The Association Between Life Satisfaction and Affective Well-Being*

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Abstract

We estimate the correlation between life satisfaction and affective (emotional) well-being—two conceptually distinct dimensions of subjective well-being. We propose a simple model that distinguishes between a stable and a transitory component of affective well-being, and which also accounts for measurement error in self-reports of both variables, including current mood-bias effects on life satisfaction judgments. The model is estimated using momentarily measured well-being data, from an experience sampling survey that we conducted on a population sample of Swedes aged 18–50 ($n = 252$). Our main estimates of the correlation between life satisfaction and long-run affective well-being range between 0.78 and 0.91, indicating a stronger convergence between these variables than many previous studies that do not account for measurement issues.

Keywords: Subjective well-being, life satisfaction, affective well-being

1 Introduction

A key question for both research and policy initiatives that assess individual welfare in terms of subjective well-being (SWB), is whether it primarily should be conceptualized and measured in terms of life satisfaction or affective well-being. According to the established definition of SWB, the former refers to a cognitive evaluation of one's life as a whole, and the latter to more specific experiences of positive and negative feelings

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(Diener, 1984).[1] A common view among psychologists is that these components are separate constructs that should be studied on their own terms (e.g. Diener et al., 1999), but there is no established theory of how the components relate to each other.[2]

The multi-dimensionality of SWB—or at least its implications—has received relatively little attention within the subfield of "happiness economics", however.[3] There are several possible reasons for this. First, it could perhaps be attributed to an intuitive understanding of happiness as one-dimensional. After all, it is hard to imagine that a person whose daily life is characterized by negative feelings, is also satisfied with his or her life as a whole, and vice versa. Second, economists have been inclined to interpret SWB data as an empirical proxy for utility, i.e. an index of preference fulfillment, which is one-dimensional by construction. A third reason is practical—there are few data sources for affect that are based on population samples, whereas several ones exist for life satisfaction, either in the form of national socioeconomic surveys (e.g. the US General Social Survey and the German Socio-Economic Panel) or international surveys (e.g. the World Values Survey and the European Social Survey). Consequently, most applied research has studied the determinants of life satisfaction, but the results have often been framed generically in terms of happiness or SWB.[4]

One-dimensionality of SWB is in fact one of its major selling points, as it is necessary for unambiguous welfare comparisons across individuals (given interpersonal comparability) and across countries and over time (given a social welfare welfare function). A one-dimensional measure of SWB is particularly useful for public policy purposes, as it provides a clear framework for cost-benefit analysis, in which the marginal well-being increase of a given policy can be weighed against the marginal costs, to yield a welfare-maximizing outcome.[5] As such, (one-dimensional) SWB is not subject to the problem

[1] Some definitions of SWB also include meaningfulness (or eudaimonia) as a separate component. This is not discussed further in this paper, but see e.g. Haybron (2016) for a discussion, and White and Dolan (2009) for an application.

[2] See Busseri and Sadava (2011) for an overview of different theoretical models, and Lucas (2016) for a discussion.

[3] In an early survey in the economics literature, Frey and Stutzer (2002) note the distinction between life satisfaction and affect, but do not discuss any implications. A later survey by Di Tella and MacCulloch (2006) does not take note of the distinction at all. The issue has been highlighted e.g. by Adler (2013) and Clark (2016).

[4] Confusion about the terminology may partly stem from the fact that global SWB is elicited with questions phrased in terms of "happiness" in some surveys (as in the GSS). This phrasing is not wrong per se, but when such questions refer to one's life as a whole or life in general, in contrast to a narrow time frame, they should properly be categorized as measures of life satisfaction and not affect.

[5] More precisely, the marginal rate of substitution of two goods/outcomes can be equated with the ratio of their respective costs, or one can express the well-being impact of some good/outcome in terms of a SWB "money-metric". Needless to say, there are huge challenges for such analyses, e.g. when it comes to establishing causal effects on well-being. In any case, a SWB-based approach has some clear

inherent to multi-dimensional approaches to welfare, of assigning welfare weights to different components, such as health and income.

If SWB were instead genuinely multi-dimensional—in the sense of life satisfaction and affective well-being being only weakly or or moderately associated with each other, as well as having different determinants—one would either have to concede the advantages just described, or take an explicit normative stance of whether to emphasize evaluative or affective aspects of well-being.[6]

It thus appears central to establish the extent of empirical overlap between life satisfaction and affective well-being. Previous research is not very clear on this point, however. There is substantial variation in previous estimates, but several studies (discussed further in Section 2 below) have found only a moderate correlation between individual-level life satisfaction and affect. As noted above, there are relatively few studies on the determinants (or correlates) of affective well-being, but some of these point to differences with respect to the determinants of life satisfaction, e.g. Kahneman and Deaton (2010) and Kahneman et al. (2010), who find that income is more strongly associated with life satisfaction than it is with affective well-being, and Knabe et al. (2010), who find that unemployment is more strongly associated with life satisfaction than with affect.

However, we believe that it is premature to rule out the possibility that discrepancies between life satisfaction and affect, at least to a large extent, are driven by measurement issues, rather than genuine differences between the two variables. In particular, we identify four measurement issues in previous estimates of the association between life satisfaction and affect.

First, affect measures are likely to pick up short-term fluctuations in well-being, as they typically refer to a relatively narrow time frame (e.g. "right now", or the previous day or week), whereas this is not the case for life satisfaction measures, which implicitly refer to a more stable condition (e.g. satisfaction "these days"). Our view, which is central for this paper, is that an affect-based measure of individual welfare should capture the individual's stable, or long-run, affective well-being.[7] Short-run measures of affect

advantages compared to approaches based on revealed or stated preferences. These advantages have been discussed extensively elsewhere, see e.g. Dolan and Fujiwara (2016), for a recent discussion.

[6] Notably, Kahneman (1999) has taken an extreme stance on this matter, by arguing that life satisfaction is basically an unreliable and biased account of affect. Consequently, Kahneman has referred to evaluative and affective well-being in terms of remembered and experienced utility. Although he has subsequently nuanced this position, with respect to the normative relevance of evaluative well-being (Kahneman and Riis, 2005), he has continued to emphasize discrepancies between evaluative and affective well-being (e.g. Kahneman et al., 2010).

[7] This point has been made previously by Campbell et al. (1976), and highlighted by Eid and Diener (2004). One could argue that this is more of a conceptual point, rather than a measurement issue, but given that the point should be quite uncontroversial, we think that it is appropriate to frame the problem

are at best noisy measures of long-run affect, and the use of such measures can thus be expected to cause attenuated correlation estimates, given that the association of interest is between life satisfaction and long-run affect.

Second, many studies do not take into account measurement error in self-reports of life satisfaction and affect, which causes correlations to be biased towards zero. Previous research has shown that reliability-adjusted correlation estimates, based on multiple items and/or repeated measurements, are markedly stronger than unadjusted estimates (Eid and Diener, 2004; Krueger and Schkade, 2008; Schimmack et al., 2002).

Third, affect measures are often based on retrospective questions, and are therefore prone to various forms of recall bias (Robinson and Clore, 2002). As it is hardly possible to remember exactly how one felt moment-to-moment in the past, respondents need to "guesstimate" how they felt. If this process is unbiased, but with a white-noise error, the resulting measure would have lower reliability compared to one for which such estimation is not necessary. The resulting correlation with life satisfaction would thus be downward biased, as noted in the previous point. Another possibility is that such a retrospective assessment is mixed up with a cognitive evaluation of the period in question, rather than a retrieval of past affective experiences. In this case, one would instead expect an upward bias in the correlation between such a measure and life satisfaction. The problem of recall bias is the main reason why momentary measurement—as in the Experience Sampling Method (ESM; Larson and Csikszentmihalyi, 1983) and in the Ecological Momentary Assessment (EMA; Stone and Shiffman, 1994)—is usually regarded as the gold standard for measuring affective well-being.

Note that this point, together with the first point above, form a paradox, or trade-off—a valid measure of experienced affect should, as far as possible, be momentary, in order to reduce recall bias and avoid conflation with evaluative well-being. But momentary measures are by construction only snapshots of an individual's life, and can therefore not be reliable summary measures of individual well-being. In our view, the only way to solve this dilemma is by using repeated, momentary measurements.

Fourth, life satisfaction judgements have been shown to be biased by current mood and situational variables, such as the question order and the weather at the time of the survey (e.g. Connolly, 2013; Deaton, 2012; Schwarz et al., 1987; Schwarz and Strack, 1999; but see also Lucas, 2016 for a critical discussion). Hence, the correlation between

in terms of measurement. Note also that we do not argue that intra-individual variation in affect has no normative relevance, but rather that such variation is of second-order importance. It may e.g. be the case that among two time-profiles of well-being with the same average, one is preferrable to the other. A parallel can also be drawn to the distinction between current and lifetime (permanent) income (see e.g. Haider and Solon, 2006 regarding measurements issues in this context).

life satisfaction and affect can be expected to be upward-biased if they are both measured on the same survey occasion.

The purpose of the present paper is to estimate the association between life satisfaction and long-run affective well-being, simultaneously taking into account all of these problems. Although the sign of the net bias from these issues is unclear, our overall hypothesis is that correlation estimates will be stronger when these issues are properly accounted for, compared to "naive" estimates for which this is not the case. We investigate this hypothesis within a simple measurement model framework, in which SWB is decomposed into a component capturing stable individual well-being, and another one capturing measurement error and temporary fluctuations. To estimate the model, we conducted a smart-phone based experience-sampling survey—on a population sample of Swedes aged 18–50 ($n = 252$)—in which respondents' momentary well-being was measured repeatedly during a seven-week period.

Previewing the results, our main correlation estimates range between 0.78 to 0.91, thus indicating a strong convergence between life satisfaction and affect. Our estimates are markedly stronger compared to estimates that do not account for measurement issues, both in previous literature and based on our own data.

