated to decrease over time. After accounting for age-related differences in both intercepts and slopes, there were still reliable interindividual differences in both parameters, which were not captured by age group.[30]

Follow-Up Analysis: Age Differences in the Time-Related Trend in Hedonic Balance Across 45 Days

A follow-up multilevel modeling analysis also examined time-related trend and age-related differences therein in the daily hedonic balance trajectories. This analysis indicated a significant increase in model fit for a linear change model as compared to a no change model (χ^2 = 27.9, *df* = 3, *p* < .001). This improvement was driven by a significant random effect (*p* < .01), whereas the single coefficient test for the fixed effect was not significant. In other words, individuals differed largely in the amount of linear trend in their day-to-day hedonic balance data, but the average trend was estimated to be flat (γ_{10} = –0.01, *p* = .22). Furthermore, an additional quadratic trend could only be fit as a fixed effect to the data, and comparison of the deviance statistics indicated that such a model did not fit the data reliably better (χ^2 = 2.2, *df* = 1, *p* = .14). Examination of age group differences in the linear slope led to a non-significant age group × slope interaction (γ_{11} = 0.01, *p* = .22) and the fit of a model that included age group as a moderator for the linear trend was also not improved as compared to a model with age group only as a moderator of individual differences in the intercept (χ^2 = 1.5, *df* = 1, *p* = .22). This

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[29] On the basis of the lack of a significant fixed effect for the effect of age group on the linear slope for PA and the small effect for the linear slope in NA, an additional, reduced age group model was fit to the data, in which only the intercept was predicted by age group, whereas the linear slope was merely estimated as a random effect with no additional predictors. Comparing this reduced model to the full model indicated that the model fit was not better for the full model for PA (χ^2= 0, *df* = 1, *p* = 1), and there was only a trend for better fit for NA (χ^2 = 3.3, *df* = 1, *p* = .07). These findings underline that age group did not explain individual differences in linear change of levels of PA, and young and older adults slightly but insignificantly in linear change trajectories of day-to-day NA.

[30] A follow-up analysis explored whether day-of-week effects were observable for PA and for NA and whether these would differ between the two age groups. The expectation was that if at all, younger adults' mood patterns should show stronger sensitivity to weekdays than older adults'. For each participant and each affect domain, five scores were computed which represented the average experience of PA and NA, respectively, on each Weekday (i.e., Monday through Friday). Two repeated measures analyses of variance (ANOVA) were then conducted for each affect domain, in which age group was the between-person factor and day-of-the-week was the five-level within-person factor. The analyses yielded no evidence of day-of-the week effects or of a weekday × age interaction in neither affect domain (see Appendix C for the specific statistics associated with this analysis).

suggests that age group was unable to explain the individual differences in time-related trends or mean levels of day-to-day hedonic balance.

4.1.4 Age-Related Differences in Day-to-Day Intraindividual Variability (Fluctuation) in Positive and Negative Affect Across 45 Days

Prior to investigating age-related differences in intraindividual variability (fluctuation), two sets of analyses were carried out to investigate whether the amount to which individuals fluctuate in their reports of PA and NA can be considered a stable interindividual difference characteristic: the zero-order correlations between (a) variability in PA and variability in NA as well as between (b) variability in PA (NA) during the first half and variability in PA (NA) during the second half of the daily assessment period. In keeping with common practice in the literature (e.g., Ghisletta, Nesselroade, Featherman, & Rowe, 2002; Fleeson, 2001), these analyses used the intraindividual SD as a gross indicator of variability. As will be discussed further down, other indicators of variability may be advisable to unconfound variability and mean levels as well as time-related trends in the data. Because the different indicators led to virtually comparable findings in the present study, these initial screening analyses were carried out with the intra-person SD such as to be comparable with the extant literature.

Daily Fluctuations in PA and NA: A Stable Interindividual Difference Characteristic?

The zero-order correlations of each individual's intraindividual standard deviation in PA and in NA were computed separately within each age group to obtain coefficients that were unbiased by age group differences in the variables in focus. These correlations were positive in young (r = .28, p = .27) and older adults (r = .27, p = .13), but they did not reach statistical significance in the present sample. However, the pattern is consistent with the notion that variability in affective experience represents a systematic individual difference characteristic, in the sense that individuals who fluctuate more in one domain (e.g., PA) also tend to fluctuate more in other affect domains (e.g., NA).

As a second approach to establishing the nature of variability as an individual difference characteristic, two indicators of variability were computed for each individual and for each affect domain: One represented variability in the first half of the daily assessment period (i.e., the first 21 personal sessions), and one represented variability in the latter half of study participation. Subsequently, the correlation between first-half and second-half variability was computed separately for PA and NA. Results yielded significant positive associations both for variability in

PA ($r = .78, p < .0001$) and for NA ($r = .53, p = .001$) within the sample as a whole. Conducting the correlational analyses separately for both age groups yielded correlation coefficients smaller in size, but the general pattern was not altered substantially (PA: $r_{young} = .54, p < .05, r_{old} = .55, p < .05$; NA: $r_{young} = .35, p = .15, r_{old} = .56, p < .05$). This speaks to a great deal of (but not perfect) stability in variability itself, indicating that it represents a rather stable individual difference characteristic for young and older adults that distinguishes one person from another in systematic ways.

Age-Related Differences in Short-Term Variability (Fluctuation) in PA and NA

There are several alternative methods for computing an indicator of intraindividual variability in time-series data. The most common of these is to compute the intraindividual standard deviation (ISD) for each individual in a sample and use this coefficient in subsequent analyses. The advantage of this approach is that it is easy to communicate because the standard deviation is a common metric in statistics. This approach is not without its problems[31] (e.g., S. G. West & Hepworth, 1991). The ISD does not take into consideration individual differences in overall mean level that may be related to individual differences in variability. The coefficient of variation (CV = ISD/IM) has been proposed to circumvent this problem (Wilson & Payton, 2002). In addition, one has to separate short-term fluctuations from true (longer-term) change across a time-series (e.g., Cattell, 1957a; S. G. West & Hepworth, 1991). Previous analyses reported above found significant time-related trends in some individuals' affect across the nine weeks. If not considered, such trends may lead to an overestimation of intraindividual variability. Given these concerns, multiple approaches to analyzing age-related differences in variability in day-to-day PA and NA were selected. All of them converged on the same pattern of age-related differences. For the purpose of parsimony, a selection of these results is presented next (i.e., the ISD and an indicator of variability controlled for time-related trends), whereas the remainder of the analyses can be found in footnotes and the Appendix. For initial screening of the data, the intraclass correlation coefficients for PA and NA were computed separately for the two age groups (Figure 4.4). Whereas for young adults, roughly 60.0% of the variance in daily affect occurred within individuals, only between 14.0% (PA) and 20.0% (NA) of the total variance in daily affect was located at the within-person level in the older group.

[31] The intraindividual standard deviation only reflects the magnitude of variability, neglecting individual differences in patterns and regularity of variability (e.g., see also Larsen, 1987; Wohlwill, 1970).

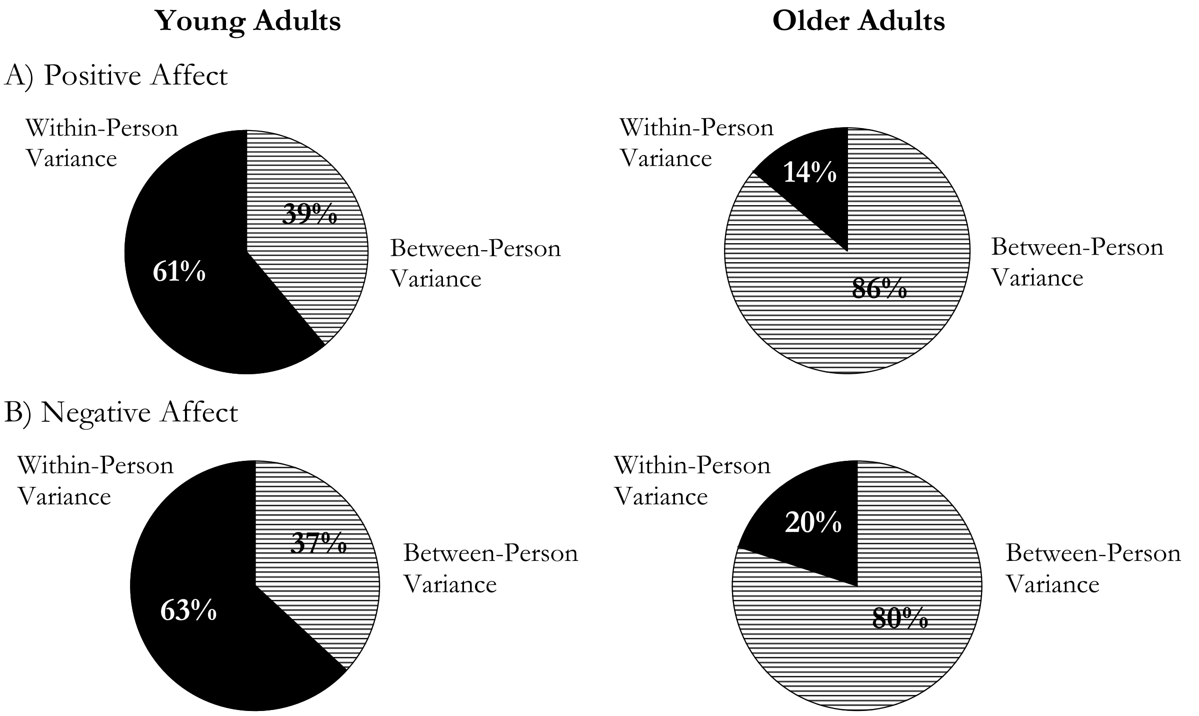

Figure 4.4. Age Differences in the Relative Proportions of Within-Person and Between-Person Variance in Day-to-Day Positive and Negative Affect

(based on the intraclass correlation coefficient obtained from the random coefficient results of multilevel modeling analyses)

Panel A in Figure 4.5 shows the average ISDs for PA and NA separately for both age groups. Despite its shortcomings, the ISD descriptives are presented for comparability with other studies because the metric is so commonly used in the literature (e.g., Charles & Pasupathi, 2003; Eid & Diener, 1999). Inspection of the graph indicates that variability was greater for young than for older adults, both regarding PA and NA.[32]

The main analysis was carried out, however, with an alternative indicator of variability: In order to separate time-related day-to-day trends from short-term fluctuations, for each individual, daily PA and daily NA were regressed on personal session. The absolute values of the residuals obtained from these analyses were aggregated for each participant. These newly computed scores

[32] For young adults, the average ISD for PA was M = 0.75 (SD = 0.21; SE = 0.05) and for NA it was M = 0.43 (SD = 0.21; SE = 0.05). For older adults, the average ISD for PA was M = 0.41 (SD = 0.15; SE = 0.03) and for NA it was M = 0.20 (SD = 0.16; SE = 0.04). A repeated measures analysis of variance yielded a significant within-person effect of affect domain (F (1, 35) = 51.29, p < .001, η_p^2 = .59). Inspection of the descriptives suggested that variability was greater for PA than for NA. The interaction of affect domain and age group was not significant, indicating that the relative variability pattern was similar in both age groups. Finally, the between-person effect of age group was significant (F (1, 35) = 35.09, p < .001, η_p^2 = .50). Follow-up oneway ANOVAS indicated, that both age groups differed significantly in their levels of variability in PA (F (1, 35) = 31.07, p < .0001, η_p^2 = .47) and NA (F (1, 35) = 14.55, p < .001, η_p^2 = .29).

can be considered indicators of short-term variability in PA and NA after taking out the change component. Panel B of Figure 4.5 shows these absolute values of the residuals after aggregation across participants within each age group. This graph illustrates that variability in both PA and NA was greater within young than within older adults. In order to statistically test for age differences, the mean absolute value of residuals for PA and NA were subjected to a repeated measures analysis of variance (ANOVA).

