



# Top-down versus bottom-up processes in the formation of positive and negative retrospective affect

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## ABSTRACT

On the basis of two large scale diary studies ( $n = 2022$ ,  $n = 762$ ) We study differences in the effects of dispositions and situations in the formation of positive and negative *retrospective affect* (retrospective-PA and retrospective-NA, respectively), the affect associated with extended (e.g. daily) experiences, as opposed to very short (episodic) experiences. We suggest that the differences between retrospective-PA and retrospective-NA is due to the fact that *positive retrospective evaluation* (i.e. the evaluation of positive retrospective affect) involves primarily top-down processing, in which people resort to their dispositions in making these evaluations, whereas *negative retrospective evaluation* (the evaluation of negative retrospective affect) is primarily based on the cumulative affects of individual experiences.

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The formation of retrospective affect (e.g. how good/bad one felt during the day) involves integration of affects of shorter experiences (e.g. the affects associated with the individual events that occurred during the day). As a result, the evaluation of retrospective affect is different from the evaluation of the affect of short experiences in three important ways. First, its formation is prone to memory (e.g. Hertenstein & Campos, 2004; Ito & Cacioppo, 2000), attention (e.g. Hajcak & Olvet, 2008; Oehman et al., 2001), and substitution (Ganzach & Yaor, 2019; Slovic et al., 2007) biases. Second, the affect of short experiences is most often unidimensional, involving either positive or negative affect (e.g. Fredrickson & Kahneman, 1993; Schreier & Kahneman, 2000), whereas retrospective affect involves both positive and negative feelings – such as the affect of a day in which one had a good conversation with a friend but was also reprimanded by the boss. And third, the evaluation of retrospective affect, more than the evaluation of the affect of a short experience, is likely to be influenced more by dispositional factors that “fill in” the faded memories of the individual experiences (a

top-down process), and less by actual affective experiences (a bottom-up process). The time gap between the evaluation of retrospective affect and the relevant individual experiences makes what was actually experienced less prominent, allowing for dispositional factors to exert a stronger influence.

## Substitution and the positive–negative asymmetry of retrospective affect

Substitution is the tendency of a difficult-to-make evaluation to be replaced by an easier-to-make evaluation (Kahneman, 2003). Evaluation by substitution was offered as a general heuristic by which difficult-to-make judgments (e.g. probability judgments) are replaced by easier to make ones (judgments of representative or availability; see Kahneman & Frederick, 2002). We suggest that substitution occurs in retrospective affective evaluations as a result of the difficulty of integrating the faded affects of individual experiences into a retrospective evaluation of these experiences. When asked to evaluate their retrospective affect – a difficult task which requires an effortful memory search for the affects of individual

experiences (Robinson & Clore, 2002) – people may substitute the required evaluation with simpler, more accessible, trait evaluation, and in particular, replace the evaluation of retrospective affect with evaluations of their affective disposition, such as trait-PA and trait-NA (Merz & Roesch, 2011; Watson et al., 1988), rather than their relevant retrospective affect.

We further suggest that there is a positive–negative asymmetry in substitution: Substitution is stronger in the evaluation of positive retrospective affect than in the evaluation of negative retrospective affect. The reason for this is that retrospective-NA is more strongly related to negative than to positive experiences (and vice versa; see Ganzach et al., 2020, as well as the discussion about compatibility below) and that memory of negative experiences is better than memory of positive experiences (“bad is stronger than good”; see Baumeister et al., 2001; Vaish et al., 2008). As a result, the formation of retrospective-PA from past experiences is more difficult than the formation of retrospective-NA, and therefore retrospective-PA is more prone to substitution than retrospective-NA. Thus, our main hypothesis is that the relationship between retrospective-PA and affective dispositions will be stronger than the relationship between retrospective-NA and these dispositions.

Finally, although our focus is on the effects of dispositions on affect, it is obvious that, other things (e.g. compatibility) being equal, a better memory of negative experiences may lead to a stronger effect of negative than positive experiences on retrospective affect. Thus, by and large, we expect “a bad is stronger than good” effect of affective experience to occur in both positive and negative retrospective affect. That is, we expect that negative experiences will have a stronger effect on both retrospective-PA and retrospective-NA.

## Compatibility

Trait-PA and positive experiences influence both positive and negative retrospective affect, and this is true also for trait-NA and negative experiences (Ganzach et al., 2020). However, an important factor that should be taken into account when studying the effect of substitution is that retrospective-PA is influenced primarily by positive affective experiences whereas retrospective-NA is influenced primarily by negative affective experiences (e.g. Clark & Watson,

1988). This phenomenon is consistent with the idea that positive and negative affect are independent, but can also be viewed as an example of a more general effect of compatibility, which implies that the weights of a feature (e.g. the weight of positive versus negative experience) is enhanced by its compatibility with the response mode (the judgment of positive versus negative affect) (Slovic et al., 1990; Tversky et al., 1988). Compatibility has been demonstrated not only with regard to the effect of affective experiences on retrospective affect, but also with regard to the effect of dispositions on retrospective effect, by showing that traits that are associated with positive [negative] affect, such as extraversion [neuroticism], are more strongly associated with retrospective-PA [NA] (David et al., 1997).