The remainder of this paper is structured as follows. In the next section, we review previous literature about the association between life satisfaction and affect. In Section 3, we outline the model and how we estimate it, whereafter we describe the survey and the data in Section 4. Our main results, on the satisfaction–affect correlation, are presented in Section 5. In Section 6, we present additional results on how life satisfaction and affect differ in terms of their socioeconomic correlates. We discuss our results further and conclude in Section 7.

2 Previous Literature

In this section, we review previous research on the association between life satisfaction and affective well-being. Some studies indicate that this association differs across countries, and in particular that it is stronger in individualistic cultures, compared to collectivistic ones (Suh et al., 1998; Schimmack et al., 2002; Kuppens et al., 2008). We limit our review to studies from individualistic/Western countries, however, consequent with that the current study is set in Sweden. We also limit our review to results on the direct correlation between life satisfaction and affect, rather than differences in their correlates, but we return to the latter question in Section 6.

Estimates of the correlation between life satisfaction and affect that are not adjusted for measurement error typically range between 0.3 and 0.6. Previous studies suffer to varying degrees from the four measurement problems identified in the introduction, and the variation in previous estimates can partly be understood in light of these. Using longer time frames for the affect questions, or asking “trait-like” questions about the frequency of affect experienced in general, tends to produce stronger correlations, compared to using a narrow time frame. Studies that explicitly account for measurement error also tend to obtain stronger correlations.

Part of the variation relates to other method differences, however, and in particular to the specific choice of SWB measures used. Life satisfaction usually correlates more strongly with positive affect than with negative affect. Aggregated measures, based on averaging several affect items (questions), tend to produce stronger correlations than single items. Such averaging is in fact an indirect way of dealing with measurement error. Importantly, measures of *hedonic balance* or *net affect*, that capture the balance between positive and negative affect—e.g. by subtracting the mean of a set of negative affect items from the mean of a set of positive affect items—typically generate stronger correlations with life satisfaction. This makes intuitive sense, to the extent that people’s full spectrum of emotional well-being matters for their life satisfaction (and/or if life satisfaction influences both positive and negative affect). Measures of hedonic balance are not always used, however.

Many studies are based on convenience samples, e.g. university students, but it is not clear from our review if the satisfaction–affect association varies systematically across different types of samples. Finally, a non-negligible part of the heterogeneity in previous estimates can probably be attributed to random sample variation.

Starting with the work that does not account for measurement error, Lucas et al. (1996) study the association between various measures of life satisfaction and affect, elicited from three different student samples. Life satisfaction was measured with the five-item Satisfaction With Life Scale (Diener et al., 1985, see further description in Section 4.4) and positive and negative affect, respectively, were measured with the ten-item PANAS scales (Watson et al., 1988). Their estimates of the correlation between satisfaction and positive affect range between 0.42 and 0.52, and those between satisfaction and negative affect range between -0.51 and -0.30. Affect was also measured with the forty-item Affect Balance Scale (Derogatis, 1975), producing somewhat stronger correlations (at most 0.65 and -0.58, for positive and negative affect, respectively).

Studies based on population surveys do not appear to yield systematically different results, per se, but such surveys typically include fewer items to measure SWB. Kööts-Ausmees et al. (2013) study a large sample of adults in 21 countries, using the European

Social Survey. They report correlations between satisfaction and positive and negative affect equal to 0.49 and −0.51, respectively. Their satisfaction measure is based on two items, and the affect measures are based on four items each, referring to the frequency of emotions during the previous week. The British Office for National Statistics (2011) reports correlations between single-item measures of life satisfaction and positive and negative affect experienced yesterday (happy/anxious), equal to 0.55 and −0.26, respectively. Their estimates are based on a population sample of British adults. Wiest et al. (2011) report correlations between life satisfaction and affect measured with SWLS and PANAS (referring to the past months), respectively, based on data from a population sample of Germans aged 40–85. Their estimates for positive and negative affect are 0.30 and −0.29, respectively.

Several studies of affect within the economics literature are based on the Day Reconstruction Method (DRM), developed by Kahneman et al. (2004; see also Kahneman and Krueger, 2006). In DRM surveys, respondents are asked about time use and affect during the previous day, which is partitioned into distinct episodes defined by the main activity performed during that time interval (e.g. commuting to work, working, eating lunch). The respondents provide details about the context of each episode (e.g. where did the activity take place, and with whom), and they also rate episodes according to a set of emotions (e.g. to what extent they felt happy, sad or stressed). A central idea behind the DRM—besides linking time use and SWB variables—is to emulate experience sampling methods (ESM/EMA) for momentary affect measurement, but without imposing the costs and response burden associated with such methods.

A series of DRM studies have found rather weak correlations between life satisfaction and affect. Kahneman et al. (2004) study a sample of employed women in the US, and obtain a correlation of 0.38 between a single item life satisfaction measure (with four response categories) and net affect. Krueger and Schkade (2008) also study a sample of US women, and obtain a corresponding estimate of 0.31. They also find the correlation between satisfaction and the u-index, a measure of time spent in an unpleasant state, to be −0.26. Knabe et al. (2010) study a sample of unemployed Germans, and obtain a correlation of 0.32 between a single-item life satisfaction measure (on a numeric 0–10 scale) and net affect. Based on a pooled sample of French and US women, Kahneman et al. (2010) obtain an estimate of 0.36, between satisfaction measured with SWLS and an affect measure defined as the value of positive affect minus the maximum value of negative affect. The fact that the DRM studies yield weaker correlations is not surprising, given the short time frame of the affect measure, which refers to the previous day only.

In the study by Krueger and Schkade (2008), the DRM survey was administered twice to the same respondents, two weeks apart. The authors use test-retest correlations of life satisfaction and affect to adjust correlation estimates for measurement error. These estimates are substantially stronger, and equal to 0.50 for net affect and −0.48 for the u-index.

Psychologists typically handle measurement error by using survey instruments that consist of multiple items designed to measure the same latent construct. The inter-item correlation, which is a measure of reliability, can then be used to disattenuate the correlation between the variable measured with error and another variable (that could be handled likewise), using different type of latent variable models (or structural equation models). The disattenuated correlation can in this context be interpreted as pertaining to the latent variables of interest.

The study by Schimmack et al. (2002) accounts for measurement error using such methods. They estimate the correlation between SWLS and a hedonic balance measure (based on several items), in samples of US and German students. They obtain unadjusted correlations equal to 0.61 and 0.62, respectively, for the US and the German samples, and the corresponding measurement-adjusted correlations are equal to 0.68 and 0.76.

Luhmann et al. (2012) compare the importance of time frames of life satisfaction and affect questions, in a US population sample of persons older than 50 years. Life satisfaction and positive and negative affect were measured using two items each, for different time frames, and a latent variable model was used to account for measurement error. Their estimates of the correlation between satisfaction in general and positive and negative affect today, are 0.33 and −0.25, respectively. When satisfaction and affect were instead assessed using a common time frame referring to the past two months, the strength of these correlations is increased to 0.63 and −0.46, respectively.

Eid and Diener (2004) estimate a latent variable model that accounts for both measurement error and temporary deviations in life satisfaction and affect, using a student sample. Three measurements of life satisfaction (SWLS) and current mood (a multi-item measure) were made four weeks apart. They obtain a correlation of 0.74 between the stable components of general mood and stable life satisfaction, i.e. a doubly disattenuated correlation.

Of the studies reviewed here, Eid and Diener (2004) are the only ones to use a momentary measure of affect. Even so, this measure was elicited by means of a standard survey, and not ecologically, i.e. in the context of the respondent's everyday life. Neither do any of the above studies measure well-being at random times. As a consequence, it is not clear, even for the studies that use a shorter time frame, if the affect measure is even a representative snapshot of an individual's well-being. In fact, some study designs are explicitly non-random (e.g. Krueger and Schkade, 2008, in which respondents were surveyed on two Thursdays, two weeks apart).

A major contribution of the current study is to address these weaknesses, by using a genuine experience-sampling design in which affect is measured momentarily, ecologically, repeatedly, and during random points in time, over an extended period. Another contribution relative to previous studies is that our analysis explicitly accounts for the possibility of a current-mood bias of life satisfaction, since we avoid correlating satisfaction and affect measures from the same occasion.

3 Model

3.1 Model

In this section, we propose a simple measurement model, which formalizes the measurement issues outlined in the introduction. The equation

$$ls_{it} = ls_i^* + e_{it} \tag{1}$$

decomposes reported (observed) life satisfaction ls_{it}, for individual i at time t, into an individual-stable latent component ls_i^* and a temporary deviation e_{it}. Similarly,

$$a_{it} = a_i^* + u_{it}, \tag{2}$$

decomposes reported affect a_{it} into a stable component a_i^* and a deviation u_{it}. Conceptually, life satisfaction refers to a relatively stable condition, so e_{it} should be interpreted as a measurement error. The presence of such an error can be expected because of the arbitrariness of the response scale of self-reported satisfaction. While we would expect most people to be able to distinguish whether they are satisfied or dissatisfied with their lives, broadly speaking, and hence in what region of the response scale to report their answers, those who are satisfied may not, e.g., be able to clearly determine whether to report a 7 or an 8. For this reason, people with the same underlying satisfaction may report slightly different answers across different situations. In addition to this "pure" measurement error component, we also expect reported life satisfaction to correlate positively with current mood, in line with previous studies cited in the introduction.

The affect error term u_{it} also captures measurement error, related to the inconsistency of scale use, as well as well as variation in current mood. With respect to measuring momentary affect, we do not think of the latter in terms of an error. But if the purpose is to measure long run affect, a_i^*, as in our case, we can nevertheless treat it as a measurement error as well, statistically.