A) Intraindividual SD on Raw Data B) Variability Controlled for Time-Related Trends

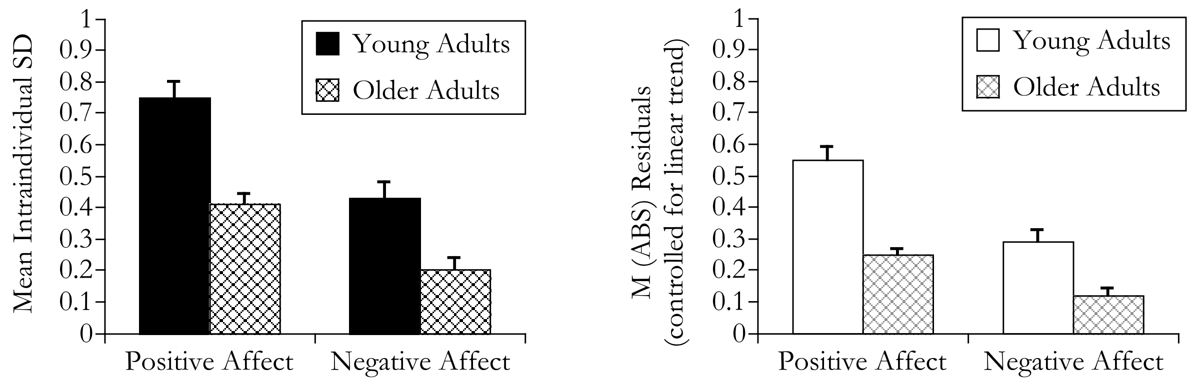

Figure 4.5. Age-Related Differences in Day-to-Day Fluctuation of PA and NA Across 45 Days (Error bars represent the standard error of the mean. Positive and Negative Affect = PANAS, Watson et al., 1988.)

In a second step, average levels of daily PA and NA were added to the two ANOVAs as covariates in order to simultaneously control for individual differences in mean levels of day-to-day affect. Table 4.7 gives an overview of the results of this final analysis. The significant within-subject effect of affect domain (F (1, 35) = 9.73, p < .001, η_p^2 = .23) suggested that consistent with the hypotheses, variability was reliably greater in positive as compared to negative affect. The significant affect domain × age group interaction (F (1, 35) = 7.22, p < .01, η_p^2 = .18), together with an inspection of the means in each age group, indicated that this relative difference was even more pronounced in older than younger adults. Finally, the between-person effect of age group was also highly significant (F (1, 35) = 32.13, p < .001, η_p^2 = .49).

Table 4.7
Results of Repeated Measures Analyses of Variance on Age Group Differences in Day-to-Day Variability (Fluctuation) in PA and NA After Controlling for Time-Related Trends and Mean Daily Affect Levels Across 45 Days

	F	*df*	*p*	η^2
Within-Person Effects				
Affect Domain	9.73	1, 35	.00**	.23
Affect Domain × Age Group	7.22	1, 35	.01**	.18
Between-Person Effects				
Age Group	32.13	1, 35	.00**	.49
Mean Daily PA	1.69	1, 35	.20	.05
Mean Daily NA	4.43	1, 35	.04*	.12

Notes. PA = Positive Affect, NA = Negative Affect (PANAS, Watson et al., 1988).
Results are reported after applying a Greenhouse-Geisser correction to the data to accommodate violation of the assumption of sphericity.
* $p < .05$, ** $p < .01$

Separate follow-up analyses of variance, in which age group was the between-person factor and the respective mean level of daily affect was entered as a covariate, yielded a significant main effect of age for both affect domains, using an adjusted alpha-level of .01 (see Table 4.8). The main effect for age group was significant both for trend-controlled variability in PA and in NA even when accounting for individual differences in the respective mean levels.[33] Furthermore, the level covariate of NA was significant with respect to variability in NA. An age-partialled correlation between level of NA and variability in NA (controlled for linear trend) indicated that individuals with greater overall levels of NA were also experiencing more pronounced day-to-day variability in NA around the general trajectory of NA across the nine weeks ($r = .59$, $p < .0001$). It should be noted that apart from its conceptual meaning, this result likely reflects a floor effect (i.e., at too low levels of NA experience, the potential range for fluctuation is limited).

[33] Another way to investigate individual differences in short-term variability involves computing the auto-correlation of a time-series and to obtain the Durbin-Watson statistic. Both were obtained using SAS Proc Regression. Greater variability should be indicated by a low auto-correlation. For young adults, the auto-correlation was .49 and .48 for PA and NA, respectively, whereas for older adults, the respective coefficients were .91 and .86. The Durbin-Watson statistic equals 2 if the errors are uncorrelated. In the present sample, it is much higher in younger (1.03 and 1.04, for PA and NA, respectively) than in older adults (0.18 and 0.29, for PA and NA, respectively), suggesting that indeed, younger adults' reported PA and NA were less correlated from one occasion to the next than for older adults.

Table 4.8
Results of Follow-Up Analyses of Variance on Age Group Differences in Day-to-Day Variability (Fluctuation) in PA and NA After Controlling for Time-Related Trends and Mean Daily Affect Levels Across 45 Days

	F	*df*	*p*	η^2
Positive Affect				
Age Group	29.97	1, 34	.00**	.47
Mean Level of Daily PA	.96	1, 34	.34	.03
Negative Affect				
Age Group	18.36	1, 34	.00**	.35
Mean Level of Daily NA	20.18	1, 34	.00**	.37

Notes. PA = Positive Affect, NA = Negative Affect (PANAS, Watson et al., 1988).
** $p < .01$ (significant effects even after adjusting alpha-level to .01 to account for multiple testing)

Follow-Up Analysis I: Age-Related Differences in Intraindividual Variability in Hedonic Balance

As a follow-up, age-related differences were also analyzed in the hedonic balance indicator, using the ISD, the absolute values of residuals after taking out a linear trend using separate regression analyses for each individual, as well as the CV. Analyses of variance across these different indicators of variability yielded slightly different results. Specifically, a significant main effect of age group emerged from the analysis using the ISD (F (1, 35) = 54.91, $p < .001$, $\eta_p^2 = .61$) and the CV (F (1, 35) = 17.84, $p < .001$, $\eta_p^2 = .34$). However, the main effect of age group was not significant when using the mean absolute residuals of regressing session on daily hedonic balance (F (1, 35) = .10, $p = .75$, $\eta_p^2 = .00$). Inspection of the individual graphs, however, suggested that some younger and some older adults' trajectories were not very well captured by a linear trend. Thus, the analysis was re-run, using residuals from estimating a quadratic trend to the data. This analysis led to a significant main effect of age group in an analysis of variance (F (1, 35) = 53.94, $p < .001$, $\eta_p^2 = .61$). In sum, these follow-up analyses overall replicated that young adults fluctuate more than older adults from day to day not only in high-arousal affect but also in a measure that captures a pleasantness-unpleasantness dimension, even after taking into account individual differences in mean level and time-related trends across the repeated measurement occasions (see Figure 4.6).[34]

[34] Interestingly, the age difference in fluctuation was also found in retrospective self-ratings of mood fluctuation during the nine-week daily assessment period, which were obtained at the end of the study. Older adults reported lower levels of both general mood fluctuation as well as specifically positive and negative mood fluctuation than young adults (see Appendix C, Table C12, for descriptives). However, only the difference concerning negative affect fluctuation reached statistical significance (F (1, 35) = 7.98, $p = .008$, $\eta_p^2 = .19$). Thus, these findings not only mirror the results of less fluctuation in affective experience as measured in a day-to-day microlongitudinal design, but

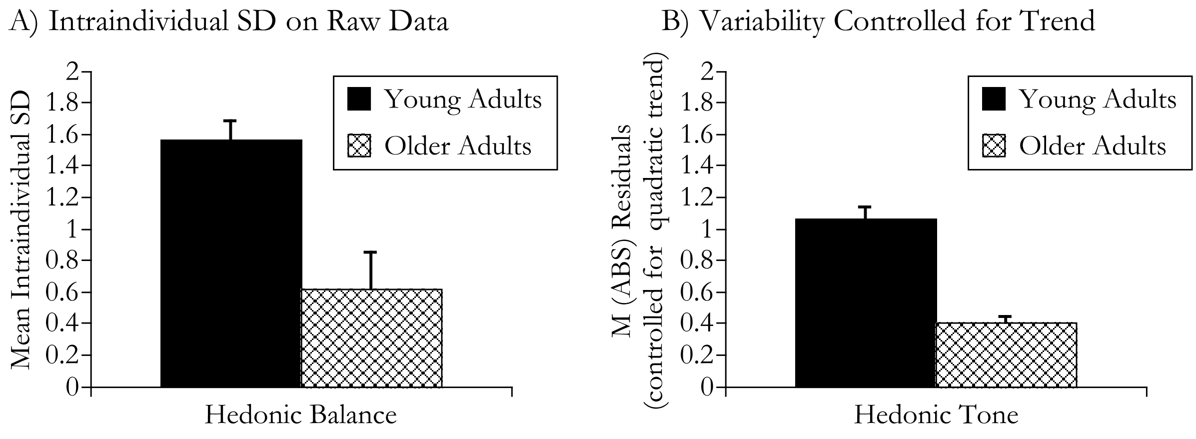

Figure 4.6. Age-Related Differences in Day-to-Day Variability (Fluctuation) of Hedonic Balance Across 45 Days

(Error bars represent the standard error of the mean. Hedonic balance = pleasantness – unpleasantness.)

Follow-Up Analyses II: Age-Related Differences in Variability in Single Affect Items

A second set of follow-up analyses examined whether the observed age group differences on the level of the PA and NA subscales are driven by specific items or by all items comprising each subscale. These item-specific indicators of variability are presented in Tables C13 and C14 in Appendix C followed by an overview of the specific analyses. In summary, findings of age-differences at the subscale-level were by and large replicated across single items. There were only some exceptions to this pattern nonetheless in the negative affect domain: No reliable differences between the two age groups emerged for variability in daily reports of feeling scared, nervous, and ashamed.

4.1.5 *Summary of Findings on Age-Related Differences in Stable and Dynamic Characteristics of Daily Positive and Negative Affect*

Age-related differences in three aspects of the stable and dynamic characteristics of daily positive and negative affect across nine weeks were examined: average level, time-related trends, and day-to-day intraindividual variability (fluctuation). Multilevel analyses that accounted for the specific hierarchical structure of the time-series data (Raudenbush & Bryk, 2002) indicated that patterns of age-related differences in average levels of affective experience differed between the two affect domains: Older adults (*M* = 74.36 years) reported significantly higher mean levels of PA than did younger adults (*M* = 25.50 years). No age-related differences emerged for mean

are also in accordance with previous evidence on age-related differences in global self-reported emotional control/emotion regulation abilities (e.g., Gross et al., 1997, Lawton et al., 1992).

levels of NA, however. These findings partially supported the first hypotheses regarding age group differences in average levels of PA and NA.

As for time-related trends in day-to-day trajectories of affect across 45 days, individual multilevel growth models indicated that both young and older adults' day-to-day PA decreased slightly across days. A linear change component captured 16.0% of the variance in daily PA, and a quadratic change component only captured an additional 0.5%. There were significant individual differences in the linear change of PA over time, but these were not accounted for by age group. On the other hand, the average estimated day-to-day trajectory of NA was flat for young adults, but showed a slight decrease in older adults. Overall, the linear change component explained 11.7% of the variance in daily NA, whereas a quadratic component only explained an additional 0.2%. Age group explained about 11.0% of the individual difference variance in the linear slope coefficient of daily NA. These findings supported the hypothesis that there would be slight time-related trends in levels of daily affect across the nine-week assessment period. They further indicated that there were significant individual differences around the average change trajectories, which could in part be explained by age group for daily NA but not for PA, even though this group difference appeared to be driven by only two older individuals and should thus not be over-interpreted.

With respect to day-to-day intraindividual variability in PA and NA, both descriptive analyses and repeated measures analyses of variance indicated that overall, there was sizable within-person variability in both affect domains, with greater amount of fluctuation in PA than in NA on average. The relative proportion of within-person to between-person variance was larger for younger than for older adults. Furthermore, even after controlling for individual differences in aggregated levels of day-to-day PA and NA, and for time-related trends in affect time-series across nine weeks, the age-related differences in intraindividual variability were robust, thus supporting the hypothesis that older adults showed significantly less fluctuation from day-to-day than younger adults, both in their reports of positive as well as negative affective experience.