Compatibility adds complexity to the analysis of the relationships between traits and retrospective affect because the effect of substitution may conflict with the effect of compatibility. For example, substitution suggests that trait-NA will have a strong effect on retrospective-PA, whereas compatibility suggests that it will have a weak effect. Therefore, in order to study only the effect of substitution, we keep compatibility constant and compare either between two compatible relationships (e.g. the correlation between trait-PA and retrospective-PA and the correlation between trait-NA and retrospective-NA) or between two incompatible relationships (e.g. the correlation between trait-NA and retrospective-PA and the correlation between trait-PA and retrospective-NA).

## Earlier studies

Two papers are of special relevance to the current work. First, in a large-scale study Ganzach and Yaor (2019) suggested that in evaluating retrospective-NA, people rely on relatively well remembered negative peak affective experiences, whereas in evaluating retrospective-PA they substitute the required evaluation with the highly available recent affective experience. Thus, underlying Ganzach and Yaor’s (2019) work is also the idea that retrospective NA involves the recall of affective experiences, or at least salient affective experiences, whereas retrospective-PA, involves substitution with easily available fill-ins (Using smaller samples but repeated measures design, Neubauer et al., 2020, found a similar pattern in retrospective PA and NA evaluations).

Second, in an earlier paper, David et al. (1997) reported an asymmetry in the effects of positive versus negative experiences and “positive” (extraversion) versus “negative” (neuroticism) traits on positive and negative retrospective affects. Although David et al. study did not examine the effect of affective dispositions, it is relevant to our work since extraversion is associated with trait-PA and neuroticism is associated with trait-NA (Watson & Clark, 1992). Furthermore, David et al. (1997) also suggested that because negative experiences are more salient than positive experiences, they are more strongly related to both positive and negative retrospective affects. However, with regard to the influence of traits on positive and negative affects our view is different from David et al. (1997). Whereas they suggested that the asymmetry between retrospective positive and negative affects is the result of the potency of the negative affective system, we suggest that it is due to a stronger tendency of substitution in the evaluation of retrospective-PA than in the evaluation of retrospective-NA. This theoretical difference leads to different predictions regarding the relationship between trait-PA and daily-PA versus the relationship between trait-NA and daily-NA. Whereas we predict that the former relationship is stronger than the latter, David et al. make the opposite prediction.

Below we examine the effect of trait-PA and trait-NA from the perspectives of these two theoretical approaches. Furthermore, since our data include information about extraversion and neuroticism, we are able to replicate David et al.’s (1997) analyses using a far larger database as well as advanced analytical techniques that were not available when David et al. conducted their study, allowing for a more sensitive examination of the influence of extraversion and neuroticism on daily affect.

## Summary

We study the role of substitution – a general heuristic by which difficult-to-make evaluations are replaced by easier to make ones – in the formation of retrospective affect. We suggest that because of substitution, retrospective affective evaluations are influenced by affective dispositions, and that this influence is stronger regarding positive than negative affect. We also suggest that this asymmetry results from a better memory for negative than positive affective experiences, and therefore it is associated also with a stronger effect of negative than positive experiences on

both retrospective-PA and retrospective-NA. Finally, we suggest that compatibility – the similarity between the evaluated affect (retrospective-PA and retrospective-NA) and its predictors (affective experiences or affective traits) – needs to be controlled in evaluating the effects of substitution.

## Method

### Data

The data were drawn from the second wave of the Midlife Development in the U.S. (MIDUS II) study (see Brim et al., 2004 for a detailed description of the study; data are available at <http://midus.wisc.edu/puboverview.php>), a national study of U.S. adults conducted in 2004. A subsample of participants took part in an additional in diary telephone study about their daily experiences (the National Study of Daily Experiences, or NSDE II) that was conducted on average nine months after they participated in the MIDUS survey, resulting in (after omitting observations with missing values) 1757 participants available for the analyses. Participants ranged in age from 33 to 84 years’ old ( $M = 56.9$ ,  $SD = 12.1$ ). The majority of the sample were female (56.9%), white (93.0%), currently married (73.0%) and reported completing at least 1–2 years of college (70.7%).<sup>1</sup>

Analysis’ scripts at: [https://osf.io/wn7c8/?view\\_only=2b51f09ecad34cda9ca96f27600ab6a3](https://osf.io/wn7c8/?view_only=2b51f09ecad34cda9ca96f27600ab6a3).

### Procedure

Respondents in the NSDE completed short telephone interviews about their daily experiences on each of eight consecutive evenings. The initial and final interviews each lasted approximately 15–20 min. The other seven interviews lasted approximately 10–15 min. Respondents completed an average of 7.4 out of a possible eight interviews (92%) yielding 14,912 daily interviews.

## Measures

### Between-subjects’ variables

These variables were taken from the basic MIDUS survey.

*Trait-PA and trait-NA* are usually measured by asking subjects to rate the extent to which they generally experienced each mood state (Burger &

Caldwell, 2000; Watson, 1988). In the MIDUS they were measured by asking subjects to rate the frequency with which they had experienced various affective states over the past 30 days on a five-point scale, ranging from 1 (none of the time) to 5 (all of the time) (see Willroth et al., 2020).<sup>2</sup> The items of the trait-PA scale were: cheerful, in good spirits, extremely happy, calm and peaceful, satisfied, and full of life. The items of the trait-NA scale were: so sad nothing could cheer you up, nervous, restless or fidgety, hopeless, that everything was an effort, worthless (see Mroczek & Kolarz, 1998 for a description of the scale development). The psychometric properties of these scales, including their factor structure, reliability and criterion validity, were examined by Joshanloo (2017) who concluded that they “can be used with confidence in American samples” (p. 236). Because the internal consistency of these scales is rather close, and since “internal consistency ... is essentially unrelated to differential validity” (McCrae et al., 2011, p. 42; see also John & Soto, 2007) we did not correct for these reliabilities in our analyses (in this respect we followed previous research that used the MIDUS’ PA and NA scales without correcting for their reliabilities. See for example, Elliot & Chapman, 2016; Mroczek & Almeida, 2004; Urban-Wojcik et al., 2020).