To clarify the meaning of "stable" or "long-run" well-being (which we use interchangeably) in this context, we do not think of ls_i^* and a_i^* as fixed individual traits, or even necessarily constant within a shorter time frame, but rather as those components that are causally related to some set of determinants pertaining to the individual's stable life circumstances, e.g. occupation, marital status and health.[8] Hence, we expect ls_i^* and a_i^* to change only when such circumstances change, as compared to e.g. having had a bad night's sleep. The maintained assumption throughout this paper—and admittedly an approximation—is that these circumstances remain unchanged over the period studied.[9]

With ls_{it} and a_{it} being demeaned measures, the model is characterized by the following covariance structure:

$$E[ls_{it}ls_{js}] = \begin{cases} \sigma_{ls^*}^2 + \sigma_e^2, i = j, t = s \\ \sigma_{ls^*}^2, \quad i = j, \forall t \neq s \\ 0, \qquad i \neq j, \forall t, s \end{cases} \tag{3}$$

$$E[a_{it}a_{js}] = \begin{cases} \sigma_{a^*}^2 + \sigma_u^2, i = j, t = s \\ \sigma_{a^*}^2, \quad i = j, \forall t \neq s \\ 0, \qquad i \neq j, \forall t, s \end{cases} \tag{4}$$

$$E[ls_{it}a_{js}] = \begin{cases} \sigma_{ls^*,a^*} + \sigma_{e,u}, i = j, t = s \\ \sigma_{ls^*,a^*}, \quad i = j, \forall t \neq s \\ 0, \qquad i \neq j, \forall t, s \end{cases} \tag{5}$$

The model has six parameters: $\sigma_{ls^*}^2$ and $\sigma_{a^*}^2$ represent the variance of the stable components of life satisfaction and affect, and σ_{ls^*,a^*} is the covariance between these variables. The variance of the measurement errors are denoted σ_e^2 and and σ_u^2, whereas $\sigma_{e,u}$ is their covariance within the same measurement occasion. Thus, $\sigma_{e,u}$ captures the current-mood bias effect on reported life satisfaction. Note that the assumptions

[8] This begs the question about how to define the long-run determinants of SWB. We leave this as a bit of an open question, but think of it loosely as such policy relevant determinants that are typically studied in the SWB literature. Formally, we can think of ls_i^* and a_i^* as being realizations of some happiness (regression) functions, conditional on these determinants at time t.

[9] Over a given period studied, there will always be some "churning", in the sense that some individuals' circumstances change, e.g. when losing one's job or divorcing. Insofar this leads to changes in long-run SWB, it may lead to inconsistent estimates in our context. We will indirectly assess to what extent this appears to be the case, in Section 5.3.

in equations (3)–(5) imply that the error variances σ_e^2 and σ_u^2 are constant over time (homoskedasticity), and that the errors have no time-series dependency (no autocorrelation). We discuss these assumptions further, and show that they are plausible, in Section 5.3. Since the between-individual covariance is always zero, we henceforth drop the individual subscripts for simplicity. The within-individual covariance structure is summarized in Table 5 in the appendix.

The object of primary interest is the population correlation between long-run life satisfaction and affect, denoted ρ, which is defined in terms of the model parameters as

$$\rho = \frac{\sigma_{ls^*,a^*}}{\sigma_{ls^*}\sigma_{a^*}}. \tag{6}$$

Note that ρ has a purely descriptive interpretation, rather than coming from a causal model. A positive value of ρ can be expected if life satisfaction has a positive causal effect on affect or vice versa, if both variables are manifestations of a single underlying SWB variable, or if there is overlap in the set of (other) determinants of the two variables.

The reliability ratios (or shares of between-person variation) of life satisfaction and affect, denoted δ_{ls} and δ_a, are also of indirect interest for estimating ρ. These are defined as

$$\delta_{ls} = \frac{\sigma_{ls^*}^2}{\sigma_{ls^*}^2 + \sigma_e^2} \qquad \text{and} \qquad \delta_a = \frac{\sigma_{a^*}^2}{\sigma_{a^*}^2 + \sigma_u^2}. \tag{7}$$

3.2 Estimation

First, note that the simple correlation estimator

$$\hat{\rho} = \frac{\widehat{\text{cov}}(ls_t, a_s)}{\sqrt{\widehat{\text{var}}(ls_t)}\sqrt{\widehat{\text{var}}(a_s)}} = \frac{\widehat{\text{cov}}(ls^* + e_t, a^* + u_s)}{\sqrt{\widehat{\text{var}}(ls^* + e_t)}\sqrt{\widehat{\text{var}}(a^* + u_s)}}, \tag{8}$$

is inconsistent, with probability limit

$$\text{plim}(\hat{\rho}) = \begin{cases} \frac{\sigma_{ls^*,a^*}+\sigma_{e,u}}{\sqrt{\sigma_{ls^*}^2+\sigma_e^2}\sqrt{\sigma_{a^*}^2+\sigma_u^2}} \lesseqgtr \rho, & t = s \\ \frac{\sigma_{ls^*,a^*}}{\sqrt{\sigma_{ls^*}^2+\sigma_e^2}\sqrt{\sigma_{a^*}^2+\sigma_u^2}} < \rho, & t \neq s \end{cases} \tag{9}$$

The asympotic bias of the within-period correlation could thus be either positive or negative, due to the current-mood bias in the numerator and the attenuation bias from the error variances in the denominator. The cross-period correlation, on the other hand, is unambiguously downward-biased (asymptotically).

Our proposed candidate for a consistent estimator is instead the reliability-adjusted cross-period correlation $\tilde{\rho}$, defined as

$$\tilde{\rho} = \frac{\hat{\rho}}{\sqrt{\hat{\delta}_{ls}}\sqrt{\hat{\delta}_a}}, \qquad t \neq s \tag{10}$$

where $\hat{\delta}_{ls}$ and $\hat{\delta}_a$ denote the test-retest correlations

$$\hat{\delta}_{ls} = \frac{\widehat{\text{cov}}(ls_t, ls_s)}{\sqrt{\widehat{\text{var}}(ls_t)}\sqrt{\widehat{\text{var}}(ls_s)}} \qquad \text{and} \qquad \hat{\delta}_a = \frac{\widehat{\text{cov}}(a_t, a_s)}{\sqrt{\widehat{\text{var}}(a_t)}\sqrt{\widehat{\text{var}}(a_s)}}, \tag{11}$$

defined across the same non-zero time horizon, denoted $\Delta(t, s) = |t - s| > 0$, as $\hat{\rho}$. It follows from the model assumptions that $\text{plim}(\hat{\delta}_{ls}) = \delta_{ls}$ and $\text{plim}(\hat{\delta}_a) = \delta_a$, and hence that $\text{plim}(\tilde{\rho}) = \rho$, i.e. $\tilde{\rho}$ is a consistent estimator of ρ.[10]

As for the inference, it is not obvious how to analytically derive the variance of $\tilde{\rho}$, given the possible dependence between the three random variables $\hat{\rho}$, $\hat{\delta}_{ls}$ and $\hat{\delta}_a$, and the cluster structure of the data (described below). Our approach is to use a non-parametric clustered bootstrap procedure, in which clusters (respondents) are re-sampled with replacement, treating the within-cluster variation as fixed. For each of 1,000 sample draws, $\tilde{\rho}$ is computed from the triplet $\{\hat{\rho}, \hat{\delta}_{ls}, \hat{\delta}_a\}$. Thereafter, a (possibly non-symmetric) 95 % confidence interval around $\tilde{\rho}$ is computed using the distances between the median and the 2.5th and 97.5th quantiles of the bootstrap distribution.

4 Data

In order to estimate the model, we conducted a survey with the aim of measuring individual well-being 1) momentarily; 2) repeatedly; 3) at random times; and 4), over a reasonably long time horizon. To these ends, we designed a longitudinal mobile phone-based survey, in which the respondents received notifications by SMS, containing a link to a short web questionnaire answered directly on the phone. It was thus required that

[10] We also tried to estimate the model with the generalized methods of moments (GMM) approach, but this turned out to be difficult due to missing values and problems of numerically inverting the variance-covariance matrix. GMM estimations on a balanced subset of the data yielded very similar results, however. We also estimated ρ more parsimoniously using only the (co-)variance terms corresponding to the off-diagonal cells of the sub-matrices of Table 5. These estimates were very similar, so we opted to present results based on reliability adjusted correlations, since the reliability ratios are of interest in themselves.

Another, and perhaps more intuitive, candidate for an estimator, is $\overline{\rho} = \widehat{\text{cor}}\left(\overline{ls}, \overline{a}\right)$, where $\overline{ls}$ and $\overline{a}$ denote within-means of life satisfaction and affect, respectively. It is straight-forward to show that $\overline{\rho}$ is asymptotically (in the number of individuals) biased towards zero for finite number of within-observations, however. When we computed $\overline{\rho}$ and adjusted for this finite-sample bias, we got results that were similar to those based on $\tilde{\rho}$, presented in the paper.

participants owned a smartphone, i.e. a phone with a web browser and a mobile Internet connection. In order to, as far as possible, capture well-being in the moment, respondents were instructed to answer as soon as possible, and each query could only be answered up to one hour after the notification.

Unlike most previous experience sampling studies, we chose not to ask about any contextual information, e.g. what the respondent was doing at the time, where, or with whom. The idea was to minimize response burden, in order to encourage quick responses and maintain a high participation and response rate throughout the study period.

4.1 Participants

Participants were contacted by means of recruitment letters sent to a simple random sample of 3,000 persons in the Swedish population aged 18–50. Out of the 263 people who signed up on the study's website, we restrict our sample to 252 persons who answered any questions during at least two of out of three survey weeks (i.e. a net participation rate of 8.4 %). Participants were rewarded with two cinema tickets, administered after the first survey week.

The composition of the participating sample was as follows: 64 % were female, 68 % were married or cohabiting, and 51 % had children living in the household. As for their occupation, 68 % were working, 17 % were students, and the remaining 14 % were either unemployed, sick or on parental leave. The age distribution was even, and similar to that in the target population.

4.2 Survey Structure

The survey was structured as follows. For each respondent, three days were drawn randomly from each of three active survey weeks, spread evenly across a seven-week period, which started on March 14 and ended on May 1, 2016. Henceforth, we will refer to the active survey weeks as survey week one, two and three (corresponding to chronological weeks one, four and seven). The choice of a seven-week period reflects that we wanted a sufficiently long period to obtain a representative picture of individual well-being, but not too long, so as to avoid picking up long-run changes in well-being (due to changed life circumstances).