Follow-up analyses were carried out to examine intraindividual fluctuation on an index of hedonic balance that is characterized by lower levels of arousal than the positive and negative affect scores based on the PANAS. These analyses replicated that older adults showed less fluctuation than young adults. Furthermore, such group differences were also analyzed with respect to the individual items of which the subscale scores are composed. Results indicated that the pattern of age-related differences found for PA (including the pleasantness items) could be generalized across all individual items. As for single items of NA and unpleasantness, older adults were found to fluctuate less than younger adults for a majority but not for all items.

4.2 Trait-Like and State-Like Correlates of Intraindividual Fluctuations in Positive and Negative Affect

The previous section provided evidence of robust age-related differences in the magnitude of intraindividual variability of day-to-day PA and NA (as well as hedonic balance). In the present section, the focus is on three main parts: First, analyses examining whether age can explain additional significant amounts of interindividual differences in variability of PA and NA above and beyond personality traits and affect intensity. Second, exploratory analyses will be reported, which pertain to the association of affect fluctuations with adaptive psychological functioning correlates, addressing the question of the functionality or dysfunctionality of high levels of variability in the two age groups. The third and last part outlines the results of multilevel modeling analyses that examined the day-to-day relationships between daily affect and daily stress and events, including the question of whether age group moderated these day-level relationships.

4.2.1 Does Age Explain Significant Amounts of Individual Difference Variance in Daily Affect Fluctuation Over and Above Personality Factors?

To address the relative role of age and personality variables in predicting interindividual differences in affect fluctuations, separate hierarchical regression analyses were conducted for the prediction of variability in PA and NA, respectively (see Table C15 in Appendix C for an overview of the intercorrelation of all predictors entered into the main and follow-up regression analyses. These intercorrelations suggest that there are some associations between the predictors, but the size of the coefficients [i.e., maximum $r = .50$ for the relationship between age group and mean daily PA] indicates that there is no construct overlap, thus reported associations should not be confounded by multicollinearity in the predictor relationships.)[35]

In the hierarchical multiple regression analysis, the two personality traits of extraversion and neuroticism were entered simultaneously in the first step. Age group was entered in the second step. The interactions between age and each of the two personality traits were entered in the third and last step. Following a recommendation of Aiken and West (1991), the interaction terms were computed on the basis of the grand-mean centered personality variables and the dichotomous age group variable (0 = young, 1 = older adults). Even though statistical trends are not usually reported, effects that are significant at $p < .10$ will be indicated as such in these

[35] There was an unexpected lack of a significant positive relationship between mean levels of PA and extraversion in the present data set. The correlation between trait PA and extraversion was small but in the expected direction, with $r = .13$ (n.s.).

analyses because our sample size was very small and a lack of power is likely to underlie marginal effects, particularly with respect to interaction effects. Table 4.9 gives an overview of the coefficients from the final step in the analysis, when all predictors had been entered into the model, including the change in R^2 at each step as an indicator of the additional variance explained at subsequent steps.

Table 4.9
Results of Hierarchical Multiple Regression Predicting Variability (Fluctuation) in Positive and Negative Affect

		Variability in Positive Affect		Variability in Negative Affect	
Step	Predictors	β	ΔR^2	β	ΔR^2
1	Extraversion	–.01	.16[#]	.03	.24**
	Neuroticism	.42*		.49[#]	
2	Age Group	–.70***	.45***	–.46**	.19**
3	Extraversion × Age Group	.17	.05	–.02	.02
	Neuroticism × Age Group	–.40[#]		–.21	
	Overall explained variance				
	Total R^2		.65[a]		.45
	Adjusted R^2		.60		.36

Notes. Age group was coded as young = 0 and older adults = 1.
Interactions are based on grand-mean centered personality variables.
Variability = *M*(ABS) Residuals.
Coefficients presented are from final step in the analysis.
[a] The individual R^2-change coefficients add up to a total R^2 of .66 instead of .65 due to rounding errors.
[#] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Of the two personality factors, greater levels of neuroticism initially predicted greater amounts of day-to-day fluctuation in PA (β = .40, $p < .05$), and this relationship remained significant even after controlling for age group and the interactions (β = .42, $p < .05$). Regarding fluctuation in NA, prior to controlling for age group, neuroticism had a reliable negative predictive effect (β = .50, $p < .01$), but this effect was attenuated to a trend in the final level of the analysis (β = .49, p = .07). It is necessary to recall that there were some floor effects in variability in NA in older adults, but the reliable positive relationship between neuroticism and fluctuation in negative mood is consistent with the literature.

Most importantly considering the research question, entering age group in the second step led to a significant change in R^2, indicating that age group reliably predicted an additional 45.0% of individual difference variance in variability of PA ($p < .001$) and an additional 19.0% of the individual difference variance in variability of NA ($p < .01$), above and beyond personality characteristics. Consistent with the findings reported in Section 4.1.4, age group (coded as 0 for young adults and as 1 for older adults) was significantly negatively associated with variability in PA ($\beta = -.70$, $p < .001$) and with variability in NA ($\beta = -.46$, $p < .01$), showing again that older adults fluctuated less than young adults in daily mood. Entering the interactions between age group and the personality factors in step 3 did not explain any additional significant amounts of variance, neither with respect to variability in PA ($\Delta R^2 = .05$, $p = .12$) nor in NA ($\Delta R^2 = .02$, $p = .66$). None of the interactions reached statistical significance. The neuroticism × age interaction was marginally significant in the model predicting variability in positive affect. As a trend, however, this interaction should not be over-interpreted, but given the small sample size, it may be indicative of interesting dynamics between personality characteristics and age-related changes that can predict individual differences in how much people vary in their daily moods. Overall, personality factors, age group and their interactions explained 65.0% and 45.0% of the individual difference variance in affect variability of PA and NA, respectively.

In order to examine the unique amounts of variance that age group and personality each could explain relative to one another in individual differences in affect fluctuation, the regression analyses were also run in the reverse order: Age group was entered in the first step of the analysis and the two personality factors were entered at the second step. When age was entered in the first step, the associated R^2 was .58 ($p < .001$) for PA and .35 ($p < .001$) for NA. The respective ΔR^2 for personality characteristics entered after age group were .03 ($p = .36$) for the prediction of variability of PA and .09 ($p = .10$) for the prediction of variability of NA. These coefficients represent the unique variance components accounted for by personality. Figure 4.7 shows the unique and shared variance components for age group and personality. The hierarchical regression analyses indicated that the unique variance components accounted for by age group over and above personality were much larger than those accounted for by personality over and above age group.

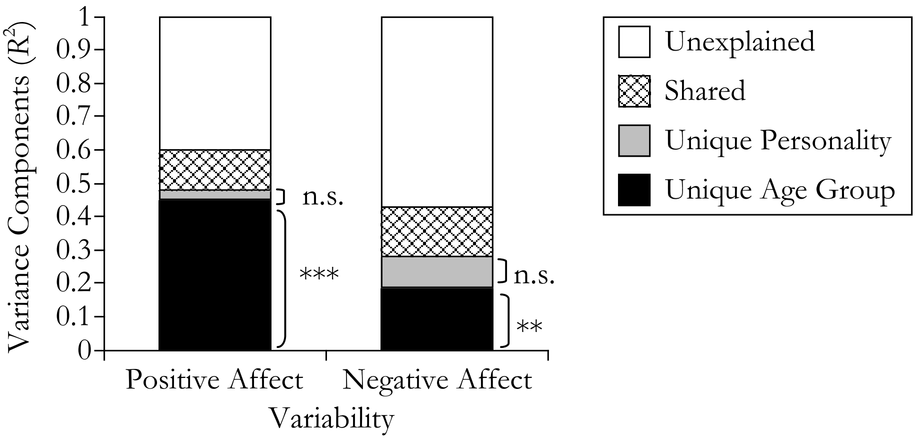

Figure 4.7. Proportions of Unique and Shared Variance Explained by Age Group and Personality in the Prediction of Variability (Fluctuation) in Positive and Negative Affect (*** $p < .001$, ** $p < .01$).

Follow-Up Analysis I: The Role of Age and Personality for Individual Differences in Fluctuations of Hedonic Balance

The hierarchical regression analyses were also conducted using variability in the hedonic balance score (after controlling for the trend in the data). This analysis indicated that the unique individual difference variance in fluctuations of hedonic tone accounted for by age group (entered after personality variables) was 39.0% ($p < .0001$), and the unique variance accounted for by personality (entered after age group) was 6.0% ($p = .11$). As such, the prominent role of age-related processes as opposed to personality factors in explaining differences between individuals in variability was replicated for an alternative indicator of daily mood and well-being.

Follow-Up Analyses II: Controlling for Background Characteristics and Mean Daily Affect

Control analyses were conducted in which additional background characteristics (gender, years of education) as well as mean levels of aggregated PA and NA and a measure of trait affect intensity (Larsen & Diener, 1987) were included into the models. As suggested in the literature (e.g., Newton & Rudestam, 1999), in order to control for the effect of the background variables, the control variables were entered as a block in the first step, followed by the two personality characteristics in the second step, age group entered in the third step, and the age group by personality interactions entered last.

The control variables indicated that background characteristics (gender, years of education) did not predict variability in either affect domain (all *ps* > .05). In addition, controlling for the background characteristics, for mean levels of affect as well as trait affect intensity, did not alter the direction of the associations between personality characteristics and particularly age with variability in PA and NA. In addition, age group still emerged as a significant additional predictor of between-person variance in within-person fluctuations in both affect domains, even though this effect was slightly reduced as compared to the models that did not include the additional control variables (PA: $\Delta R^2 = .25$ [$p < .001$] in the control model vs. $\Delta R^2 = .45$ in the initial model; NA: $\Delta R^2 = .10$ [$p < .01$] in the control model vs. $\Delta R^2 = .19$ in the initial model; see Table C16 in Appendix C for a detailed overview of the hierarchical regression findings).

In sum, age group did explain significant amounts of variance in daily fluctuations of PA and NA over and above personality characteristics. The unique variance components explained by age were reliably larger than the unique amounts of individual difference variance explained by personality factors over and above age group. These findings were robust after controlling for mean levels of affect, trait affect intensity, and background characteristics, even though particularly for the negative affect domain, controlling for mean level of NA resulted in a large reduction in variance explained uniquely by age group.

4.2.2 Associations Between Variability (Fluctuation) in Positive and Negative Affect and Trait-Like Psychological Well-Being

In an attempt to explore the functional or dysfunctional implications of day-to-day fluctuations in PA and in NA, the associations of variability in each affect domain with indicators of psychological adjustment and functioning were examined next. A note of caution is needed at this point: The current sample is rather small, particularly when one is interested in age-related differences in between-person correlates of variability. Therefore, the power to detect small effects was low. In addition, the reported between-person associations are based on cross-sectional data, thus precluding any inferences about causality. Nonetheless, these exploratory analyses were judged to be useful in a more complete understanding of the phenomenon of daily affect fluctuations in young and older adults.

The zero-order correlations between variability in daily PA and NA (i.e., controlled for linear time-related trends across the testing period) and psychological well-being and happiness are outlined in Table 4.10. Given the strong relationship between variability and age, these correlations are presented separately for the two age groups. Keeping in mind the small sample size, these analyses were exploratory in nature because true relationships may not have been discovered in our sample due to restrictions in power. Some interesting age-trends emerged as well, however.