*Neuroticism and extraversion* were assessed via the self-administered adjectival measures of the Big Five (Zimprich et al., 2012). Respondents were asked how much each of 25 adjectives described themselves on a scale ranging from 1 (not at all) to 4 (a lot). The adjectives were moody, worrying, nervous, and calm (neuroticism); outgoing, friendly, lively, active, and talkative (extraversion). Reliabilities were .74 for neuroticism and .76 for extraversion.

### ***Within-subjects’ variables***

These variables were taken from the NSDE diary. The NSDE collected only frequency measures of affect, and in this respect our data are different from most earlier studies of retrospective affective evaluation, which have tended to rely on intensity as the dependent variable. However, as Ganzach and Yaor (2019) showed, affect frequency and affect intensity essentially measure a similar construct. We also note that, if anything, the evaluation of affect intensity has been criticised as being an ambiguous task, sensitive to conversational norms and standards of comparison (Ariely & Loewenstein, 2000) as opposed to the evaluation of frequency, which is a

relatively non-ambiguous task that provides subjects with clear norms and standards (Warr et al., 1983).

*Daily positive and negative affect* were assessed from the reports of the NSDE participants in eight days of telephone interviews (see <http://midus.wisc.edu/> for the instrument that was used to collect the affect frequency data). On each day, the participants reported how much time (since the last interview) they had felt various positive and negative feelings. The negative feelings that were assessed were the same six feelings that were used to assess the trait-NA plus eight more negative feelings. The positive feelings that were assessed were the same six feelings that were used to assess the trait-PA plus seven more positive feelings. Responses ranged from 0 (none of the time) to 4 (all of the time). To create measures of daily positive and negative affect, positive and negative items were averaged separately with higher values representing higher positive or negative affect (Mroczek & Almeida, 2004; Mroczek & Kolarz, 1998; Robinette et al., 2013). The Cronbach alpha reliabilities of the daily affects measures were .96 and .89 for the positive and negative affect, respectively.

### ***Positive and negative experiences***

On each of the eight days of the NSDE study, participants completed a measure of the occurrence of positive daily events and negative daily events. Occurrence of daily negative events was measured by the Daily Inventory of Stressful Events (Almeida et al., 2002), which asks subjects to indicate whether they had experienced any of the following negative events: an interpersonal conflict, a situation that could end in an argument but they decided to avoid, a problem at work, a problem at home, something bad happening to a close other, perceived discrimination, and any other stressful experiences not covered by the previous categories. Occurrence of positive daily events was measured by asking subjects whether they had experienced any of the following events: a positive interaction with someone, a positive event at work, a positive event at home, something good happening to a close other, and any other pleasant events not covered by the previous categories. Mean number of stressors and positive events experienced per day was 0.53 (SD = 0.46) and 1.13 (SD = 0.67), respectively.

## Analytical approach

We present two types of analyses. In the first, we examine differences between zero-order correlations. In the second we estimate multi-level SEM models. The first allows for a simplified, between-subjects presentation of the results, while the second takes into account the within-subjects structure of the data. But as can be seen from the results, the outcomes of the two analyses are very similar. In addition, this approach facilitates comparison with David et al. (1997), since this is the analytical approach they used. This is particularly important since, whereas David et al.'s (1997) study lacked power (a sample size of 96 participants) resulting in some conclusions that were based on non-significant results, our study provides considerable power for hypotheses testing. Furthermore, David et al. (1997) based some of their conclusions on significance tests concerning correlations or regression coefficients, rather than tests concerning differences between correlations and regression coefficients. Thus, we view our results as more reliable than David et al.'s.

## Results

### Correlational analysis

Table 1 presents descriptive statistics and inter-correlations of our trait variables, the positive and negative daily affect and the number of positive and negative experiences, where the daily affects and the number of experiences is averaged across the eight days of the diary. We first report the results of the compatible correlations and then the results of the incompatible correlations. We consider the compatible correlations more informative, since we believe that compatible associations better represent the processes underlying the formation of retrospective affect.

*The compatible correlations:* The correlation between trait-PA and daily-PA (.54) is stronger than the correlation between trait-NA and daily-NA (.46),  $Z = 2.8$ ,  $p < .005$ . This result is consistent with more top-down processing in retrospective-PA than in retrospective-NA. The correlation between negative experiences and daily-NA (.48) is stronger than the correlation between positive experiences and daily-PA (.08),  $Z = 12.5$ ,  $p < .0001$ . This result is consistent with more bottom-up processing in retrospective-NA than in retrospective-PA. Together, these two pairs of results suggest that affective traits are more

strongly related to retrospective-PA than to retrospective-NA, whereas affective experiences are more strongly related to retrospective-NA than to retrospective-PA.