For each of the nine active survey days, queries were sent out on random times in the morning (9 am – 1 pm), in the afternoon (1 pm – 5 pm) and in the evening (5 pm – 9 pm). Each respondent thus received a total of 27 queries, containing a total of 54 questions, i.e. on average two questions per query. An affect question (described below) was included in each query, whereas other well-being questions were added randomly within individuals and survey weeks, so that each respondent had his or her unique schedule, but with everyone receiving the same set of questions each week (and hence also across the whole survey).

Participants were also required to complete a questionnaire with questions about life satisfaction and demographic/socioeconomic background variables, when they signed up on the study's website one to three weeks prior to the study. A separate questionnaire was also sent out on the last day of the study, with questions about life satisfaction and an evaluation of the survey.

4.3 Response Behaviour

Out of a total of 6804 queries sent (252 respondents times 27 queries), 5378 were answered, yielding an overall response rate of 79 %, or 21 answers per respondent on average. The distribution of individual response rates is shown in the left panel of Figure 1. The response rate was stable over the survey period: 79 % during the first week, 80 % during the second, and 78 % during the third. The distribution of response times, i.e. the time passed between when a query was sent and when it was answered, is shown in the right panel of Figure 1. Responses were generally provided very quickly—the mean and median response times were 633 and 170 seconds, respectively, and three-quarters of all responses were provided within 15 minutes. Hence, we are confident in interpreting our affect measures as genuinely capturing well-being "here and now".

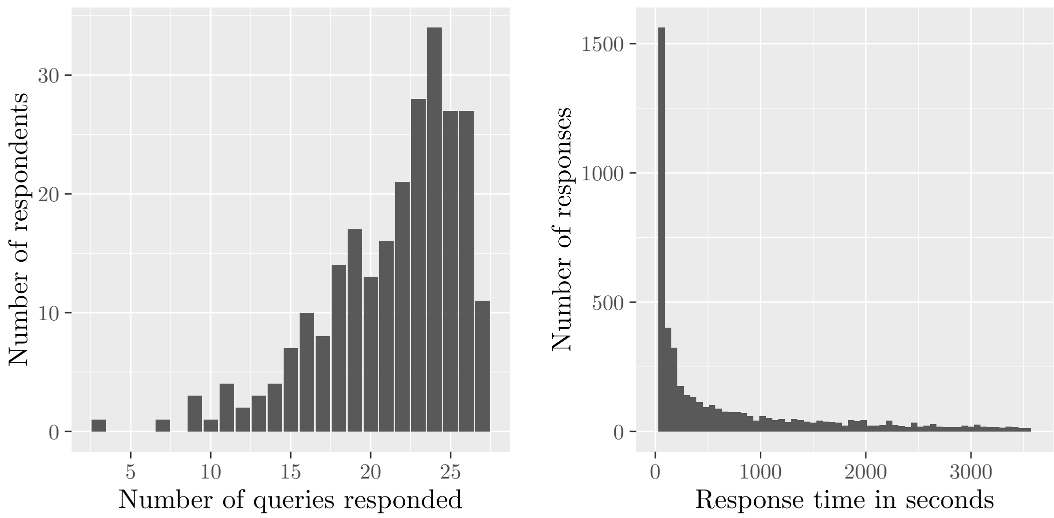

Figure 1: Distribution of response rates and response times

4.4 Well-Being Measures

A single item life satisfaction measure (henceforth SILS) was included once every survey week, based on the question "All things considered, how satisfied are you with your life as a whole nowadays?", with a response scale ranging from 0 to 10, and with endpoints labelled "extremely dissatisfied" and "extremely satisfied".[11] Life satisfaction was also measured in the sign-up and end questionnaires, using the Satisfaction With Life Scale (Diener et al., 1985), which includes five questions that are all answered on a scale from 0 to 6, with endpoints labelled "completely disagree" and "completely agree". We use the mean of the scores from these five questions (henceforth SWLS).[12] The distributions of SILS (mean = 6.8, sd = 1.9) and SWLS from sign-up (mean = 4.0, sd = 1.1) scores are shown in Figure 2.[13]

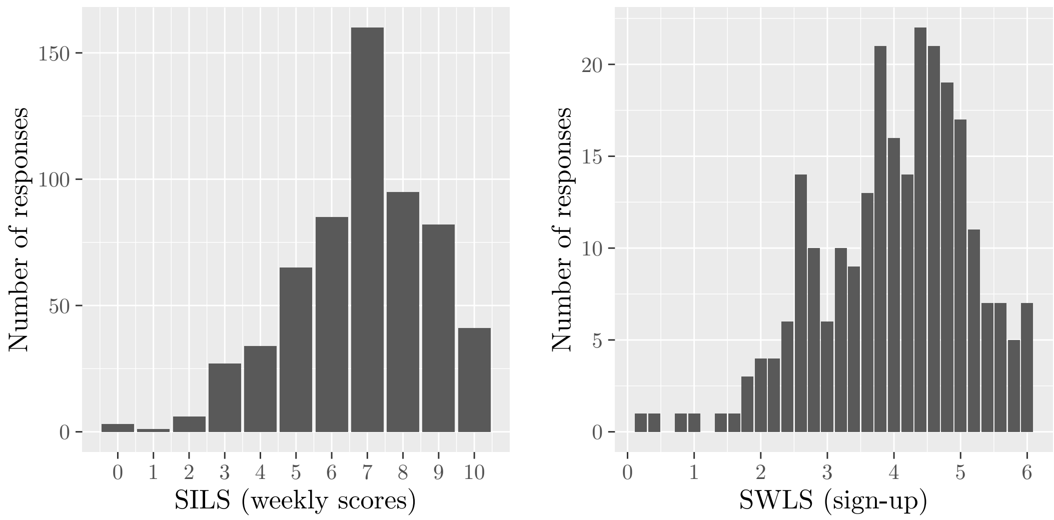

Figure 2: Distribution of life satisfaction responses

Our main measure of affective well-being is based on the question "How do you feel right now?", and was included in each of the 27 queries. The answers were elicited on a bipolar numeric response scale ranging from 0 to 10, with the endpoints labelled with

[11] The survey was in Swedish, and the Swedish formulation of this question was adopted from the European Social Survey. The Swedish questionnaire can be accessed online from Martin Berlin's website: `http://www.su.se/english/profiles/mabe7257`. We treat all SWB measures as cardinal.

[12] The SWLS questions are "In most ways my life is close to my ideal", "The conditions of my life are excellent", "I am satisfied with my life", "So far I have gotten the important things I want in life" and "If I could live my life over, I would change almost nothing". The internal consistency of the SWLS scale in our sample, as measured by Cronbach's alpha, is equal to 0.86 (sign-up) and 0.88 (end).

[13] The correlation between SWLS at sign-up and SILS during survey week one, two and three are 0.69, 0.57, and 0.64.

a set of negative and positive adjectives: “extremely sad, displeased, depressed” and “extremely glad, pleased, happy”, respectively.[14] We chose a bipolar measure in order to capture the full spectrum from negative to positive affect, as discussed in Section 2, without having to impose the extra response burden of including several specific negative and positive affect questions. Henceforth, we refer to this measure as momentary affect, or simply affect, when clear from the context. The mean and standard deviation of this variable, across all responses, are 6.5 and 1.9, respectively, and its distribution is shown in the left panel of Figure 3. For comparison, the distribution of within-individual affect means (mean = 6.5, sd = 1.2) is shown in the right panel of Figure 3.

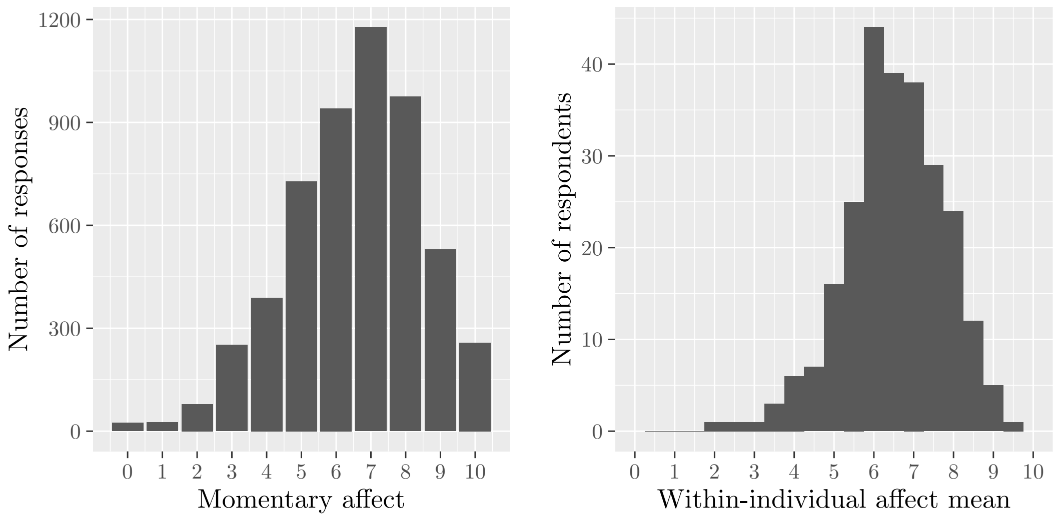

Figure 3: Distribution of momentary affect scores

A block of questions with specific emotions—happiness, sadness, stress, tiredness and pain—was included once a week, with questions phrased like “How happy do you feel right now?” (and similarly for other emotions). The response scale for these questions was unipolar, ranging from 0 to 6, and with endpoints labelled e.g. “I don’t feel happy at all” and “I feel extremely happy”.[15]

Table 1 shows how the specific affect variables correlate with momentary affect, within the same measurement occasion (i.e. the same query). As can be seen from the strong correlations with happiness and sadness, momentary affect captures both positive and negative affect, as intended. The correlation with stress and tiredness is weaker,

[14] The adjectives were taken from the valence dimension of the Swedish Core Affect Scale (Västfjäll et al., 2002).