Table 4.10
Bivariate Correlations for Young and Older Adults Between Intraindividual Variability (Fluctuation) in PA and NA With Trait Indicators of Psychological Well-Being and Happiness

	Variability in Positive Affect		Variability in Negative Affect	
Trait Indicators of Well-Being	Young Adults *r (p)*	Older Adults *r (p)*	Young Adults *r (p)*	Older Adults *r (p)*
Psychological Well-Being	.17 (.50)	.00 (.99)	–.57 (.01)**	–.69 (.00)***
Happiness	.01 (.98)	–.14 (.58)	–.60 (.01)**	–.65 (.00)***

Notes. Variability = *M*(ABS) Residuals.
Positive and negative affect = PANAS (Watson et al., 1988). Psychological Well-Being = Mean of Ryff Wellbeing Scales. Happiness = Mean of life satisfaction, pleasantness and unpleasantness (reverse scored).
** $p < .01$, *** $p < .001$

The most striking pattern of differences was observable between the two affect domains: Consistent with the hypothesis, for both age groups, greater variability in negative affect was reliably related to lower psychological well-being and to lower happiness (*r*s ranged between –.57 to –.69, at least $p < .01$). Coefficients were even slightly higher in older than in younger adults. On the other hand, associations between variability in PA and the trait-like indicators of psychological health did not reach statistical significance.

The small sample size of the current study makes it worthwhile, however, to examine individual cases at a descriptive level more closely to better understand the relationships between variability and psychological adjustment. Closer inspection of Tables C1 and C2 in Appendix C indicates single individuals in both age groups, who show extremely high or low amounts of variability in PA and NA with respect to their age-reference group. With respect to variability in NA, for example, IDs 11008 and 12022 among the young adults and IDs 21037, 22010, and 22039 all have relatively high levels of day-to-day fluctuation in NA, which were between 2–3 *SD*s above their respective age group means. The two young adults and two out of the three older adults were at or above the cut-off score for self-reported depressive symptoms. In addition, inspection of the session protocols indicated that participant 21037 continuously reported stress and exhaustion as well as sadness over the chronically severe medical condition of his wife for whom he had been caring for the past years. Participant 22010, an older woman, also reported relatively high mean levels of NA, including sadness, and the daily event protocols revealed that her brother died during the course of the nine-week daily assessment following severe illness. These single cases hence are consistent with the correlational findings, which suggested that across both age groups, *greater* levels of variability in NA were associated with *lower* levels of psychological adjustment. At the same time, inspection of patterns of variability in PA for these same individuals indicated that at least the younger woman (ID 12022) showed relatively little variability in her daily reports of PA as compared to her age group mean (ca. 2 *SDs* lower), whereas the two older adults with IDs 21037 and 22010 were slightly above their age group mean of 0.41 in daily fluctuations of PA.

Follow-Up Analysis: Association between Trait Well-Being and Variability in Hedonic Balance

The association between fluctuations in well-being states and trait-like psychological health was examined also for the hedonic balance index. Because the happiness construct was an aggregate of life satisfaction and trait-like hedonic balance, only the life satisfaction score was used as an indicator of happiness. For young adults, greater variability in hedonic balance was inversely related with psychological well-being ($r = -.20$, $p = .43$) as well as with life satisfaction ($r = -.20$, $p = .43$). For older adults, these inverse relationships were much stronger and in part significant (psychological well-being: $r = -.55$, $p < .05$; life satisfaction: $r = -.36$, $p = .13$). Thus, whereas for young adults, variability in positive activation was either unrelated or positively related to indicators of successful psychological functioning, variability in a dimension of pleasantness/happiness and unpleasantness/sadness was negatively related to overall psychological well-being. For older adults, the direction of the associative pattern was similar across both PA and hedonic tone.

4.2.3 Age-Related Differences in the Coupling Between Daily Affect and Daily Stress and Events

One of the reasons why young and older adults differ in their day-to-day variability in PA and NA may be found in age-related differences in individuals' daily lives, and more specifically, in the occurrence of positive and negative daily events. In our sample, however, we found no evidence for age-related or gender differences in the number of days on which participants reported positive or negative daily events (age: $F\ (1, 33) = 1.06$, $p = .31$, $\eta_p^2 = .031$, gender: $F\ (1, 33) = .01$, $p = .93$, $\eta_p^2 = .000$). The age × gender interaction was also not significant at the .05 level, but there was a trend for younger men to report slightly more days with any type of daily event in general, and more positive and/or negative occurrences than younger women in particular, and an opposite pattern within the older group ($F\ (1, 33) = 3.36$, $p = .076$, $\eta_p^2 = .092$).

Alternatively, age differences in the magnitude of day-to-day fluctuations in both affect domains may in part be driven by age-related differences in the *coupling* of daily affect with daily stress appraisals and event occurrence. The hypothesis was that daily PA and NA would be more strongly coupled with daily stress and event occurrence in younger than in older adults. In order to examine the coupling of daily affect with daily stress and event measures, multilevel modeling was employed using the program SAS Proc Mixed. Specifically, separate models were estimated for the prediction of day-to-day PA and NA, respectively. The baseline model for comparison was the linear change model for both day-to-day PA and NA. After determining the best-fitting within-person model, age group was added as a predictor of the affect intercept and, more importantly, of the day-level coupling between affect and stress appraisal as well as event variables. Tables C17, C18, C20, and C21 in Appendix C give an overview of the sequence of models fitted to the daily PA data and to the daily NA data, respectively, including information on the respective deviance statistics and model fitting results.

In the following paragraphs, the results of the models predicting day-to-day positive and negative affect will be outlined. Overall, the following equation represents the full model, in which daily PA and NA were predicted by an intercept and the three time-varying covariates of stress, positive events as well as negative events, after controlling for linear time-related trends: γ_{ij} (Daily Affect)= β_{0j} + β_{1j} (Session) + β_{2j} (Stress) + β_{3j} (Pos. Event) + β_{4j} (Neg. Event) + r_{ij} as the within-person model and $\beta_{0j} = \gamma_{00} + \gamma_{01}$ (Age Group) + u_{0j} as well as $\beta_{aj} = \gamma_{a0} + \gamma_{a1}$ (Age Group) + u_{0j} as the between-person models for the intercept and slopes, respectively.

Prediction of Day-to-Day Positive Affect by Daily Stress and Event Variables

Subsequently adding daily stress (χ^2 = 92, df = 4, p < .001), positive events (χ^2 = 27.2, df = 4, p < .001), and negative events (χ^2 = 61.2, df = 4, p < .001) as predictors of daily PA in addition to the linear session term led to a substantive reduction in deviance and thus a significantly better model fit for each successive model.

The left column in Table 4.11 displays the fixed effects results of the daily context model predicting daily PA (after controlling for linear time-related trends in the daily PA data) before adding age group to the model. In this model, the PA intercept, indicating the level of PA at the beginning of the nine-week period for individuals who were at their average level of perceived stress and experienced no positive and no negative event, was estimated to be 4.53, differing significantly from zero (p < .0001). In order to determine whether the model fit improved when adding a new predictor and in determining the unique variance associated with each daily predictor, a model including all three time-varying predictors was compared to three separate models that lacked either daily stress, daily positive events, or daily negative events, respectively.

The first line in the left column of Table 4.11 shows the fixed effect for the stress appraisal slope, indicating the average within-person association between daily PA and daily stress appraisal. For each unit change in stress appraisal, daily PA was lowered by 0.07 ($p < .01$), suggesting a small (albeit) significant relationship between the two variables. Inspection of the pseudo-R^2 statistic indicated that daily stress accounted for 7.7% of the within-person variance in daily PA. The model also estimated reliable between-person differences in the stress-PA relationship, as suggested by the significant random effect associated with the stress slope ($p < .01$; see Table C19 in the Appendix C for a detailed overview of the random effects results for this model).

The average within-person relationship between daily PA and positive event occurrence can be seen in the second line of the left column in Table 4.11. It was positive and significant ($p < .01$). On average, days with at least one positive event were characterized by a level of PA that was 0.20 higher than the participants' mean level of affect. The reduction in variance due to this additional predictor led to a pseudo-R^2 value of .026. Positive event occurrence thus explained an additional 2.6% of the variance in day-to-day reports of PA on average. This relationship appeared to be rather uniform across individuals, with only a marginally significant random effect associated with the positive event slope ($p = .07$). Interestingly, the addition of the positive event predictor did not alter the stress-PA slope ($\gamma_{20} = -0.085$ vs. $\gamma_{20} = -0.083$).

Table 4.11
Results from Multilevel Modeling Analyses on Within-Person Coupling and Age-Related Differences in Coupling of Daily Positive Affect with Daily Stress and Events

Fixed Effects for Coupling Analyses		Within-Person Coupling Model	Age Differences in Coupling Model
Daily Stress Slope, β_2	γ_{20}	–0.07**	–0.08**
Age Group × Stress	γ_{21}		–0.05
Daily Positive Event Slope, β_3	γ_{30}	0.20**	0.28***
Age Group × Positive Event	γ_{31}		–0.19#
Daily Negative Event Slope, β_4	γ_{40}	–0.24**	–0.45***
Age Group × Negative Event	γ_{41}		0.43***

Notes. Age group was coded as young = 0, old = 1. Daily stress was group-mean centered (response scale ranged from 1 to 7). Daily events were coded as No event = 0 and Event = 1.
In both models, the linear trend in the daily PA data was accounted for. In the model estimating age differences in coupling, age group differences in the intercept were also controlled for. As age group did not account for differences in the linear trend, age group was not included as a covariate of the linear slope of session in this model to maximize parsimony.
# $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Days with negative events as opposed to those without were on average characterized by lower PA (γ_{40} = –0.24, $p < .01$, see the third line in the left column of Table 4.11), with negative events explaining an additional 4.8% of the residual within-person variance in day-to-day PA. The associated random effect indicated that there was significant individual difference variance in the negative event–PA association. As can be seen from the significant covariance parameter (σ_{04} = 0.15, $p < .05$), greater mean levels of PA were associated with a less negative association between negative events and PA. In other words, individuals with overall higher levels of PA showed a smaller degree of coupling between their PA fluctuations and the occurrence of negative events.

Age Group Differences in Coupling of Daily Positive Affect with Stress and Events

In the first two steps of the model fitting process in determining age-related differences in the day-to-day coupling of daily affect with daily stress appraisals and events, previously found age group differences in mean levels of affect as well as in linear time-related trends were controlled for. Table C18 in Appendix C outlines the sequence of models estimated to examine age-group differences in the coupling of PA with daily context variables.

Adding age group as a predictor of the stress appraisal–PA coupling did not improve model fit (χ^2 = 0.8, df = 1, p = .37), and neither yielded the single effect test a significant coefficient. On the other hand, age group emerged as a marginally significant predictor of individual differences in the positive event–PA coupling (χ^2 = 3.2, df = 1, p = .07) and as a significant predictor of individual differences in the negative event–PA coupling (χ^2 = 12.2, df = 1, $p < .001$). The right column of Table 4.11 displays the estimated coefficients from this final age group difference model.

For young adults, on days with as opposed to without a positive event, PA was 0.28 higher, but this positive association was marginally significantly lower for older adults (γ_{31} = –0.19, p = .06). Likewise, younger adults' PA was almost half a scale point lower on days with a negative event than on days without such a stressor (γ_{40} = –0.45, $p < .001$), but this negative association was significantly smaller for older adults as indicated by a positive interaction coefficient (γ_{41} = 0.43, $p < .001$). The significant and marginally significant interactions between age group and the time-varying context predictors of daily PA are illustrated in Figure 4.8: The dotted line, representing the coupling between events and daily PA for older adults, is almost flat, indicating the near-absence of any relationship within the older group. In contrast, the black line representing young adults are steeper and show that the presence versus the absence of a positive event is related to higher daily PA and that the presence versus the absence of a negative event is related to lower daily PA.