Note also that the correlation between trait-PA and daily-PA being stronger than the correlation between trait-NA and daily-NA is the opposite of what is expected from David et al.'s (1997) theoretical framework, which emphasises the potency of the negative affective system in the formation of retrospective affect. Finally, a somewhat different view of the difference between retrospective-PA and retrospective-NA that emerges from our results is that retrospective-PA has a far stronger association with trait-PA (.54) than with positive experiences (.08),  $Z = 15.2$ ,  $p < .001$ , whereas the association of retrospective-NA with negative experiences (.48) and with trait-NA (.46),  $Z = 0.6$  is about the same.

*The incompatible correlations:* The correlation between trait-PA and daily-NA.

(-.33) is weaker than the correlation between trait-NA and daily-PA (-.39),  $Z = 2.4$ ,  $p < .05$ . Again, this result is consistent with more top-down processing in retrospective-PA than in retrospective-NA. The correlation between positive experiences and daily-NA (+.07; with a sign that is opposite to the expected) is weaker than the correlation between negative experiences and daily-PA (-.30),  $Z = 12.0$ ,  $p < .0001$ . Although this result is inconsistent with more bottom-up processing in retrospective-NA than in retrospective-PA, it is consistent with a "bad is stronger than good" effect.

*The personality traits:* Viewing extraversion and neuroticism as associated with trait-NA and trait-PA, the pattern of the inter-correlations involving the personality traits is somewhat different from the pattern of inter-correlations of the affective traits. In particular, unlike David et al. (1997), the correlation between extraversion and retrospective-PA (.35) is not significantly different from the correlation between neuroticism and retrospective-NA (.33),  $Z = 0.64$ ,  $p = .52$ . However, consistent with the idea that positive retrospective affective evaluations are substituted with trait evaluations, the correlations between daily-PA and our two personality traits are relatively high (.34 and -.37 for extraversion and neuroticism, respectively). On the other hand, the correlation of retrospective-NA with extraversion is low (-.15) (although because of compatibility, its correlation with neuroticism is relatively high, .34).

**Table 1.** Descriptive statistics and inter-correlations.

	Mean	STD	1	2	3	4	5	6	7
1.Daily-PA	2.72	0.71	–						
2.Daily-NA	0.21	0.28	-.50	–					
3.#positive experiences	1.12	0.68	<b>.08<sup>a</sup></b>	<i>.07<sup>b</sup></i>	–				
4.#negative experiences	0.53	0.48	<i>-.30<sup>b</sup></i>	<b>.48<sup>a</sup></b>	.43	–			
5.Trait-PA	3.61	0.75	<b>.54<sup>c</sup></b>	<i>-.33<sup>d</sup></i>	.13	-.14	–		
6.Trait-NA	1.53	0.52	<i>-.39<sup>d</sup></i>	<b>.46<sup>c</sup></b>	-.02	.25	-.48	–	
7.Extraversion	3.12	0.57	<b>.35<sup>e</sup></b>	<i>-.15<sup>f</sup></i>	.17	-.03	.46	-.25	–
8.Neuroticism	2.04	0.62	<i>-.37<sup>f</sup></i>	<b>.34<sup>e</sup></b>	-.07	.17	-.43	.58	-.24

Note: Extraversion and neuroticism were measured on a 1–4 scale. Trait PA and trait NA were measured on a 1–5 scale. Daily PA and daily NA were measured on a 0–4 scale. All correlations above .07 are significant at  $p < .01$ , above .13 at  $p < .0001$ . N ranges between 1765 and 2022 depending on missing values. Compatible coefficients are in bold, and traits' coefficients (as opposed to experiences' coefficients) are in italics. The tests of differences between correlations are performed on correlations that have the same superscripts. The Z scores and  $p$  values of these tests are: <sup>a</sup>12.5,  $p < .0001$ ; <sup>b</sup>12.0,  $p < .0001$ ; <sup>c</sup>3.4,  $p < .001$ ; <sup>d</sup>2.2,  $p = .028$ ; <sup>e</sup>0.64,  $p = .52$ ; <sup>f</sup>7.0,  $p < .0001$ .

### Regression analysis

The correlational analyses provide only an approximate test of our hypotheses for two reasons. First, they did not consider the fact that daily affects and affective experiences are nested within subjects; and second, our zero-order correlations did not provide estimates for the effects of the independent variables when the other variables are controlled for. Therefore, in the current section we present the results of multi-level regression of positive and negative daily affect as a function of the number of positive and negative experiences (level-1 variable) and positive and negative traits (level-2 variables). Since the tests of our hypotheses involve comparing regression slopes and since the scales of our independent variables are not equal (see Table 1), all independent and dependent variables were standardised to have a mean of zero and standard deviation of 1. As a result, the size of the regression coefficient represents the strength of the relationships between our predictors and daily PA and NA.<sup>3</sup>

The results of models based on affective traits and on personality traits are presented in Table 2 and

Table 3, respectively. It is apparent that the pattern of the results in these tables is similar to the pattern in the correlational analysis of Table 1. To statistically test differences between coefficients, we compared the two coefficients associated with each test by simultaneously estimating the daily-PA and the daily-NA models, and comparing, for each test, the fit of a model in which the two relevant coefficients were set as equal to the fit of a model in which the two were allowed to vary. The results of these tests were similar to the results of the correlation tests. They are reported in the notes to Tables 2 and 3.