[15] Respondents were also asked about their day satisfaction once a day, but this measure is not used in the current paper.

Table 1: Correlations between momentary affect and specific affect measures

	Happiness	Sadness	Stress	Tiredness	Pain
r	0.74	−0.64	−0.36	−0.35	−0.28
c.i.	(0.67, 0.80)	(−0.70, −0.57)	(−0.44, −0.27)	(−0.42, −0.26)	(−0.35, −0.19)

$n = 246$, $N = 613$. The 95% confidence intervals in parentheses are based on a non-parametric cluster-bootstrap procedure.

which is to be expected, since these emotions are more ambiguous with respect to how good or bad an experience is. The weak correlation with pain is a bit surprising, on the other hand, but it should also be noted that there is relatively little variation in this measure.

5 Results

5.1 Computation of the Correlation Estimator

Given the data structure, there are several possible ways of computing the reliability-adjusted correlation estimator $\tilde{\rho}$, proposed in Section 3.2. For SILS, the cross-period correlation $\hat{\rho}$ and the reliability ratios $\hat{\delta}_{ls}$ and $\hat{\delta}_a$ can be computed either for the time horizon $\Delta(t, s) = 3$ weeks, or for $\Delta(t, s) = 6$ weeks, since there were two weeks of downtime between each of the three active survey weeks. We present results separately for both these cases. In each case, the triplet $\{\hat{\rho},\ \hat{\delta}_{ls},\ \hat{\delta}_a\}$ is computed symmetrically, i.e. across the same time horizon, and using all available pooled observation pairs. For $\Delta(t, s) = 6$ weeks, $\hat{\rho}$, $\hat{\delta}_{ls}$ and $\hat{\delta}_a$ are based on up to $2 \times 9 = 18$, 1 and $9 \times 9 = 81$ observation-pairs per individual, respectively (but fewer for most because of missing values). For $\Delta(t, s) = 3$ weeks, there are twice as many observations.

The reliability ratio of SWLS is computed across the sign-up and the end of the study, and hence across a time horizon of seven to nine weeks, depending on when the respondent signed up. We use SWLS–affect correlations computed across six to nine weeks, and we compute the reliability of affect across six weeks, to make the time horizons as comparable as possible. The (maximum) number of observations used per individual is the same as in the SILS case when $\Delta(t, s) = 6$ weeks.

As noted in Section 3.2, the basic motivation for computing $\hat{\rho}$ across different periods is to avoid a current-mood bias on life satisfaction judgments. Although such a bias is only present within the same measurement occasion in our model, it is possible that short-term fluctuations in affect are sluggish, and will spill over also to life satisfaction judgments that are close in time, e.g. during the same day. Rather than modelling such short-run dynamics, we choose to use only the cross-week covariance between life satisfaction and affect for computing $\hat{\rho}$. The crucial assumption for the consistency of our estimates is thus whether such dynamics persist across three or six weeks. This does in fact not appear to be a problem, as we show in Section 5.3 below.

5.2 Main Results

The results are presented in Table 2, which is structured as follows. The first column shows simple correlation estimates ($\hat{\rho}$), the second and third show reliability ratios for life satisfaction and affect ($\hat{\delta}_{ls}$ and $\hat{\delta}_a$), and the fourth column shows the adjusted correlation estimates ($\tilde{\rho}$), obtained from the other estimates within the same row. Different time horizons and measures are organized by rows, within which samples are homogenized so as to include all individuals who contribute at least one observation pair to each estimate in that row.

Table 2: Correlations between life satisfaction and affect, test-retest correlations, and reliability-adjusted correlations

	$\hat{\rho}$	$\hat{\delta}_{ls}$	$\hat{\delta}_a$	$\tilde{\rho}$	n	N
SILS–affect $t = s$	0.65 (0.59, 0.71)				246	599
SILS–affect $\Delta(t, s) = 3$ w.	0.42 (0.36, 0.48)	0.72 (0.63, 0.78)	0.30 (0.24, 0.36)	0.91 (0.86, 0.98)	190	26,406– 48,159
SILS–affect $\Delta(t, s) = 6$ w.	0.43 (0.34, 0.50)	0.72 (0.63, 0.79)	0.33 (0.25, 0.39)	0.88 (0.79, 0.96)	163	13,203– 22,320
SWLS–affect $\Delta(t, s) = 6$–9 w.	0.40 (0.33, 0.46)	0.78 (0.70, 0.84)	0.34 (0.29, 0.39)	0.78 (0.69, 0.84)	229	18,549– 29,853

Correlations on the same row are based on the same sample of individuals (n) who contribute at least one observation-pair to each correlation. The first row shows the momentary correlation between SILS and affect. The remaining rows show correlations computed across all combinations of cross-week observation-pairs (N), across three and six weeks (and up to ten weeks, for SWLS). $\hat{\rho}$ denotes the unadjusted cross-measure correlation, $\hat{\delta}_{ls}$ and $\hat{\delta}_a$ are test-retest correlations (reliability ratios), and $\tilde{\rho}$ is the reliability-adjusted correlation, computed as $\tilde{\rho} = \hat{\rho}/\sqrt{\hat{\delta}_{ls} \cdot \hat{\delta}_a}$. The 95% confidence intervals in parentheses are based on a non-parametric cluster-bootstrap procedure.

For comparison with subsequent estimates, the top row shows that $\hat{\rho} = 0.65$, when computed between SILS and affect within the same measurement occasion. Recall from Section 3.2 that this estimate is subject both to current-mood and attentuation bias, which go in different directions, and it is not clear *ex ante* which one of these dominates.

Moving to the second row, we see that the corresponding correlation is equal to 0.42, when instead computed across a three-week period. The contrast between these two estimates thus shows that the current mood-bias is sizeable. The across-three-week estimate increases to 0.91, however, when adjusted with the reliability ratios of life satisfaction and affect. Besides the fact that this is a remarkably strong correlation in absolute terms, it also shows the huge overall impact of attenuation bias due to measurement error and temporal deviations in well-being, and that this source of bias dominates the current-mood bias, in line with our overall hypothesis. Unpacking the attenuation bias, we see that it is mainly due to the low reliability of affect, equal to 0.30, compared to the reliability of SILS, which is equal to 0.72. This is not surprising, given that momentary affect is expected to fluctuate more over a three-week period compared to life satisfaction, and our estimates in this respect are consistent with previous studies (Schimmack et al., 2002 and Eid and Diener, 2004).

Moving to the results for SILS across six weeks (third row), we see that they are very similar, with a slightly higher estimate of 0.33 for the reliability of affect, and hence a smaller adjusted correlation of 0.88. The quantitative similarity of these estimates is reassuring for our estimation strategy, as it suggests that the well-being dynamics are rather stable over the time period studied.

The results for SWLS (bottom row) differ somewhat from those for SILS. The unadjusted correlation between SWLS and affect (computed across six to nine weeks) is equal to 0.40, which is slightly weaker than the corresponding estimates for SILS. The reliability of SWLS, equal to 0.78, is higher, however, which is expected given that it is an average score of five sub-items.[16] Consequently, the adjusted correlation of 0.78 is slightly weaker compared to SILS, though still impressive in absolute terms, and stronger than correlations typically reported in previous studies.[17] We cannot say for sure why SWLS produces weaker correlations, but one candidate explanation is that the SWLS items are more retrospective and trait-like compared to the SILS question, which is instead framed in terms of satisfaction with life "these days". Hence, an individual's SWLS score may to a larger extent be "locked in". It should also be noted that a difference between SILS and SWLS is that the latter was not measured on random occasions. We are not able to assess if this has an impact, however.

Turning to the precision of the point estimates, as indicated by the 95 % confidence intervals, we see that it is unlikely that the true values are smaller than around 0.8 for

[16] For comparison, Diener et al. (1985) report a two-month test-retest correlation of 0.82 for SWLS, and our estimate lies in the upper range of comparable estimates reported in Pavot and Diener (1993).

[17] Interestingly, the estimate of 0.74 in Eid and Diener (2004) is close to, and within the confidence interval of, our estimate.

SILS and 0.7 for SWLS. An informal inspection also rules out the possibility that the contrasts of main interest are produced by chance. For example, the confidence intervals of $\hat{\rho}$ and $\tilde{\rho}$ within the same row are non-overlapping throughout. We also did a formal test of the equality of $\tilde{\rho}$ across SILS and SWLS, treating their respective bootstrap distributions as independent. According to this test, we can reject the hypothesis that the difference is zero at a significance level of no less than $\alpha = 0.1$.

Summing up the results, our estimates that account for reliability issues are markedly stronger than those that do not, whether based on our own data, or those typically reported in previous literature. This is true both for the SILS and SWLS measures, although stronger correlations were found for SILS. Moreover, we also find a rather sizeable current-mood bias effect on SILS.

5.3 Testing for Heteroskedasticity and Autocorrelation

Our model formulation and estimation strategy rely on the assumption that the variance and covariance of the life satisfaction and affect error terms are stable. To take an example—which should be clear from equations (10)–(11) in Section 3.2—a positive autocorrelation in affect would cause an upward (asymptotic) bias in the estimator of the reliability ratio $\hat{\delta}_a$, and hence a downward bias in the adjusted correlation $\tilde{\rho}$. Specifically, the model assumptions must hold across survey weeks, for our estimation strategy to be valid.

As noted in Section 5.2, the fact that the results for SILS are similar whether they are based on a time horizon of three or six weeks suggests that this is not a problem in practice. To assess this in more detail, we can examine the empirical variance–covariance matrix of SILS and affect, shown in Table 6 in the appendix. In this table, affect observations are indexed by individual measurement occasion $1, 2, \ldots, 27$, and life satisfaction by week $1, 2, 3$. Each cell on the lower and main diagonal represents the covariance of the row and and column variable, i.e. the mean of the (demeaned) within-individual cross-products, and the upper diagonal shows the corresponding correlation coefficients. The affect measurements which are simultaneous with life satisfaction are shown separately in rows/columns 28–30, to highlight the impact of current-mood bias on life satisfaction.