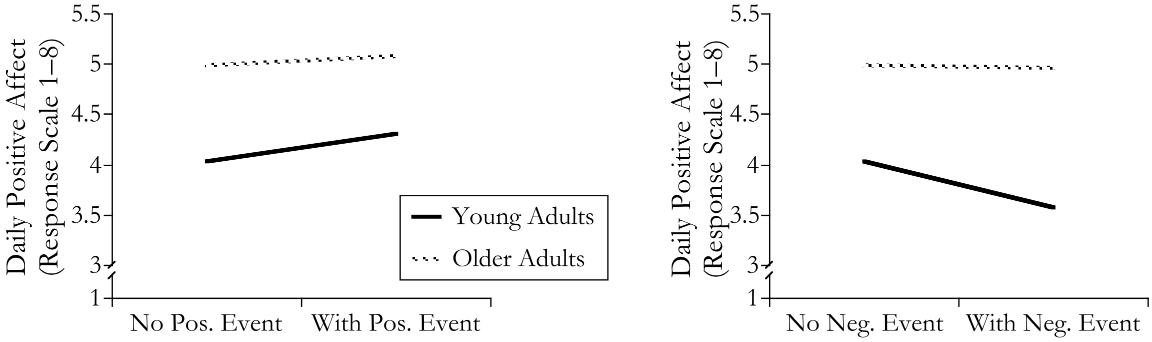

Figure 4.8. The Moderating Effect of Age Group on the Within-Person Coupling of Daily Positive and Negative Events with Daily Positive Affect

(The age difference in within-person coupling between daily affect and events was marginally significant for positive affect and positive events [p = .06] and reached statistical significance for the relationship between daily positive affect and negative events [p < .001]. Estimates were derived from multilevel modeling analyses.)

Prediction of Day-to-Day Negative Affect by Daily Stress and Event Variables

A step-wise procedure of entering daily stress, daily positive and negative events separately to a model that was controlled for linear time-related trends in the day-to-day negative affect data (see Appendix C, Table C20 for overview of the model-testing procedure and Table C22 for an overview of the random effects results) indicated that of the time-varying daily covariates, only stress (χ^2 = 115.4, df = 4, p < .001) and negative events (χ^2 = 201.6, df = 4, p < .001) emerged as significant predictors of fluctuations in negative affect, whereas the addition of positive events as a predictor did not result in a significant increase in model fit (χ^2 = 4.1, df = 4, p = .39). Furthermore, neither the fixed nor the random effect was estimated to be significant in the single coefficient tests. Because this predictor was of conceptual interest, however, it was retained in the final model and its coefficient is displayed in Table 4.12 (left column).

The negative affect intercept in the final coupling model was estimated to be 1.43, being significantly different from zero (p < .001). This intercept represents the level of NA at the beginning of the daily assessment period (because session was centered at the first occasion) for individuals who reported their individual average level of stressfulness on days with no negative or positive event.

Table 4.12
Results from Multilevel Modeling Analyses on Within-Person Coupling and Age-Related Differences in Coupling of Daily Negative Affect with Daily Stress and Events

Fixed Effects for Coupling Analyses		Within-Person Coupling Model	Age Differences in Coupling Model
Daily Stress Slope, β_2	γ_{20}	0.06***	0.07***
Age Group × Stress	γ_{21}		–0.04
Daily Positive Event Slope, β_3	γ_{30}	–0.04	–0.07*
Age Group × Positive Event	γ_{31}		$0.08^{\#}$
Daily Negative Event Slope, β_4	γ_{40}	0.29***	0.38***
Age Group × Negative Event	γ_{41}		–0.18

Notes. Age group was coded as young = 0, old = 1. Daily stress was group-mean centered (response scale ranged from 1 to 7). Daily events were coded as No event = 0 and Event = 1.
In both models shown, the linear trend in the daily NA data was accounted for. In the model estimating age differences in coupling, age group differences in the linear slope but not in the intercept were also controlled, because age differences in the intercept were not significant.
$^{\#}p < .10$, $^{*}p < .05$, $^{***}p < .001$

Specifically, days appraised to be more stressful than usual were also the days with greater negative affect than usual ($\gamma_{20} = 0.06$, $p < .001$). In addition, days with at least one reported negative event were also characterized by higher levels of NA ($\gamma_{40} = 0.29$, $p < .001$). Inspection of the random effects for the stress-slope and the negative events-slope suggested that apart from these average level associations, there were reliable differences between individuals in the pattern of coupling. In addition, the significant covariance between the NA intercept and the negative event slope ($\sigma_{04} = 0.02$, $p < .05$) suggested that for individuals with greater mean levels of NA, the association between daily NA and negative events was slightly stronger. Keeping the floor effects for fluctuation in day-to-day negative affect especially for some older adults in mind, these findings should be regarded with caution. With regard to estimates of variance explained by each predictor, the residual within-person variance in daily NA in a model including all three time-varying predictors was compared to three separate models that lacked either one of the three time-varying covariates daily stress, daily positive events, or daily negative events, respectively. Inspection of the reduction in within-person variance in the model including the respective predictor to the one without suggested that daily stress accounted for 8.0% of the residual within-person variance in daily NA, negative events accounted for 14.5%, and positive events accounted for no variance.

Age Group Differences in the Coupling of Daily Negative Affect with Stress and Events

The results of fitting a sequence of age difference models to the coupling model of daily negative affect and daily context variables are outlined in the appendix (Table C21). Even though the positive event-negative affect coupling was not related to a better model fit, age-related differences in this model were of conceptual interest and therefore, age group differences were tested also in this within-person coupling. With respect to the coupling with the other time-varying covariates, the model fit was not significantly improved after the inclusion of age group as predictor of individual differences in the NA–stress appraisal coupling (χ^2 = 2.2, df = 1, p = .14), nor in the NA–negative event coupling (χ^2 = 1.5, df = 1, p = .22). The fixed effect results for these two within-person relationships are displayed in Table 4.12 for illustration.

There was a trend, however, for a moderating effect of age group in the daily NA-positive event coupling: Adding age group marginally improved model fit (χ^2 = 3.0, df = 1, p = .08). Inspection of the single coefficients (see Table 4.12, right column) indicated that for young adults, there was a trend for experiencing slightly less negative affect on days with a positive event (the coefficient of γ_{30} = –0.07 shows that on days with a positive event as compared to without, negative affect was lowered by not even 1/10 of a scale point). The marginally significant interaction coefficient for the moderating effect of age group on this coupling, γ_{31} = 0.08, can be interpreted such that for older adults as a group, there was no coupling between daily NA and the occurrence of daily positive events [(–0.07) + 0.08 = 0.01]. However, because the improvement in model fit was only marginally significant, and random effects had been estimated to be zero in the model without age group as a moderator, this interaction effect should not be over-interpreted. This caution is also necessary when considering the floor effects in variability of NA that were evident for many older adults in the sample.

Comparing the residual between-person variance associated with each of the coupling coefficients between a model that included age group as a moderator with a model that did not include age group as a moderator, resulted in pseudo-R^2 statistics that are difficult to interpret: According to this statistic, age group accounted for 8.0% of the variance in the NA–stress coupling, even though model fit was not improved and the fixed effects were also not significant. With respect to the NA–negative event coupling and NA–positive event association, variance components could not be computed, because after addition of the between-person variable age group, the residual variance was actually increased (see Singer & Willett, 2003, for cautioning about over-interpretation of pseudo-R^2 statistics in multilevel modeling).

Follow-Up Analysis: Age-Related Differences in Coupling Between Daily Hedonic Balance, Stress, and Events

Using the daily context variables stress, positive events, and negative events as predictors of fluctuations in day-to-day hedonic balance, the direction of the within-person relationships and the age-related differences replicated the pattern found for positive affect: Hedonic tone was more positive on days with lower stress, with a positive, and without a negative event. It is interesting to note, however, that in terms of pseudo-R^2 statistics, the effect of experiencing at least one negative event on a given day had a much stronger effect on daily hedonic balance (pseudo-R^2 = .19) than on daily positive affect (pseudo-R^2 = .05). Variance components for stress and positive events were nearly identical for both mood indicators (see Table C23 in Appendix C for a complete overview of the multilevel results for hedonic balance).

4.2.4 *Summary of Findings on Trait-Like and State-Like Correlates of Intraindividual Variability in Positive and Negative Affect*

In support of the hypothesis, after controlling for personality characteristics such as extraversion and neuroticism, age group accounted for significant amounts of individual difference variance in variability in PA and in variability in NA. Of the personality traits, only neuroticism emerged as a significant predictor of individual differences in affect fluctuation. However, there were marginally significant interactions between personality variables and age group, which, if replicated in a larger sample, may indicate interesting dynamics between personality traits and age-related changes in explaining individual differences in daily mood variability.

With regard to the relationship between variability in affect and psychological well-being and happiness, exploratory correlational analyses indicated that the strongest relationships between fluctuation in affect and psychological well-being emerged for variability in negative affect. More specifically, greater variability in NA was associated with lower levels of psychological adjustment and happiness. Conducting the analyses separately for the young and for the older group showed associations between variability in PA and trait well-being that did not reach statistical significance in the present sample. These associations may indicate interesting differences in the functional meaning of variability in PA between young and older adults if replicated in a larger sample. These results were consistent with previous research and with the hypothesis that in general, variability in NA is associated with lower positive adjustment and with dysfunctional outcomes, whereas variability in PA may be associated with either higher or lower levels of adjustment in different subgroups.

Multilevel analyses of the day-to-day covariation of PA and NA with stress appraisals as well as with positive and negative events indicated that for the average person, daily PA covaried with all three daily contextual variables. On days of higher stress and days with a negative event, individuals tended to experience lower positive affect, whereas days with a positive event co-occurred with reports of higher PA. To the contrary, NA was on average higher on stressful days and on days with a negative event, but on average did not reliably covary with positive events. There were significant individual differences in all of these within-person couplings, indicating that some individuals reliably departed from the average association pattern[36]. The age groups did not significantly differ in the associations between stressfulness and affect. However, the negative association between daily PA and negative events was significantly smaller for older as opposed to younger adults (age group explained 59.0% of the individual difference variance in the PA–negative event association), and there was a trend for a smaller positive association between daily PA and positive events in older as opposed to younger adults as well (age group explained 33.0% of the individual difference variance in the PA–positive event coupling). Hence, the hypothesis of a weaker day-to-day coupling between fluctuations in affect with fluctuations in stress and events was supported with respect to PA. In the domain of NA, age group did not emerge as a reliable predictor of the individual differences in coupling.

4.3 The Role of Age in Within-Person Coupling of Day-to-Day Fluctuations in Affect and Reaction Time Performance

The third and last set of questions consists of three main parts: (a) Are daily PA and NA associated with daily cognitive (i.e., reaction time) performance at the intraindividual level (b) Are there reliable interindividual differences in patterns of intraindividual coupling, which can be explained by age? (c) Do average daily performance or personality factors that are related to individual differences in emotional experience (i.e., extraversion, neuroticism) moderate the coupling? These analyses were initially conducted on a vigilance task, and subsequently replicated using a cognitively more demanding spatial working memory task.

[36] The only exception was the NA-Positive Event Coupling, for which the model was unable to estimate any variance. Multilevel modeling analyses with a small number of Level 2-units, in this case persons, often have difficulty in estimating the random effects (Singer & Willett, 2003).

4.3.1 *The Day-to-Day Coupling of Positive and Negative Affect with Reaction Time Performance in Two Cognitive Tasks*

Before examining whether daily PA and daily NA were associated with daily reaction time (RT) performance at the level of individuals, it was important to disentangle fluctuations around a learning curve from the learning across the nine-week period itself. Therefore, a set of individual growth models was tested to investigate the extent of learning in the vigilance data. Model fitting of the N-Back data was done at the level of the Dynamics project because these data were only used for replication in the present dissertation. Inspection of the individual reaction time trajectories revealed effects of learning within and between days, and exponential curves were fitted to these individual time-series on a trial-to-trial basis (see Heathcote, Bown, & Mewhort, 2000).

In a second step, the zero-order correlations between PA and RT as well as between NA and RT were computed separately for each individual to get a descriptive impression of the observable associative patterns. In a third step, multilevel modeling was used to jointly examine within-person relationships as well as individual differences in coupling. For these analyses, the within-person model for vigilance is represented as γ_{ij} (Daily Vigilance-RT) = β_{0j} + β_{1j} (Session) + β_{2j} (PA/NA) + r_{ij}, and the within-person model for working memory is represented as γ_{ij} (Daily Working Memory-RT) = β_{0j} + β_{1j} (PA/NA) + r_{ij}. In the latter model, the working memory data consisted of residuals from fitting exponential learning curves to the data. At the between-person level, the main interest was in modeling the Affect-Slopes, which represent the average within-person coupling between daily affect and daily performance, as a function of several individual difference variables (β_{aj} = γ_{a0} + γ_{a1} (Individual Difference Variable) + u_{0j}). However, individual differences were also controlled for at the level of the intercept (β_{0j} = γ_{00} + γ_{01} (Individual Difference Variable) + u_{0j}).