### Replication

We replicated our main study with an additional sample taken from the MIDUS Refresher (<http://www.midus.wisc.edu/refresher/index.php>). This is also a representative sample of adult Americans, but the target population is younger by about eight years, and the time period of the data collection was characterised by severe economic hardship that followed the 2008–2009 economic crisis.

**Table 2.** Multilevel model of daily positive and negative affect with trait-PA and trait-NA as dispositions.

Effect	Daily-PA			Daily-NA		
	Estimate	Standard error	t Value	Estimate	Standard error	t Value
Intercept	-.0180	.0171	–1.1	-.0073	.0137	–.5
#positive events	<b>.0600<sup>a</sup></b>	<b>.0062</b>	<b>9.6</b>	<i>.0039<sup>b</sup></i>	.0080	.5
#negative events	<i>-.1036<sup>b</sup></i>	.0059	–17.6	<b>.2945<sup>a</sup></b>	<b>.0094</b>	<b>31.5</b>
Trait-PA	<b>.4025<sup>c</sup></b>	<b>.0196</b>	<b>22.5</b>	<i>-.0953<sup>d</sup></i>	.0157	–6.1
Trait-NA	<i>-.1426<sup>d</sup></i>	.0198	–7.2	<b>.2604<sup>c</sup></b>	<b>.0160</b>	<b>16.3</b>

Note: All coefficients are significant,  $p < .0001$  except for the coefficient of #positive events in the daily-NA model, which is not significant. Compatible coefficients are in bold, and traits' coefficients (as opposed to experiences' coefficients) are in italics. The equality of slopes tests is performed on coefficients that have the same superscripts. The chi square (with  $df = 1$ ) and  $p$  values of these tests are: <sup>a</sup>684.8,  $p < .0001$ ; <sup>b</sup>143.6,  $p < .0001$ ; <sup>c</sup>22.4,  $p < .0001$ ; <sup>d</sup>2.8,  $p = .096$ .

**Table 3.** Multilevel model of daily positive and negative affect with extraversion and neuroticism as dispositions.

Effect	Daily-PA			Daily-NA		
	Estimate	Standard error	t Value	Estimate	Standard error	t Value
Intercept	-.018	.018	-1.0	-.008	.014	-.6
#positive events	<b>.060<sup>a</sup></b>	<b>.006</b>	<b>9.5</b>	.004 <sup>b</sup>	.008	.5
#negative events	-.105 <sup>b</sup>	.006	-17.8	<b>.302<sup>a</sup></b>	<b>.010</b>	<b>31.4</b>
Extraversion	<i>.244<sup>e</sup></i>	<i>.019</i>	<i>12.9</i>	<i>-.057<sup>f</sup></i>	<i>.015</i>	<i>-3.8</i>
Neuroticism	<i>-.258<sup>f</sup></i>	<i>.019</i>	<i>-13.6</i>	<i>.209<sup>e</sup></i>	<i>.015</i>	<i>14.1</i>

Note: All coefficients are significant,  $p < .0001$  except for the coefficient of #positive events in the daily-NA model, which is not significant. Compatible coefficients are in bold, and traits' coefficients (as opposed to experiences' coefficients) are in italics. The equality of slopes tests is performed on coefficients that have the same superscripts. The chi square (with  $df = 1$ ) and  $p$  values of these tests are: <sup>a</sup>700.3,  $p < .0001$ ; <sup>b</sup>143.9,  $p < .0001$ ; <sup>e</sup>1.6,  $p = 0.20$ ; <sup>f</sup>60.8,  $p < .0001$ .

## Method

The MIDUS Refresher was conducted in 2011–2014, with a new sample of 3,577 adults, aged 24–74. A random subsample of 762 participants completed a diary study about their daily experiences. Respondents' average age was about 48 and 56% were women. The method used for this sample was similar to the one used in the MIDUS II diary study. In this sample, respondents completed on average 7.6 interviews out of a possible eight (95%), yielding 5,849 daily interviews. Less than 5% of the sample completed four or fewer diary days.

## Results

We first compared the two samples on our measures of affect. The MIDUS Refresher sample has lower average daily-PA and trait-PA and higher average daily-NA and trait-NA (the  $t$ -test for differences between the means with  $df = 2782$  and  $p$  values are, respectively: 6.5,  $p < .0001$ ; 4.5,  $p < .0001$ ; 1.7,  $p = .096$ ; 3.8,  $p < .001$ ). Thus, by and large, the affect of the refresher sample appears to be lower. This could be attributed to the lower age of its participants (which is known to be associated with lower positive affect. See for example Charles & Carstensen, 2010) or to the more difficult period in which the study was conducted.

The main results are presented in Table 4 (for the correlational analysis) and in Table 5 and Table 6 (for the regression analysis). It is evident from these tables that the pattern of the relationships between daily-PA and daily-NA and our predictors, particularly affective disposition and affective experience, is similar to the pattern of the relationships in the main study, although the relationship between retrospective-PA and trait-PA was not stronger than the relationship between retrospective-NA and trait-NA.

This difference may be the result of the more negative affect of the refresher sample (most likely due to its younger age) and to the more difficult period in which the study was conducted.