An informal inspection of Table 6 suggests that there is a daily affect "shock", in the sense that affect correlates more strongly within a given day than across days. Moreover, there seems to be an autoregressive structure within days, so that affect in the morning is more correlated with affect in the afternoon, than with affect in the evening.

There does not appear to be any similar dependence in the covariance across days and weeks, however, and neither does the variance appear to change systematically. For life satisfaction, the covariance between six weeks is slightly less than that between three weeks, whereas this is not true for the correlation coefficients.

Table 3: Test of homoskedasticity and autocorrelation of life satisfaction and affect

	$ls_t ls_s$		$a_t a_s$		$ls_t a_s$	
	$t = s$	$\Delta(t,s) \geq 3$ w.	$t = s$	$\Delta(t,s) \geq 3$ w.	$t = s$	$\Delta(t,s) \geq 3$ w.
Intercept	3.66	2.63	3.65	1.11	2.44	1.56
	(0.39)	(0.39)	(0.22)	(0.12)	(0.30)	(0.19)
Week 2	0.17		−0.16		0.09	
	(0.35)		(0.23)		(0.35)	
Week 3	−0.19		0.09		−0.02	
	(0.40)		(0.25)		(0.37)	
$\Delta(t,s) = 6$ weeks		−0.21		0.09		0.01
		(0.24)		(0.10)		(0.12)
Wald test, p-value	0.56	0.37	0.48	0.34	0.94	0.92
n	246	217	252	252	246	246
N	599	489	5,378	39,260	599	8,747

Each column shows results from regressions of week or cross-week indicators on within-individual cross-products of life satisfaction (SILS) and affect. The standard errors in parentheses are based on a robust variance-covariance matrix with individual-level clustering, and so is the Wald-test, which tests the null hypothesis that all coefficients except the intercept are zero.

To test the assumptions of homoskedasticity and autocorrelation more formally, we run regressions with subsets of the individual cross-products as outcomes, on indicator variables corresponding to the relevant regions in Table 6.[18] To test for heteroskedasticity, the cross-products for $t = s$ are regressed on dummies for week two and three (compared to week one). To test for autocorrelation, the cross-week products are regressed on a dummy for when the time horizon is six weeks (compared to three weeks). In the presence of heteroskedasticity and autocorrelation, we would expect these models to yield results that are significantly different from zero. For example, if there were a weekly affect shock that was autocorrelated across weeks, we would expect the covariance between affect during the first and second survey weeks to be stronger than that

[18] The individual data was used, rather than the aggregated data in Table 6, in order to be able to compute a consistent, cluster-robust, variance-covariance matrix of the estimates. Strictly speaking, the results from these regressions do not capture the weekly (co-)variance, as the data were demeaned across all weeks. The variation in means across weeks is negligible in practice, however.

between the first and the third.

The results from these regressions are presented in Table 3. In neither case can we reject the null hypothesis of homoskedasticity and zero autocorrelation across weeks. Thus, we conclude that these issues should not be a problem for the consistency of our estimations. The stability of the cross-week covariances also suggests that the stable (latent) components of life satisfaction and affect are indeed stable during the period studied (see also footnote 9).

5.4 Robustness to Survey Context Effects

In our survey design, both the timing of the queries and the type of query (the set of questions included), are randomized within individuals. Hence, there should be little room for systematic survey context effects, as might be the case if, e.g., everyone answered the survey on the same particular day. As an additional robustness check, however, we also re-estimate the main results (for SILS) using life satisfaction and affect scores net of survey context effects. These scores are obtained as residuals from OLS estimations, in which SILS and momentary affect are regressed on a quadratic function of response time and a set of indicator variables capturing hour of the day, day of the week, survey week and type of query.

The results, shown in Table 9 in the appendix, are almost identical to the original results, with point estimates of the reliability-adjusted correlations computed across three and six weeks equal to 0.89 and 0.89, respectively. The similarity of the results is unsurprising in light of the low explanatory power of the survey context regressions, and the fact that the residuals correlated strongly with the original scores ($r = 0.99$ for both SILS and affect).

As an interesting sidenote, we only find statistically significant response effects for affect, with higher well-being on weekends and during evenings. It is possible that our sample size is too small to detect such effects on life satisfaction, however, and the point estimates suggest that there may be a small positive weekend effect also in this case.

5.5 Results for Alternative Well-Being Measures

To assess the generality of the results presented in Section 5.2, and to address the concern that these are driven by our specific choice of affect measure, we also estimated the correlation between life satisfaction and a set of specific emotions measured once each survey week (as described in Section 4.4). The results from these estimations are presented in the appendix, in Table 7 for SILS, and in Table 8 for SWLS. The latter table also presents separate estimates for the sub-item of the SWLS scale which is most comparable with SILS—the question "I am satisfied with my life" (henceforth SWLS-4). For comparison with previous literature, tables 7 and 8 also include two affect measures derived from the specific affect questions: *net affect*, which is defined as the happiness score minus the average score of sadness, stress and pain; and the *u-index*, which is equal to 1 if the happiness score is larger or equal to the maximum score of sadness, stress and pain.[19] Since the specific affect questions were only included on three occasions for each individual, the sample sizes are somewhat smaller, with lower precision as a consequence. Hence we focus solely on the point estimates.

By and large, these results are in line with the main results. The happiness and sadness measures, which can be considered rather clear measures of positive and negative affect, correlate strongly and almost symmetrically with both SILS and SWLS, although somewhat stronger in the case of sadness for SWLS. In each case, the correlation is somewhat weaker in absolute terms, compared to the results based on the momentary affect measure used in the main analysis. This is expected, however, since momentary affect is bi-polar, i.e. it captures a spectrum of both positive and the negative affect. The correlation between net affect and life satisfaction ranges between 0.68, for SWLS, and 0.84, for SILS measured across three weeks. The strength of the correlation is somewhat weaker for the u-index (-0.60 for SWLS and -0.79 for SILS across three weeks), but this is perhaps not so surprising, given that it is a dummy variable, which discards variation in well-being above a certain threshold.

Turning to the more specific emotions tiredness, stress and pain, it can be seen that all of these correlate less strongly with both SILS and SWLS. Perhaps with the exception for pain, this is expected, in so far that these are less clear measures of positive and negative affect, as already noted in Section 4.4. Being tired is not a desirable state in general, but it is possible, e.g., to be both happy and tired after a workout or an eventful day. The fact that these correlations are weaker can be interpreted as life satisfaction exhibiting discriminant validity with respect to these measures.

Lastly, it can be noted that the adjusted correlation between SWLS-4 and momentary affect is equal to 0.78, i.e. the same as between the composite SWLS measure and momentary affect. Compared to SWLS, SWLS-4 appears to correlate more strongly with the other affect measures, but due to the low precision of these estimates, we cannot draw any clear conclusions.

[19] The u-index was proposed by Krueger (2008) and in their context it was aggregated over time so that the resulting measure could vary between 0 and 1. Since our measure refers to a single point in time only, we should perhaps call it the "u-indicator" instead.

6 Socioeconomic Correlates

It follows from our model (and random sampling within individuals), that the within-mean of momentary affect, $\overline{a}_i = \frac{1}{T_i}\sum_{T_i} a_{it}$, is a consistent estimator (in the number of within-observations T_i) of individual long-run affect a_i^*. Hence, we can use this as a summary measure of individual well-being. It is interesting to see how this measure compares with life satisfaction in terms of its socioeconomic correlates. We do this by using the variables from the sign-up questionnaire (marital status, sex, presence of children in the household, employment and age) to run happiness regressions with aggregated affect, $\overline{a}_i$, and life satisfaction as outcomes, on a subset of 246 individuals for which all outcomes are available. To facilitate comparisons, all regressions are run on the z-scores of the outcome variables. We use SWLS from the sign-up questionnaire, whereas for SILS we use both the first non-missing weekly observation and a within-mean across all weeks, as separate outcomes.

The regression results are shown in Table 4, with coefficient estimates in the left panel (with standard errors in parentheses). Although the sample size is relatively small, several coefficient estimates are significantly different from zero. For example, the positive impact of marriage/cohabitation found in several other studies, is replicated across all outcomes. We also find a very strong negative impact of being long term sick or early retired, across all outcomes. Moreover, being older is associated with higher affect and life satisfaction in our sample (in contrast with results from several other studies), and so is being on parental leave (though insignificant in one SILS model). Socioeconomic variables explain more variation in SWLS than in affect, in terms of their respective R^2-values of 0.24 and 0.15, with SILS somewhere inbetween with $R^2 = 0.21$ (which is not improved by averaging the SILS scores across weeks).

An informal inspection of the magnitudes of the coefficients—which should be interpreted in terms of standard deviations of the outcome variable—seems to suggest that life satisfaction and affect are similar in terms of their correlates. It is more relevant to compare the ratios of coefficient-pairs from within the same regression, however. Such ratios are directly informative of the well-being tradeoffs between different factors, which is ultimately what matters for whether policy implications might differ as a result of using different SWB measures. Moreover, the magnitude of the ratios is not sensitive to differences in the amount of noise in the outcome variables, as is the case for z-scores.