Age-Related Differences in Cognitive Performance Across 45 Days

Figure 4.9 shows the individual trajectories of mean RTs for correct responses in the vigilance task across the nine-week assessment period, separately for each age group. Inspection of these individual descriptive trajectories suggests that one younger adult's learning trajectory looked very different from the rest: This participant is the only one who became slower in his mean performance across nine weeks. He was therefore excluded from the following analyses. In addition, only 18 older adults were included in the final sample for the working memory data (one older person was unable to learn the task across the nine-week period and had to be deleted from the sample). Therefore, the coupling analyses between affect and cognitive performance were conducted using N = 35 individuals (17 young, 18 older adults) to make findings comparable between the oddball and the working memory task.

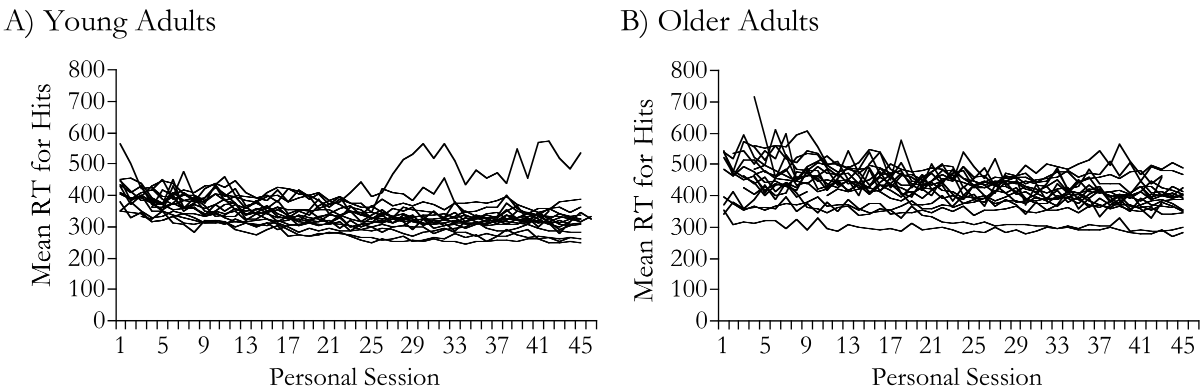

Figure 4.9. Trajectories of Mean Reaction Times (RT) for Hits in Vigilance Task (Raw Data)

Age-related differences in average reaction time performance were analyzed separately for the two cognitive tasks, using multilevel modeling analyses: In vigilance, young adults performed faster (336.53 ms) than older adults (420.73 ms, p < .0001). The age group effect was also significant in the working memory data, with young adults (375.94 ms) outperforming older adults (814.36 ms, p < .0001). In comparison to the vigilance task, both young and older adults' reaction times were increased in the working memory task, and this discrepancy was much more pronounced in older adults. These differences suggest that task demands were indeed much higher in the working memory condition than the vigilance task. In addition to aggregated levels, age group differences in day-to-day variability in reaction time performance were also examined in both tasks (after taking out learning-related change across nine weeks): In both tasks, older adults showed reliably greater fluctuation than young adults in their reaction time performance (Vigilance: F (1, 33) = 15.55, p < .0001, η_p^2 = .32; Working Memory: F (1, 33) = 12.59, p < .001, η_p^2 = .28).

The vigilance task had been selected because no or little learning was expected to occur across repeated practice. The model fitting procedure regarding the vigilance RT data suggested that a linear change model described the data significantly better than a baseline model assuming no change over sessions (χ^2 = 1121.2, df = 3, p < .0001; see Table C24 in Appendix for detailed modeling results). In addition, a quadratic change model did improve model fit in comparison to a linear model, but the quadratic session term only accounted for 12.0% of the variance in daily vigilance RT as compared to 56.0% of the variance accounted for by a linear change model. Changes in performance were small. The model estimated change from one day to the next to be 1.72 ms, and 77.31 ms across the entire 45-day period. This is relatively little change, as expected when selecting the task. In order to not overfit the data and to allow for variance left to examine coupling with the daily affect data and keep the model's parsimony in order, learning following a linear shape was controlled for in the subsequent coupling analyses. A follow-up analysis on age differences in the linear slope in addition to age differences in the intercept yielded an insignificant model fit improvement for the addition of age group as moderator for the linear slope (χ^2 = 0, *df* = 1, *p* = 1). Therefore, the coupling models were only controlled for age differences in the intercept.

Coupling of Daily Fluctuation in PA and NA with Vigilance Performance

Figure 4.10 shows the zero-order associations between daily affect and daily vigilance reaction time performance for each individual. Specifically, each dot represents the relationship between affect and performance after controlling for learning in the vigilance task. This graph is meant to illustrate the individual differences in both magnitude and direction of the relationship between daily affect and vigilance performance.[37]

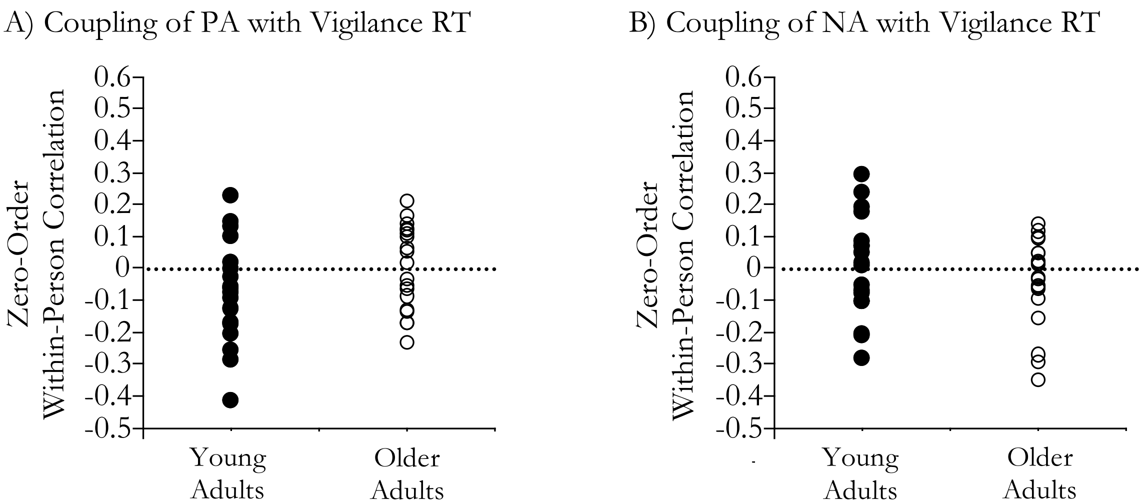

Figure 4.10. Individual Differences in Within-Person Coupling Between Daily Affect and Daily Vigilance Reaction Time Performance

(Coefficients shown represent OLS correlation coefficients based on detrended data. Each dot represents the correlation between affect and reaction time for a single individual.)

[37] It should be noted that the correlation coefficients obtained from ordinary least squares (OLS) analyses can be used to illustrate the magnitude of a given effect, but tests of significance have to be performed using multilevel modeling analyses which account more properly for the differences in reliability in two or more variables as well as for the nested and auto-correlated data structure in micro-longitudinal designs (Nezlek, 2001).

Table 4.13 summarizes those fixed and random effects of the multilevel modeling analyses that are of central interest to the research question. In order to formally test the within-person relationship between daily affect and reaction time (RT) performance in the vigilance task, three nested multilevel models each for daily PA and daily NA, respectively, were fitted to the data. In a first step, daily PA and daily NA were each added to a baseline model, in which the linear trend in vigilance RT was controlled.

Table 4.13
Results of Multilevel Modeling Analyses Estimating the Coupling of Daily Affect with Daily Reaction Time Performance in Vigilance

	Within-Person Coupling Model	
	Coupling with Daily Positive Affect	Coupling with Daily Negative Affect
Fixed Effects		
Daily Affect	–0.54	2.25
Random Effects (Variance Components)		
Within-Person	553.29***	558.30***
Between-Person		
In daily affect slope	45.28#	73.45#
Variance Explained		
Pseudo-R^2_ε	.020	.011
Goodness-of-fit		
Deviance (–2*LL*)[a]	14308.3	14309.6
χ^2 *(df)*: Daily affect as random effect	7.4 (2), $p < .05$	6.9 (4), $p = .14$

Notes. Positive and negative affect = PANAS (Watson et al., 1988; Response scale ranged from 1 to 8).
The covariance between the positive affect slope with the linear slope and the intercept was fixed to be zero to ensure greater parsimony and model conversion. In the model for daily negative affect, allowing for these covariance parameters to be freely estimated improved the model's ability for conversion.
Only the coefficients relevant for the central research question are shown in this table.
[a] Comparison of model fit and variance explained was determined in relation to the simple linear change model. In the model shown, the linear trend was controlled.
# $p < .10$, *** $p < .001$

The left column of Table 4.13 outlines the results for the relationship between daily PA and daily vigilance performance. The comparison of the deviance statistics indicated that the model fit was not improved when daily PA was added as a fixed effect only ($\chi^2 = 0.8$, $df = 1$, $p = .37$). However, model fit was significantly improved as compared to the baseline model when the PA-slope, representing the within-person relationship between daily PA and daily vigilance performance, was allowed to differ between individuals ($\chi^2 = 7.4$, $df = 2$[38], $p < .05$). The coefficient for fixed effect, representing the average coupling pattern, was estimated to be $\gamma_{20} = -0.54$ ($p = .76$). In other words, on average, for each unit change in positive affect (on the 8-point response scale), RT in vigilance decreased by half a millisecond. The pseudo-R^2 coefficient derived from the reduction in within-person residual variance due to the addition of the daily PA predictor indicated that daily PA, on average, explained 2.0% of the within-person variance in daily vigilance performance. The single coefficient test for the associated random component yielded a marginally significant effect, corroborating the model fitting results ($p = .053$). In conclusion, daily positive affect and reaction time fluctuations in this vigilance task did not covary within the average person. Fluctuations in the two domains were, nonetheless, related on a day-to-day basis for some individuals. Panel A of Figure 4.10 suggests that such between-person differences can both be found in the magnitude and the direction of the coupling.

The right column of Table 4.13 shows the results for the relationship between daily NA and daily vigilance performance. The addition of daily NA to the model did not lead to a significant improvement in model fit, not even when allowing the within-person coupling to differ between individuals ($\chi^2 = 6.9$, $df = 4$, $p = .14$). The single coefficient test for the random effect was only marginally significant ($p = .098$). One reason for this may have been that some individuals, particularly among the older group, did not show sufficient variability in day-to-day negative affect. According to the pseudo-R^2 statistic, daily negative affect, on average, explained 1.1% of the variance in daily vigilance RT. In sum, findings were similar to those for the coupling between positive affect and performance: Daily NA and daily vigilance performance in terms of reaction times are unrelated in the average individual, with a tendency for differences in coupling patterns between persons. The model's ability to reliably estimate these individual differences in these within-person relationships was restricted, however.

Coupling of Daily Fluctuations in PA and NA with Working Memory Performance

The coupling analyses were repeated with an alternative cognitive task to serve two main purposes: The first purpose was to see whether the findings obtained with the vigilance task could be replicated using a different measure of cognitive performance. The second albeit related purpose was to examine whether stronger evidence for coupling could be found using a cognitive task that put higher processing demands on individuals' resources, thus challenging the allocation

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[38] In order to increase the model's parsimony and to ensure conversion, the PA-slope was estimated as having a random effect, but covariation with the intercept and the linear slope was set to be zero. Therefore, for this model comparison, only two instead of four degrees of freedom (i.e., fixed effect, random effect, and covariance with intercept, covariance with linear slope) were used.

between regulatory attentional resources between the domains of affect and cognition. Figure 4.11 displays the coupling coefficients (after controlling for time-related trends in the data) for each single individual.