## Discussion

The current study shows that retrospective-PA is more strongly associated with affective dispositions than retrospective-NA, and suggests that this difference is due to a better memory for negative affective experiences, which in turn leads to asymmetric substitution, namely a stronger tendency to replace the evaluation of positive retrospective affect with the evaluation of affective disposition. Among other things, this is evident by the fact that retrospective-PA has a far stronger association with trait-PA than with positive experiences, whereas the strength of the association of retrospective-NA with negative experiences and with trait-NA is about the same.

The current study suggests that reports about retrospective affect, particularly reports about positive retrospective affect, needs to take into account the judgmental processes that are involved in these reports. If Russell's (2017) argued that "Feeling bad is one thing, judging something to be bad is another" (p. 111), we emphasise that this is particularly true for feeling good. But notwithstanding questions about the difference between positive and negative affect, it is clear that Russell's (2003, 2017) constructionist view of emotion, and his attention to the correspondence between experienced emotions and reported emotions, are directly relevant to the understanding of our results. Yet, we note that Russell did not offer an empirical method to study this correspondence, most likely because as long as "true" affect (core affect in Russell's terminology) is unknown, it is not clear how the correspondence between retrospective reports and

**Table 4.** Descriptive statistics and inter-correlations.

	Mean	STD	1	2	3	4	5	6	7
1.Daily-PA	2.52	0.75	–						
2.Daily-NA	0.23	0.29	-.46	–					
3.#positive experiences	1.31	0.74	<b>.18<sup>a</sup></b>	<i>.06<sup>b</sup></i>	–				
4.#negative experiences	0.57	0.47	<i>-.27<sup>b</sup></i>	<b>.43<sup>a</sup></b>	.31	–			
5.Trait-PA	3.46	0.84	<b>.56<sup>c</sup></b>	<i>-.32<sup>d</sup></i>	.22	-.11	–		
6.Trait-NA	1.62	0.65	<i>-.39<sup>d</sup></i>	<b>.53<sup>c</sup></b>	-.06	.21	-.55	–	
7.Extraversion	3.06	0.60	<b>.38<sup>e</sup></b>	<i>-.12<sup>f</sup></i>	.23	-.05	.45	-.19	–
8.Neuroticism	2.15	0.69	<i>-.34<sup>f</sup></i>	<b>.35<sup>e</sup></b>	-.05	.17	-.41	.55	-.20

Note: Extraversion and neuroticism were measured on a 1–4 scale. Trait PA and trait NA were measured on a 1–5 scale. Daily PA and daily NA were measured on a 0–4 scale. All correlations above 0.15 or below  $-0.15$  are significant at  $p < .001$ . Correlations above 0.1 or below  $-0.1$  are significant at  $p < 0.01$ . All other correlations are not significant. N ranges between 771 and 782 depending on missing values. Compatible coefficients are in bold, and traits' coefficients (as opposed to experiences' coefficients) are in italics. The tests of differences between correlations are performed on correlations that have the same superscripts. The Z scores and  $p$  values of these tests are: <sup>a</sup>5.4,  $p < .0001$ ; <sup>b</sup>6.6,  $p < .0001$ ; <sup>c</sup>0.8,  $p = .40$ ; <sup>d</sup>1.6,  $p = .12$ ; <sup>e</sup>0.68,  $p = .50$ ; <sup>f</sup>4.6,  $p < .0001$ .

actual experiences can be examined. The current study approaches this issue indirectly. It does not attempt to assess the correspondence between true emotions and reported emotions, but it does try to identify biases in these reports and assess their direction. This assessment is based on the comparison between reports of actual affective experiences and reports about retrospective affect, and on comparison between reports about positive affect and reports about negative affect.

Although our approach is somewhat similar to that of Russell (2003, 2017), it is worthwhile noting that while Russell suggestion would imply (when our qualification about the difference between PA and NA is taken into account) "Feeling good is one thing, judging something to be good is another", we suggest that "Feeling good is one thing, reporting about this feeling is another". The difference is that Russell (2003, 2017) distinguishes between the experience of contemporary affect on the one hand and the judgment of the affective qualities of the situation as pleasant or unpleasant on the other hand. We distinguish between the delayed evaluation of affect and the report about this affect. We note, however,

that to the extent that one's own affect is the judged stimuli, our view coincides with Russell's.<sup>4</sup>

Yet, caution should be exercised in generalising from the current results. First, the delayed evaluation of extended (daily) affective experiences may be different from the evaluation of contemporary affective experiences, since the evaluation of contemporary affect is likely to be less sensitive to constructionist biases: Delayed affective reports involve retrieval of affective information from memory, whereas contemporary affective reports are primarily based on direct access to one's feelings. Second, our frequency measure of affect may be more sensitive to cognitive construction of emotions than other measures, particularly intensity measures of affect, since the former calls for cognitive construction, whereas the latter involves a direct access of experienced affect (Watson, 1988).