The ratio estimates are presented in the right panel of Table 4, using the coefficient for being married or cohabiting as the denominator throughout. As an example, consider the ratio between the coefficients "Sick/early retired" and "Married/cohabiting". This

Table 4: Socioeconomic correlates of aggregated affect and life satisfaction

	Coefficient estimates				Ratio estimates			
	$\overline{\text{Affect}}$	SILS	$\overline{\text{SILS}}$	SWLS	$\overline{\text{Affect}}$	SILS	$\overline{\text{SILS}}$	SWLS
Married/cohabiting	0.32	0.52	0.46	0.53	1.00	1.00	1.00	1.00
	(0.15)	(0.14)	(0.14)	(0.15)	–	–	–	–
Female	−0.15	0.04	−0.05	0.21	−0.45	0.07	−0.12	0.40
	(0.13)	(0.12)	(0.12)	(0.12)	(0.49)	(0.27)	(0.31)	(0.31)
Any children in hh	−0.07	−0.18	−0.16	−0.23	−0.22	−0.34	−0.35	−0.43
	(0.17)	(0.16)	(0.17)	(0.16)	(0.49)	(0.29)	(0.33)	(0.33)
Student	0.10	0.29	0.28	0.35	0.30	0.55	0.61	0.66
	(0.16)	(0.17)	(0.16)	(0.17)	(0.50)	(0.33)	(0.39)	(0.40)
Parental leave	0.66	0.40	0.71	0.62	2.05	0.77	1.55	1.17
	(0.26)	(0.27)	(0.25)	(0.16)	(1.67)	(0.46)	(0.89)	(0.44)
Unemployed	−0.31	−0.57	−0.40	−0.72	−0.95	−1.08	−0.87	−1.37
	(0.38)	(0.33)	(0.34)	(0.41)	(1.14)	(0.70)	(0.67)	(1.04)
Sick/early retired	−1.07	−1.61	−1.44	−1.59	−3.32	−3.07	−3.13	−3.01
	(0.34)	(0.33)	(0.36)	(0.29)	(3.53)	(1.94)	(2.43)	(1.66)
Age 27–35	0.37	0.32	0.34	0.23	1.15	0.62	0.74	0.44
	(0.20)	(0.19)	(0.20)	(0.17)	(0.60)	(0.30)	(0.34)	(0.29)
Age 36–44	0.51	0.40	0.57	0.57	1.59	0.76	1.23	1.07
	(0.23)	(0.21)	(0.22)	(0.21)	(1.06)	(0.35)	(0.58)	(0.45)
Age 45–50	0.65	0.50	0.63	0.62	2.01	0.96	1.37	1.17
	(0.24)	(0.22)	(0.22)	(0.22)	(1.37)	(0.44)	(0.67)	(0.54)
R^2	0.15	0.21	0.20	0.24				

The standard errors in parentheses are based on a heteroskedasticity-robust covariance matrix, and are computed using the Delta Method for the ratio estimates. The ratios in the right panel are computed by dividing the coefficient estimates in the left panel by the "Married/cohabiting" coefficient. All regressions are based on the same sample of $n = 246$ individuals. The outcome variables are z-scores of, from left to right: within-mean of affect, SILS (first weekly non-missing observation), within-mean of SILS, and SWLS (from sign-up). The within-means of affect and SILS are based on an average of 21.6 and 2.4 within-observations, respectively. The reference category is male, neither married nor cohabiting, has no children in the household, is working/employed, and is between 18–26 years old. The intercept and a category for other employment that only applies to one person is omitted from the results.

estimate can be interpreted as the well-being impact of being sick or early retired (relative to being employed), measured in units equivalent to the well-being impact of being married or cohabiting (relative to not). This ratio is equal to −3.3, based on the affect estimates, −3.1 for SILS, −3.1 for averaged SILS, and −3.0, for SWLS. The estimated negative well-being impact of being long term sick or early retired is thus about three times stronger than the positive impact of being married or cohabiting, regardless of which outcome we consider. The question of whether the use of different SWB measures implies different trade-offs could be assessed in terms of whether the differences in ratios like this are statistically and economically significant across estimations.[20] Although the differences between some ratios are economically significant, we do not find any statistically significant differences. In fact, most of the ratios are themselves not significantly different from zero.[21] Our results are thus not inconsistent with life satisfaction and affect having the same determinants, but in fact we lack the statistical power to detect such discrepancies.

At this point, we also want to comment on a pair of studies by Kahneman and Deaton (2010) and Kahneman et al. (2010), concerned with discrepancies between the correlates of life satisfaction and affect. The affect measures used in both these studies refer to the previous day only, in contrast to the measure in our study, which is measured momentarily, across three different weeks during a seven-week period. Assuming that a measure of yesterday's affect captures long-run affect plus white noise (in accordance with our model), then one would expect to obtain weaker correlations between socioeoconomic factors and affect, than for the correlations with life satisfaction. This is consistent with the results in Kahneman et al. (2010).

Kahneman and Deaton (2010) focus on the association between SWB and income, and find that its association with life satisfaction is stronger than the one with respect to either positive or negative affect, at least in relation to some covariates, such as being married. Moreover, they find a satiation point—beyond which there is no significant association with income—with respect to affect, but not with respect to life satisfaction. Due to lack of income data in our study (and a too small sample), we cannot replicate their analysis. However, we highlight as an important question for future research to investigate whether income has differential impacts on life satisfaction and affect, also when the affect measure is based on momentary measurement (and adjusted or aggregated so as to remove the impact of temporary fluctuations).

[20] Clark and Senik (2011) and Clark (2016) use the correlation between the vectors of coefficient estimates based on different SWB outcomes, to quantify the degree of similarity with respect to socioeconomic correlates. This measure can obscure differences in the ratios, however, e.g. if the coefficients fall on a straight line with a non-zero intercept. Hence, we focus on the ratios instead. For comparison, we find that the coefficient vectors (excluding the intercept) from our estimations are strongly correlated—the correlation between the coefficient estimates based on mean affect, on the one hand, and those based on SILS, mean SILS and SWLS, on the other hand, are equal to 0.95, 0.98 and 0.94, respectively.

[21] The inference for ratios of regression coefficients is somewhat complicated. We rely on the asymptotic results of the Delta Method, which provides a formula for computing standard errors, based on the covariance matrix of the OLS coefficient estimates. Asymptotically, the ratios should be normally distributed, but this may not be a good approximation in our case, due to the small sample size.

7 Conclusion

Summing up, we find a strong correlation between life satisfaction and long-run affect, when accounting for various reliability-related measurement issues. Potential violations of the model assumptions, in the form of heteroskedasticity and autocorrelation, do not appear be a problem for our estimation strategy, and neither do survey context effects. Moreover, our results apply to several different SWB measures, although the magnitudes of the different estimates vary somewhat. A strong correlation between life satisfaction and affect does not rule out the existence of differences in their determinants, however. Due to data limitations, we cannot provide a precise answer on this matter, but at least we do not find any clear discrepancies in the relative importance of different socioeconomic correlates.

To be clear, we believe that the increased awareness of the conceptual distinction between life satisfaction and affective well-being is a good thing, and in general, we do not suggest that these should be bunched together under a generic happiness label. On the contrary, we believe that the use of a particular SWB measure should be conceptually and normatively well-motivated. Our results do suggest, however, that the empirical differences between evaluative and affective aspects of SWB might have been exaggerated in some previous research. Besides the evidence presented in this paper, there are also strong theoretical reasons to believe that life satisfaction and affect should correlate strongly in the long run—if people care about their day-to-day emotional well-being, we would expect that their long-run affect levels should be an important input for their life satisfaction judgments, and vice versa, one might expect people's life satisfaction to spill over to their day-to-day mood. Therefore, we suggest as an idea for future research to further explore the hypothesis of a one-dimensional long-run SWB dimension.

Our finding of a strong convergence between life satisfaction and affect has practical implications for the measurement of SWB. In particular, our results provide a rationale for the common practice in applied research to use life satisfaction as a summary measure of individual SWB, as it has higher (though still imperfect) reliability and is easier to measure than affect. This point also applies to policy initiatives with the aim of measuring national SWB levels. Whether the aim is to collect data on life satisfaction or affective well-being, however, we stress the value of survey designs that allow for repeated individual measurements. Already with two measurements, it is possible to estimate the reliability of the measures used, which in turn can be used to compute reliability-adjusted estimates.

Previous literature has discussed the importance of survey context effects on life satisfaction judgments (see Lucas, 2016). The present study contributes to this debate, by showing that there is a direct and non-negligible association between current mood and reported life satisfaction—i.e. a current-mood bias. We therefore caution researchers against correlating different SWB measures from the same survey occasion. Moreover, we conjecture that the current-mood bias may spill over to other subjective variables, such as subjective health. This would lead to an upward bias in estimates of the impact on such variables on SWB.[22]

Some limitations of our study, and suggestions for future research, should also be mentioned. First, the data available for this study do not allow us to do an in-depth assessment of whether there are systematic differences in the correlates of life satisfaction and long-run affective well-being. This topic should be a priority for future studies, since applied research on SWB, and policy implications from such research, is typically concerned with the relationship between SWB and various socioeconomic variables. A crucial point is whether future studies can reveal systematic and substantial differences in the relative strength of the determinants of life satisfaction and long-run affect. If not, policy implications based on either life satisfaction or affective well-being would not differ, regardless of the strength of the direct association between the two variables.

Second, it would be interesting to study the relationship between life satisfaction and affect over a longer time period. Although the seven-week long survey period of the current study should be enough to account for moment-to-moment and day-to-day fluctuations in well-being, and provide a fairly representative sample of the experiences of most people, this may not be the case for everyone, e.g. due to the survey period coinciding with a particularly stressful, but temporary, period at work. It is a bit of an open question to what extent people's life satisfaction judgments are forward and backward looking, but at least for scales such as the SWLS, which include explicitly backward-looking questions, it would seem like a "fair" comparison with affective well-being would require the latter to be measured over a rather long period. To the extent that the results based on such long-run measurements would differ from those of the present study, we hypothesize that the satisfaction–affect association may be even stronger. It is important to note, however, that studies based on long-run data must use methods that do not conflate temporary fluctuations with long-run changes in SWB.

Finally, future studies should replicate our results in other samples, e.g. to assess whether the association between life satisfaction and affect differs across countries or across different groups within countries.

[22] But there would also be a downward bias working in the other direction, due to imperfect reliability of subjective health and similar measures.