A series of multilevel models were conducted (see Table 4.14 for an overview of the central coefficients). In a first step, daily PA and daily NA were each added to a baseline model, in which the exponential residuals of working memory (WM) RT represented the dependent variable, and no additional time-varying predictor was entered to the model. The left column of Table 4.14 depicts the findings for daily PA. Comparison of deviance statistics indicated that the model fit was not improved when daily PA was added as a fixed effect only ($\chi^2 = 0$, $df = 1$, $p = 1$). However, model fit was significantly improved when the relationship between daily PA and daily working memory performance was allowed to vary between individuals ($\chi^2 = 25.0$, $df = 2$[39], $p < .0001$).

The fixed coefficient for the coupling was estimated to be $\gamma_{20} = 0.86$, indicating that on average for each unit change in positive affect (on the 8-point response scale), working memory reaction time increased not even by 1.0 ms ($p = .86$). The reduction in within-person residual variance due to the addition of the daily PA predictor indicated that daily PA, on average, explained 3.9% of the within-person variance in daily working memory performance. The single coefficient test for the associated random component yielded a significant effect, corroborating the model fitting results ($p < .01$). In sum, daily positive affect and reaction time fluctuations in this spatial working memory task did not covary for the average person. For some individuals, however, the two domains were coupled from one day to the next, as indicated in Figure 4.11. The overall picture looks very similar as the one depicted for the affect-vigilance relationships shown in Figure 4.10. Each dot represents the within-person association between daily affect and daily working memory performance for a single individual.

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[39] Because the dependent variable consisted of residuals, the covariance between the daily affect predictors and the intercept was assumed to be zero and modeled as such to increase the model's parsimony. Therefore, for this model comparison, only two instead of three degrees of freedom (i.e., fixed effect, random effect, and covariance with intercept) were used.

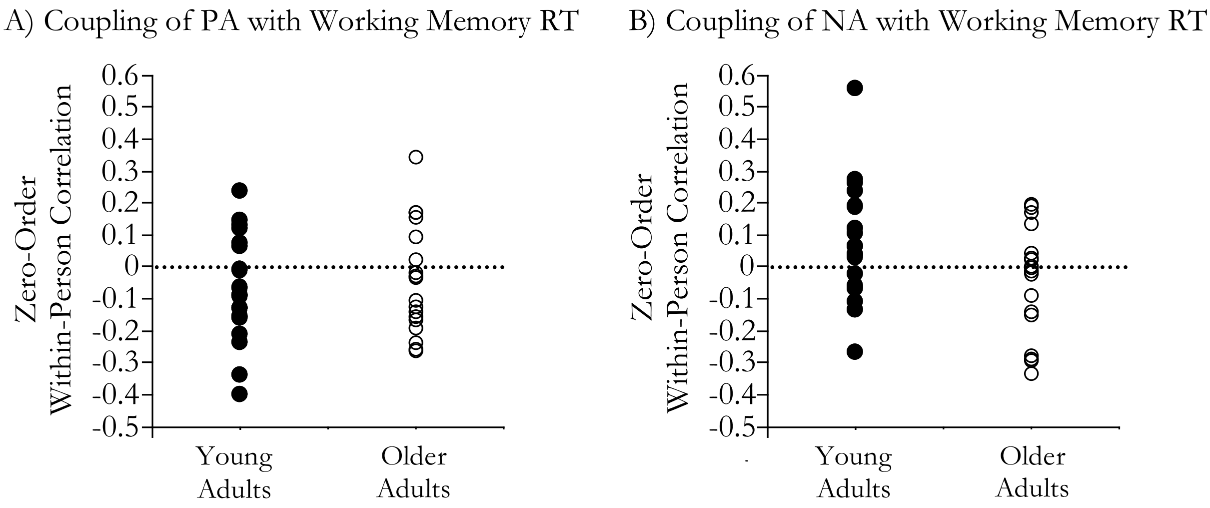

Figure 4.11. Individual Differences in Within-Person Associations Between Daily Affect and Daily Working Memory Reaction Time Performance

(Coefficients shown represent OLS correlation coefficients based on detrended data. Each dot represents the correlation between affect and reaction time for a single individual.)

The right column of Table 4.14 outlines the central results for the coupling of daily NA and daily working memory performance. Adding daily NA as a fixed effect predictor of daily working memory performance did also not improve model fit ($\chi^2 = 1.1$, $df = 1$, $p = .29$), but again the less restrictive model that allowed the relationship between fluctuations in NA and WM-RT to be different across individuals led to a marginally significant better fit to the data ($\chi^2 = 5.7$, $df = 2$, $p = .06$). The fixed effect for the NA-slope was estimated to be $\gamma_{20} = 4.92$ ($p = .43$), which indicates that for the average person, one unit change in negative affect on the 8-point response scale was related to a reaction time that was 5 ms larger than on average.

The reduction in within-person residual variance due to the addition of the daily NA predictor indicated that daily NA, on average, explained only 1.2% of the within-person variance in daily working memory performance. It is likely that given the presence of floor effects in variability in negative affect for some individuals, estimation of the daily affect coupling models was difficult, particularly with respect to the estimation of random effects given the relatively small sample size of 35 individuals. In conclusion, the within-person coupling models suggested that even though the average association between daily affect and working memory performance fluctuations is close to zero, there are reliable between-person differences in within-person pattern (see Figure 4.11). In the next step, these differences were thought to explore primarily with regard to age group differences.

Table 4.14
Results of Multilevel Modeling Analyses Estimating the Coupling of Daily Affect with Daily Reaction Time Performance in Working Memory

	Within-Person Coupling Model	
	Coupling with Daily Positive Affect	Coupling with Daily Negative Affect
Fixed Effects		
Daily Affect	0.86	4.92
Random Effects (Variance Components)		
Within-Person	3696.51***	3802.96***
Between-Person		
In daily affect slope	531.46**	352.10[#]
Variance Explained		
Pseudo-R^2_ε	.039	.012
Goodness-of-fit		
Deviance (–2*LL*)[a]	17247.1	17266.4
χ^2 (*df*): Daily affect as random effect	25.0 (2), $p < .0001$	5.7 (2), $p = .06$

Notes. Positive and negative affect = PANAS (Watson et al., 1988; Response scale ranged from 1 to 8).
The covariance between the positive and negative affect slopes with the intercept were fixed to be zero to ensure greater parsimony and model conversion.
Only the coefficients relevant for the central research question are shown in this table.
[a] Comparison of model fit and variance explained was determined in relation to the simple linear change model. In the model shown, the linear trend was controlled.
[#] $p < .10$, ** $p < .01$

Follow-Up Analysis: Coupling of Daily Hedonic Balance and Cognitive Performance Fluctuations

The coupling analyses were repeated using the daily hedonic balance index instead of positive and negative affect scores. In sum, after controlling for learning in the vigilance data, there was a significant improvement in model fit when daily hedonic balance was added as a *random* effect predictor of reaction time fluctuations to the model (χ^2 = 11.6, *df* = 4, $p < .05$). The fixed effect suggested that for each unit change in hedonic balance (ranging from –7 to +7, with zero indicating neutral hedonic tone), vigilance performance was faster by slightly less than 1 ms on average (γ_{20} = –0.89, p = .25). For working memory, improvement in model fit was even greater, both in comparison of the baseline learning model with a fixed hedonic balance effect model and in comparison of the fixed with a random effects model (χ^2 = 23.8, *df* = 1, $p < .0001$). The fixed effect indicated that for each unit change in hedonic balance, reaction time performance in working memory was about 3.0 ms faster (γ_{10} = –3.20, p = .32). In conclusion, these findings replicate those found for the PA and NA data (see Appendix C, Table C25, for an overview of these results).

4.3.2 Exploring the Role of Age and Other Individual Difference Variables in the Day-to-Day Coupling of Affect and Reaction Time Performance

The within-person coupling models indicated that there were reliable individual differences in the within-person associations between daily affect and daily cognition. In order to test the hypothesis that coupling should be strongest when the allocation of resources between the domains of emotion and cognition is under great competition, a first between-person factor added to the within-person models was age. In a second step, individual differences in mean cognitive performance were entered. Lastly, and on a more exploratory fashion, personality traits were entered as moderators of the within-person coupling pattern. Due to the small sample size in the current study, which limits the ability to estimate variance at the between-person level, the between-person variables were entered in separate models each and model fit was determined in each case with respect to the simple within-person coupling model.

Examining Individual Differences in Coupling of Daily Affect and Vigilance

Table 4.15 gives an overview of the central fixed effect results for the separate analyses on individual differences in the affect-vigilance coupling, together with information on model fit and variance explained (for those models, in which estimation of these was possible; see Singer & Willett, 2003). These analyses revealed that contrary to predictions, there were no reliable age group differences in the coupling of daily affect and vigilance performance. Furthermore, neither individual differences in mean reaction times in vigilance nor in neuroticism emerged as reliable interindividual difference factors regarding the within-person coupling.

Table 4.15

Fixed Effect Results of Multilevel Modeling Analyses Estimating Individual Differences in the Coupling of Daily Affect with Daily Reaction Time Performance in Vigilance

	Individual Differences in Coupling Model	
	Coupling with Daily Positive Affect	Coupling with Daily Negative Affect
Central Individual Difference Covariate of Within-Person Coupling		
Fixed Effects		
Daily Affect	–0.47	3.29
Daily Affect × Age Group	–0.25	–2.94
Model Fit and Variance Explained		
χ^2 (*df*)	0.0 (1), $p = 1$	0.3 (1), $p = .58$
Pseudo-$R^2_{Coupling}$ (by Age Group)	—[a]	—[a]
Additional Individual Difference Covariates of Within-Person Coupling		
Fixed Effects		
Daily Affect	–0.08	2.30
Daily Affect × Mean Daily RT	0.03	0.19
Model Fit and Variance Explained		
χ^2 (*df*)	0.8 (1), $p = .37$	0.0 (1), $p = 1$
Pseudo-$R^2_{Coupling}$ (by Mean RT)	—[a]	—[a]
Fixed Effects		
Daily Affect	–0.54	2.27
Daily Affect × Extraversion	–7.30*	4.07
Model Fit and Variance Explained		
χ^2 (*df*)	5.2 (1), $p < .05$	0.6 (1), $p = .44$
Pseudo-$R^2_{Coupling}$ (by Extraversion)	.48	—[a]
Fixed Effects		
Daily Affect	–0.92	1.68
Daily Affect × Neuroticism	3.88	3.49
Model Fit and Variance Explained		
χ^2 (*df*)	1.1 (1), $p = .29$	0.5 (1), $p = .48$
Pseudo-$R^2_{Coupling}$ (by Neuroticism)	.03	—[a]

Notes. Positive and negative affect = PANAS (Watson et al., 1988; Response scale ranged from 1 to 8).

Age group was coded as young = 0 and older = 1. All other between-person predictors were grand-mean centered.

Comparison of model fit and variance explained was determined in relation to the simple linear change model, that was controlled for a moderating effect of the between-person variable on the intercept only to examine whether its moderating effect on the coupling led to an additional model fit improvement. In the model shown, the linear trend was controlled.

Only the coefficients relevant for the central research question are shown in this table.

[a] No reduction in residual variance.

* $p < .05$

In contrast, the analysis yielded a significant moderating effect of extraversion for the intraindividual coupling between PA and vigilance latency (χ^2 = 5.2, *df* = 1, *p* < .05). The fixed effects suggested that whereas for individuals low in self-reported extraversion (E), positive affect and reaction time in vigilance were not coupled (γ = –0.54), there was a significant negative relationship between PA and performance for individuals high in extraversion (γ = –7.30). In other words, high-E individuals were about 7 ms faster in their reactions in the vigilance task on days on which they reported experiencing positive affect as one scale point higher than their own average (on an 8-point response scale).