On the other hand, there are reasons to believe that diary studies based on contemporary intensity measures of momentary experiences will not yield very different results. First, even accessing current feelings is a cognitive process that requires access to information not readily available (Ellis et al.,

**Table 5.** Multilevel models of daily positive and negative affect with trait-PA and trait-NA as dispositions.

Effect	Daily-PA			Daily-NA		
	Estimate	Standard error	$t$ Value	Estimate	Standard error	$t$ Value
Intercept	-.0555	.0281	-2.0	.0260	.0255	1.0
#positive events	<b>.0758<sup>a</sup></b>	<b>.0101</b>	<b>7.5</b>	<i>-.0064<sup>b</sup></i>	.0127	-0.5
#negative events	<i>-.0918<sup>b</sup></i>	.0103	-8.9	<b>.2262<sup>a</sup></b>	<b>.0151</b>	<b>15.0</b>
Trait-PA	<b>.4204<sup>c</sup></b>	<b>.0343</b>	<b>12.3</b>	<i>-.0284<sup>d</sup></i>	.0299	-1.0
Trait-NA	<i>-.1270<sup>d</sup></i>	.0329	-3.6	<b>.3647<sup>c</sup></b>	<b>.0298</b>	<b>12.2</b>

Note: All coefficients are significant,  $p < .0001$  except for the coefficient of #positive events in the daily-NA model, which is significant at  $p < .05$ , as well as the coefficient of trait-PA in the daily-NA model, which is not significant. Compatible coefficients are in bold and trait coefficients (as opposed to experiences' coefficients) are in italics. The equality of slopes tests is performed on coefficients that have the same superscripts. The chi square (with  $df = 1$ ) and  $p$  values of these tests are: <sup>a</sup>74.6,  $p < .0001$ ; <sup>b</sup>82.1,  $p < .0001$ ; <sup>c</sup>1.9,  $p = .20$ ; <sup>d</sup>2.2,  $p = .15$



**Table 6.** Multilevel models of daily positive and negative affect with extraversion and neuroticism as dispositions

Effect	Daily-PA			Daily-NA		
	Estimate	Standard error	t Value	Estimate	Standard error	t Value
Intercept	-.0511	.0306	-1.7	0.0265	.0277	1.0
#positive events	<b>.0741<sup>a</sup></b>	<b>.0100</b>	<b>7.4</b>	-.0075 <sup>b</sup>	.0125	-0.6
#negative events	-.0922 <sup>b</sup>	.0102	-9.0	<b>.2265<sup>a</sup></b>	<b>.0149</b>	<b>15.2</b>
Extraversion	<b>.2732<sup>e</sup></b>	<b>.0318</b>	<b>8.6</b>	-.0441 <sup>f</sup>	.0275	-1.6
Neuroticism	-.2445 <sup>f</sup>	.0314	-7.8	<b>.2505<sup>e</sup></b>	<b>.0270</b>	<b>9.3</b>

Note: All coefficients are significant,  $p < .0001$  except for the coefficient of #positive events in the daily-NA model, which is significant at  $p < .05$ , as well as the coefficient of extraversion in the daily-NA model, which is not significant. Compatible coefficients are in bold, and traits' coefficients (as opposed to experiences' coefficients) are in italic. The equality of slopes tests are performed on coefficients that have the same superscripts. The chi square (with  $df = 1$ ) and  $p$  values of these tests are: <sup>a</sup>73.8,  $p < .0001$ ; <sup>b</sup> 81.9,  $p < .0001$ ; <sup>e</sup>1.8,  $p = 0.25$ ; <sup>f</sup>57.6,  $p < .0001$ .

1984), and therefore sensitive to substitution biases. For example, if no meaningful affective experience is available, the widely used method of prompting subjects to report about their current affect via smartphone notification may also elicit evaluations of affective dispositions.<sup>5</sup> And second, by and large, the pattern of delayed affective reports tends to be similar to the pattern of contemporary affective reports and so does the pattern of reports elicited by frequency format and reports elicited by intensity format (Watson, 1988; Ganzach & Yaor, 2019).

Except of the measurement of affect, the measurement of the number of positive and negative events is bound to introduce errors and biases into the estimated effects. In particular, the reported average number of positive/negative events may be low because participants may have forgotten about many of these events when reporting about them at the end of the day. This calls for relying on diary method in which subjects are prompted to report (e.g. by smartphones) about the occurrence of positive or negative events when they occur (or for that matter, to report about the intensity of their positive and negative affect). Indeed, this is what Neubauer et al. (2020) did in their recent study. However, these authors focused only on the effects of affective experiences on retrospective affect, ignoring the effect of affective traits<sup>6</sup>, thus not allowing for the examination of the relative effects of affective traits and affective experiences on retrospective affect. Future research could adopt Neubauer et al.'s (2020) methods but add a measurement of affective traits to the design. Finally, as we already mentioned that the evaluation of positive retrospective affect is not very different from evaluations that are studied in the judgment and decision making research, such as the evaluation of probability: They are both influenced by substitution processes, which in our study influence the evaluation, or judgment, of

retrospective PA, as evident by its association with dispositions. Furthermore, our analysis of retrospective affect is built on the idea that judgments are often the product of substitution of affect, an idea which was called by Daniel Kahneman in his Noble Laureate acceptance speech "the most important development in the study of judgment heuristics in the past few decades" (Kahneman, 2003, p. 18).<sup>7</sup> In particular, our analysis of retrospective affect is similar to the behavioural-economic' analysis of retrospective utility (the valence of extended affective experience) from momentary utilities (the valence of the momentary affective experience that are associated with this retrospective utility) (Kahneman et al., 1997; Morewedge, 2015; Schreiber & Kahneman, 2000). Using the language of behavioural-economic's analysis of retrospective utility, retrospective NA (e.g. retrospective daily-NA), could be viewed as experienced affect (core affect in Russel's terminology), an affect that represent actual affective experiences, and retrospective-PA (e.g. retrospective daily- PA) could be viewed as remembered affect (reported affect in Russel's terminology), the affect people remember, or wish to remember. These analogies between behavioural economic's research and emotion research may be fertile ground for future research.

## Notes

1. The study was conceptualised by the first author, but data analysis and report writing was done by all the three authors. The study was not pre-registered.
2. This question is a mixture of what Schimmack et al. (2000) called frequency (since it depends on the number of times the emotion was felt during the day) and duration (the amount of time it was felt once it was experienced). We preferred to use the term frequency because this is the common term used in the MIDUS literature to refer to this (and other similar) variables.

3. We note that our hypothesis about the level-1 predictors is that the relationship between negative events and daily-NA is stronger than the relationship between positive events on daily-PA. To be most general, we do not distinguish between the level-1 and level-2 effects of daily events: we analyze the variance in the daily affects disregarding the sources of this variance (whether it is associated with level-1 or level-2 variables). However, in the appendix we report estimates of “pure” level-1 effects based on analyses in which the positive and negative daily events were standardised within subjects. It is clear that the results of these analyses are very similar to the results reported in the text. Finally, no additional analysis was necessary regarding the level-2 predictors (trait-PA and trait-NA), since, by design, their effect concern only between person effects.
4. We also note that the distinction between experienced affect and reported affect is relevant and to the distinction between remembered utility (Schreiber & Kahneman, 2000), which corresponds to Russel’s reported affect and experienced utility (Kahneman et al., 1997), which corresponds to Russel’s core affect.
5. Kahneman et al.’s (2004) day reconstruction method in which subjects report about meaningful affective experiences may overcome this problem. However, this method involves retrospective affective evaluation, and thus may introduce substitution biases associated with this type of affective evaluations.
6. We note that Neubauer et al. (2020) focused on the effects of the intensity of positive and negative experiences, rather than the number of these experience, and therefore although they did not model the effects of affective traits, they could model effects of experiences’ intensity.
7. In this respect substitution is relevant not only to the evaluation of one’s affect, but also to the evaluation of other concepts such as well-being (Kahneman & Krueger, 2006) or life satisfaction (Kahneman & Riis, 2005).

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## Data availability statement

Data are available at <http://midus.wisc.edu/>.

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## Appendix

**Table A1.** Multilevel model of daily positive and negative affect with trait-PA and trait-NA as dispositions for standardised level-1 variables

Effect	Estimate	Daily-PA			Daily-NA		
		Standard error	<i>t</i> Value		Estimate	Standard error	<i>t</i> Value
Intercept	-0.0180	0.0174	-1.0	-0.0023	0.0154	-0.2	
#positive events	<b>0.0445<sup>a</sup></b>	<b>0.0050</b>	<b>8.9</b>	0.0060 <sup>b</sup>	0.0065	0.9	
#negative events	-0.0857 <sup>b</sup>	0.0052	-16.5	<b>0.2367<sup>a</sup></b>	<b>0.0083</b>	<b>28.5</b>	
Trait-PA	<b>0.4099<sup>c</sup></b>	<b>0.0200</b>	<b>20.5</b>	-0.1022 <sup>d</sup>	0.0177	-5.8	
Trait-NA	-0.1542 <sup>d</sup>	0.0201	-7.7	<b>0.3116<sup>c</sup></b>	<b>0.0179</b>	<b>17.4</b>	

Note: All coefficients are significant,  $p < .0001$  except for the coefficient of #positive events in the daily-NA model. Compatible coefficients are in bold and traits' coefficients (as opposed to experiences' coefficients) are in italics. The equality of slopes tests are performed on coefficients that have the same superscripts. The  $p$  values of these tests are: <sup>a</sup> $p < .0001$ ; <sup>b</sup> $p < .0001$ ; <sup>c</sup> $p < .0001$ ; <sup>d</sup> $p = .082$ .

**Table A2.** Multilevel model of daily positive and negative affect with trait-PA and trait-NA as dispositions for standardised level-1 variables (Refresher dataset).

Effect	Estimate	Daily-PA			Daily-NA		
		Standard error	<i>t</i> Value		Estimate	Standard error	<i>t</i> Value
Intercept	-0.0668	0.0300	-2.2	0.0681	0.0286	2.4	
#positive events	<b>0.0805<sup>a</sup></b>	<b>0.0112</b>	<b>7.2</b>	-0.0198 <sup>b</sup>	0.0136	-1.0	
#negative events	-0.0934 <sup>b</sup>	0.0112	-8.3	<b>0.2394<sup>a</sup></b>	<b>0.0160</b>	<b>15.0</b>	
Trait-PA	<b>0.4064<sup>e</sup></b>	<b>0.0367</b>	<b>11.1</b>	-0.0330 <sup>f</sup>	0.0333	-1.0	
Trait-NA	-0.1239 <sup>f</sup>	0.0361	-3.4	<b>0.3532<sup>e</sup></b>	<b>0.0329</b>	<b>10.7</b>	

Note: All coefficients are significant,  $p < .0001$  except for the coefficients of #positive events and Trait-PA in Daily-NA model. Compatible coefficients are in bold and traits' coefficients (as opposed to experiences' coefficients) are in italics. The equality of slopes tests are performed on coefficients that have the same superscripts. The  $p$  values of these tests are: <sup>a</sup> $p < .0001$ ; <sup>b</sup> $p < .0001$ ; <sup>e</sup> $p = 0.15$ ; <sup>f</sup> $p < .0001$ .

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