Examining Individual Differences in Coupling of Daily Affect and Working Memory

The central results of the separate individual difference multilevel models for the affect-working memory coupling are provided in Table 4.16. Similar to the findings for the vigilance task, adding age group as a person-level predictor of the coupling did not improve model fit regarding either affect domain. Individual differences in the within-person relationships between daily PA (but not NA) and reaction time (RT) in the spatial working memory task could be explained by mean levels of working memory performance (χ^2 = 4.6, *df* = 1, *p* < .05). The fixed effects suggested that the coupling was slightly higher for individuals with larger reaction times (i.e., worse performance) than for higher performing individuals: For the former group, a one-unit change in PA was associated to an increase in RTs by about 2.09 ms It should be noted, however, that this effect was mainly driven by one older lady, whose performance in the working memory task was much lower than that of the remaining sample (she was identified as the only outlier in the data, see Method chapter), and the coupling of PA and RT was very high for her. This restriction and its implications will be discussed in the last chapter.

The second moderating effect was found for neuroticism and the within-person relationship between negative affect and working memory performance (χ^2 = 7.3, *df* = 1, *p* < .01): Whereas for individuals low in self-reported neurotic symptoms, a unit change in NA was related to a decrease in RT by roughly 2.5 ms, individuals high on a dimension of neuroticism showed a performance slowing by about 32 ms on days that were experienced as one unit higher in NA on an 8-point rating scale as compared to an average day. The analyses yielded no moderating effect of extraversion for either PA or NA.

Table 4.16
Fixed Effect Results of Multilevel Modeling Analyses Estimating Individual Differences in the Coupling of Daily Affect with Daily Reaction Time Performance in Working Memory

	Individual Differences in Coupling Model	
	Coupling with Daily Positive Affect	Coupling with Daily Negative Affect
Central Individual Difference Covariate of Within-Person Coupling		
Fixed Effects		
Daily Affect	–0.71	7.12
Daily Affect × Age Group	3.87	–7.22
Model Fit and Variance Explained		
χ^2 *(df)*	0.1 (1), $p = .92$	0.3 (1), $p = .58$
Pseudo-$R^2_{Coupling}$ (by Age Group)	.01	— [a]
Additional Individual Difference Covariates of Within-Person Coupling		
Fixed Effects		
Daily Affect	2.06	6.40
Daily Affect × Mean Daily RT	0.03*	0.02
Model Fit and Variance Explained		
χ^2 *(df)*	4.6 (1), $p < .05$	1.7 (1), $p = .19$
Pseudo-$R^2_{Coupling}$ (by Mean RT)	.22	.35
Fixed Effects		
Daily Affect	0.95	4.91
Daily Affect × Extraversion	–7.27	8.50
Model Fit and Variance Explained		
χ^2 *(df)*	0.5 (1), $p = .82$	0.4 (1), $p = .53$
Pseudo-$R^2_{Coupling}$ (by Extraversion)	.02	.03
Fixed Effects		
Daily Affect	–0.04	–2.45
Daily Affect × Neuroticism	12.07	31.73**
Model Fit and Variance Explained		
χ^2 *(df)*	1.4 (1), $p = .24$	7.3 (1), $p < .01$
Pseudo-$R^2_{Coupling}$ (by Neuroticism)	.06	.61

Notes. Age group was coded as young = 0 and older = 1. All other between-person predictors were grand-mean centered. Positive and negative affect = PANAS (Watson et al., 1988; Response scale ranged from 1 to 8).

Comparison of model fit and variance explained was determined in relation to the exponential change model, that was controlled for a moderating effect of the between-person variable on the intercept only to examine whether its moderating effect on the coupling led to an additional model fit improvement. In the model shown, the exponential trend was controlled.

Only the coefficients relevant for the central research question are shown in this table.

[a] No reduction in residual variance.

* $p < .05$; ** $p < .01$

Follow-Up Analyses: Individual Differences in Coupling Between Daily Hedonic Balance and Cognitive Performance Fluctuations

Conducting the multilevel modeling analyses on individual differences in the couplings between subjective mood states and cognitive performance with the hedonic balance indicator, yielded a pattern of results that mirrored the one for positive affect and cognition: First, age group did not emerge as a reliable person-level predictor in the coupling with vigilance performance nor with working memory performance. Second, extraversion was found to have a significant moderating effect on the hedonic balance–vigilance coupling ($\chi^2 = 3.8$, $df = 1$, $p < .01$), but not on the hedonic balance-working memory coupling: For each unit increase in hedonic balance (i.e., leading to a more pleasant tone), low-extraversion persons were by almost 1 ms faster in their vigilance performance (γ = –0.89), but high-extraversion individuals showed a performance increase by around 3 ms ($\gamma_{interaction}$ = –2.43 [–0.89]). Third, average working memory performance moderated the hedonic balance–working memory coupling (again mainly driven by one very low performing older adult), even though the direction was opposite to the one for positive affect, which yielded a performance-impairing effect: Each unit increase in hedonic balance was related to slightly faster performance in low-performing individuals (γ = –4.61 ms) than in higher performing individuals (γ = –4.59 ms). Average vigilance performance did not moderate the relationship between daily hedonic balance and daily vigilance RT (see Appendix C, Table C26 for a summary of these findings).

4.3.3 Summary of Findings on Within-Person Coupling Between Affect and Cognitive Performance and Individual Differences in Coupling Patterns

The last set of research questions concerned patterns of within-person coupling between daily affect and daily cognitive performance, and whether such pattern would vary as a function of age or other theoretically relevant individual difference factors. Day-to-day fluctuations in two cognitive tasks (i.e., in reaction times for correct responses) were predicted by daily positive and negative affect: The central task was a vigilance task, and analyses were then repeated with a highly demanding spatial working memory task to examine whether a similar or different pattern of coupling could be identified using two alternative cognitive tasks (attention vs. working memory) that also varied in the degree of cognitive demands.

Results from a set of multilevel modeling analyses demonstrated that daily performance fluctuations in both cognitive tasks could be predicted by fluctuations in positive and negative affect. One important qualification of this general statement, however, is that the strength of the within-person association as well as the direction differed significantly between individuals. The average relationship was close to zero. Coupling evidence was slightly stronger for positive affect and for the working memory task. One reason for this finding may have been that particularly among older adults, individuals did not vary sufficiently in reports of negative affect. The greater improvement in model fit after adding the daily affect predictors to the prediction of working memory perturbations as compared to fluctuations in vigilance may be a first but weak indicator that coupling is slightly more pronounced when task demands are higher.

Follow-up multilevel models that examined whether age, average cognitive performance or personality would moderate the coupling at the individual level. By and large, not much evidence for such moderating effects were found in the present study. Contrary to the hypothesis, coupling patterns at the within-person level did not vary as a function of age for either affect or cognitive domain. The only moderators that improved the model fit reliably were extraversion for the PA-vigilance coupling, neuroticism for the NA-working memory coupling, and there was a tendency for average level of working memory performance to moderate the PA-working memory coupling. Follow-up analyses using the hedonic balance indicator revealed a pattern that was similar to the coupling of PA with vigilance and working memory performance.

Table 4.17 summarizes the research questions and hypotheses again, indicating which hypotheses could be supported and for which hypotheses the analyses yielded no or only partial empirical support.

Table 4.17
Overview of Research Questions and Summary of Supported and Unsupported Hypotheses

Research Question and Hypothesis	Empirically Supported?
I. Are there age-related differences in the stable and dynamic characteristics of day-to-day PA and NA?	
1. Young and older adults differ significantly in the stable and the dynamic characteristics of day-to-day PA and NA:	
(a) Regarding mean levels of day-to-day PA and NA, there will be a significant main effect of valence (NA < PA) and a significant age group × valence interaction: All individuals will report higher mean levels of PA than of NA, and older adults will report higher mean levels of PA and lower mean levels of NA than young adults.	*Partially* PA: yes NA: as a trend
(b) Regarding time-related trends in mean levels of affect across the assessment period, there will be a small but significant main effect of time, but no significant age group × time interaction: Both age groups exhibit slight decreases in self-reported PA and NA across the nine weeks.	*Partially* PA: yes NA: no
(c) Regarding day-to-day intraindividual variability in affect, there will be a significant main effect of valence (NA < PA) and a significant main effect of age group (older < young): Both age groups will show less fluctuation from one day to the next in NA as compared to PA. Older adults will report less day-to-day fluctuations in PA and NA across the nine-week period than younger adults.	*Yes*
II. Does age explain significant amounts of variance in day-to-day fluctuations in PA and NA above and beyond personality? Are there age-related differences in the association between fluctuations in PA and NA and trait-like and state-like correlates representing stress and psychological adjustment?	
2. Individual differences in day-to-day fluctuations of PA and NA can be explained by age, above and beyond the effects of personality factors such as extraversion and neuroticism.	
(a) Neuroticism is positively related to variability in NA and to a lesser extent in PA, extraversion is weakly positively related to variability in PA: Individuals who report higher levels of neuroticism tend to show greater day-to-day variability in NA and in PA, individuals who report higher levels of extraversion tend to show slightly greater day-to-day variability in PA.	*Partially* Extraversion: no Neuroticism: yes
(b) After controlling for personality factors, age group will be a significant additional predictor of affect fluctuation, leading to a significant change in the individual difference variance explained: Even after controlling for individual differences in personality factors, age group will show a significant negative association with variability in both affect domains.	*Yes*

(Table continues)

Table 4.17 *(continued)*

Research Question and Hypothesis	Empirically Supported?
3. There are valence-specific interrelations between affect variability and psychological adjustment.	
(a) In both age groups, variability in NA is negatively associated with psychological adjustment: Regardless of age, individuals who fluctuate more in NA tend to be less well psychologically adjusted.	*Yes*
(b) In young adults, variability in positive affect is positively related to psychological adjustment: Within young adults, individuals who show greater variability in PA tend to show higher psychological adjustment. The association between variability in PA and psychological adjustment in older adults will be explored.	*Partially* Trends did not reach statistical significance
4. There will be an age group × daily event/stress interaction in the prediction of daily PA and NA: Age moderates the extent to which day-to-day fluctuations in PA and NA are related to fluctuations in perceived stress and daily events.	
(a) In young adults, daily positive affect is positively related to daily positive events, and slightly negatively related to or unrelated to daily negative events and daily stress: Within young adults, days characterized by the presence of a positive event, the absence of a negative event, and below average stress tend to be days on which PA is higher.	*Yes* (in part, stronger effects than predicted)
(b) In young adults, daily negative affect is positively related to daily negative events and daily stress, and unrelated to daily positive events: Within young adults, days with a negative event and those that are higher in perceived stress than the average day tend to be days on which NA is higher.	*Yes* (in part, stronger effects than predicted)
(c) In older adults, daily reports of positive and negative affect are only slightly or even unrelated to daily positive and negative events and stress: Within older adults, reporting a minor positive or negative event and reporting greater stress than on average tends to be independent of reporting higher or lower daily PA and NA.	*Yes*
III. Are there reliable within-person associations of daily PA and NA with cognitive performance, and do age or other individual difference factors moderate this coupling?	
5. Fluctuations in PA and NA are moderately related to fluctuations in cognitive performance at the level of individuals, and age, mean cognitive performance, personality, and task characteristics moderate the within-person coupling of affect and cognitive performance.	
(a) In the total sample, the average within-person relationship (i.e., slope) between daily reaction time and daily PA is positive: On days with higher than average PA, reaction times are also higher indicating that individuals' responses are slower.	*No* Only evidence for significant random effect

(Table continues)

Table 4.17 *(continued)*

Research Question and Hypothesis	Empirically Supported?
(b) On the other hand, the average within-person relationship (i.e., slope) between daily reaction time and daily NA is negative: On days with higher than average NA, reaction times tend to be lower indicating that individuals' responses are faster.	*No* Only evidence for significant random effect
(c) There is a significant age group × daily affect interaction in the prediction of daily cognitive performance: Older adults show stronger coupling than younger adults.	*No*
(d) The direction of the potential moderating role of average cognitive performance and personality factors for the affect-performance coupling will be explored by testing average cognitive performance/personality × daily affect interaction terms in the prediction of daily performance.	*Partially*

Notes. PA = Positive Affect, NA = Negative Affect.

Hypotheses are first stated in statistical terms, followed by summarizing each hypothesis in more descriptive terms