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Appendix

Table 5: Within-individual covariance matrix of life satisfaction and affect

	ls_t	ls_s	a_t	a_s
ls_t	$\sigma^2_{ls^*} + \sigma^2_e$	$\sigma^2_{ls^*}$	$\sigma_{ls^*,a^*} + \sigma_{e,u}$	σ_{ls^*,a^*}
ls_s	$\sigma^2_{ls^*}$	$\sigma^2_{ls^*} + \sigma^2_e$	σ_{ls^*,a^*}	$\sigma_{ls^*,a^*} + \sigma_{e,u}$
a_t	$\sigma_{ls^*,a^*} + \sigma_{e,u}$	σ_{ls^*,a^*}	$\sigma^2_{a^*} + \sigma^2_u$	$\sigma^2_{a^*}$
a_s	σ_{ls^*,a^*}	$\sigma_{ls^*,a^*} + \sigma_{e,u}$	$\sigma^2_{a^*}$	$\sigma^2_{a^*} + \sigma^2_u$

Table 6: Estimated matrix of cross-products of life satisfaction and affect

	Affect week 1									Affect week 2									Affect week 3									Affect together with SILS					
	Day 1			Day 2			Day 3			Day 4			Day 5			Day 6			Day 7			Day 8			Day 9			Affect			SILS		
	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9	a_{10}	a_{11}	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}	a_{17}	a_{18}	a_{19}	a_{20}	a_{21}	a_{22}	a_{23}	a_{24}	a_{25}	a_{26}	a_{27}	a_{ls_1}	a_{ls_2}	a_{ls_3}	ls_1	ls_2	ls_3
a_1	3.52	*0.47*	*0.41*	*0.34*	*0.51*	*0.42*	*0.37*	*0.38*	*0.17*	*0.24*	*0.24*	*0.26*	*0.29*	*0.35*	*0.26*	*0.35*	*0.28*	*0.19*	*0.34*	*0.21*	*0.25*	*0.32*	*0.44*	*0.35*	*0.31*	*0.32*	*0.35*	*0.44*	*0.35*	*0.30*	*0.47*	*0.50*	*0.47*
a_2	1.49	3.25	*0.43*	*0.18*	*0.38*	*0.27*	*0.24*	*0.31*	*0.26*	*0.14*	*0.36*	*0.36*	*0.11*	*0.36*	*0.19*	*0.14*	*0.34*	*0.25*	*0.33*	*0.26*	*0.33*	*0.40*	*0.38*	*0.38*	*0.27*	*0.18*	*0.32*	*0.43*	*0.20*	*0.44*	*0.37*	*0.44*	*0.53*
a_3	1.41	1.35	3.21	*0.38*	*0.36*	*0.36*	*0.29*	*0.33*	*0.34*	*0.24*	*0.37*	*0.37*	*0.27*	*0.31*	*0.31*	*0.28*	*0.27*	*0.37*	*0.28*	*0.33*	*0.29*	*0.34*	*0.37*	*0.31*	*0.30*	*0.35*	*0.42*	*0.49*	*0.38*	*0.34*	*0.45*	*0.41*	*0.36*
a_4	1.19	0.58	1.32	3.66	*0.63*	*0.50*	*0.41*	*0.30*	*0.37*	*0.35*	*0.38*	*0.41*	*0.23*	*0.13*	*0.20*	*0.39*	*0.24*	*0.35*	*0.28*	*0.38*	*0.24*	*0.20*	*0.43*	*0.34*	*0.29*	*0.28*	*0.29*	*0.48*	*0.42*	*0.32*	*0.43*	*0.44*	*0.43*
a_5	1.87	1.28	1.26	2.27	3.82	*0.60*	*0.50*	*0.38*	*0.43*	*0.40*	*0.38*	*0.34*	*0.21*	*0.40*	*0.37*	*0.29*	*0.36*	*0.33*	*0.41*	*0.40*	*0.38*	*0.42*	*0.46*	*0.38*	*0.34*	*0.29*	*0.36*	*0.60*	*0.43*	*0.39*	*0.50*	*0.53*	*0.51*
a_6	1.60	0.92	1.28	2.00	2.34	4.21	*0.45*	*0.43*	*0.48*	*0.33*	*0.33*	*0.41*	*0.33*	*0.36*	*0.42*	*0.30*	*0.40*	*0.36*	*0.30*	*0.35*	*0.28*	*0.36*	*0.38*	*0.35*	*0.32*	*0.28*	*0.44*	*0.54*	*0.37*	*0.31*	*0.54*	*0.44*	*0.42*
a_7	1.24	0.80	1.01	1.56	1.86	1.70	3.63	*0.57*	*0.43*	*0.37*	*0.33*	*0.48*	*0.23*	*0.34*	*0.27*	*0.29*	*0.28*	*0.22*	*0.25*	*0.27*	*0.28*	*0.30*	*0.46*	*0.41*	*0.18*	*0.21*	*0.26*	*0.51*	*0.40*	*0.35*	*0.40*	*0.50*	*0.38*
a_8	1.34	1.09	1.20	1.09	1.49	1.74	2.07	3.95	*0.60*	*0.30*	*0.29*	*0.47*	*0.34*	*0.48*	*0.39*	*0.28*	*0.37*	*0.33*	*0.34*	*0.34*	*0.38*	*0.39*	*0.40*	*0.35*	*0.35*	*0.33*	*0.41*	*0.49*	*0.43*	*0.32*	*0.53*	*0.56*	*0.47*
a_9	0.59	0.87	1.22	1.39	1.63	1.89	1.65	2.29	3.69	*0.28*	*0.40*	*0.42*	*0.24*	*0.38*	*0.45*	*0.28*	*0.29*	*0.32*	*0.32*	*0.39*	*0.36*	*0.49*	*0.33*	*0.33*	*0.38*	*0.29*	*0.35*	*0.47*	*0.43*	*0.30*	*0.49*	*0.44*	*0.39*
a_{10}	0.89	0.48	0.81	1.23	1.41	1.22	1.29	1.07	1.06	3.76	*0.64*	*0.49*	*0.25*	*0.35*	*0.28*	*0.24*	*0.12*	*0.15*	*0.35*	*0.36*	*0.24*	*0.28*	*0.29*	*0.27*	*0.31*	*0.28*	*0.23*	*0.33*	*0.39*	*0.27*	*0.25*	*0.28*	*0.24*
a_{11}	0.75	1.18	1.15	1.35	1.35	1.23	1.19	1.00	1.43	2.20	3.18	*0.54*	*0.35*	*0.38*	*0.39*	*0.34*	*0.25*	*0.34*	*0.30*	*0.37*	*0.29*	*0.33*	*0.21*	*0.38*	*0.26*	*0.25*	*0.31*	*0.32*	*0.46*	*0.29*	*0.36*	*0.50*	*0.41*
a_{12}	0.87	1.11	1.16	1.33	1.13	1.41	1.54	1.57	1.44	1.51	1.64	2.97	*0.42*	*0.45*	*0.38*	*0.40*	*0.40*	*0.37*	*0.31*	*0.34*	*0.27*	*0.27*	*0.34*	*0.29*	*0.29*	*0.28*	*0.41*	*0.39*	*0.53*	*0.34*	*0.38*	*0.51*	*0.42*
a_{13}	0.95	0.36	0.89	0.78	0.71	1.23	0.79	1.24	0.88	0.98	1.19	1.41	3.59	*0.64*	*0.43*	*0.33*	*0.41*	*0.38*	*0.26*	*0.25*	*0.08*	*0.21*	*0.13*	*0.19*	*0.28*	*0.17*	*0.36*	*0.27*	*0.47*	*0.10*	*0.35*	*0.42*	*0.30*
a_{14}	1.23	1.18	1.04	0.43	1.48	1.37	1.17	1.71	1.29	1.23	1.27	1.37	2.13	3.54	*0.57*	*0.35*	*0.51*	*0.47*	*0.23*	*0.31*	*0.29*	*0.34*	*0.36*	*0.39*	*0.33*	*0.29*	*0.43*	*0.36*	*0.59*	*0.31*	*0.44*	*0.57*	*0.47*
a_{15}	0.86	0.64	0.98	0.72	1.40	1.67	0.99	1.49	1.64	0.97	1.33	1.22	1.46	1.88	3.48	*0.43*	*0.38*	*0.36*	*0.35*	*0.37*	*0.28*	*0.29*	*0.30*	*0.35*	*0.37*	*0.21*	*0.32*	*0.37*	*0.46*	*0.26*	*0.42*	*0.54*	*0.43*
a_{16}	1.38	0.50	1.00	1.43	1.11	1.15	0.99	1.06	1.06	0.95	1.22	1.33	1.24	1.25	1.61	3.92	*0.57*	*0.46*	*0.28*	*0.41*	*0.28*	*0.32*	*0.37*	*0.40*	*0.29*	*0.25*	*0.36*	*0.42*	*0.59*	*0.28*	*0.39*	*0.53*	*0.36*
a_{17}	0.90	1.11	0.88	0.90	1.33	1.68	1.00	1.41	1.12	0.45	0.84	1.35	1.44	1.88	1.41	2.22	3.75	*0.62*	*0.26*	*0.41*	*0.25*	*0.36*	*0.39*	*0.42*	*0.38*	*0.31*	*0.41*	*0.47*	*0.56*	*0.26*	*0.44*	*0.55*	*0.46*
a_{18}	0.62	0.78	1.15	1.26	1.15	1.35	0.79	1.17	1.13	0.51	1.13	1.08	1.27	1.63	1.18	1.59	2.16	3.36	*0.24*	*0.42*	*0.33*	*0.40*	*0.39*	*0.34*	*0.33*	*0.34*	*0.44*	*0.25*	*0.50*	*0.38*	*0.44*	*0.50*	*0.43*
a_{19}	1.10	1.10	0.93	0.92	1.43	1.11	0.90	1.26	1.11	1.19	0.96	0.93	0.93	0.76	1.16	1.03	0.90	0.80	3.30	*0.61*	*0.59*	*0.42*	*0.43*	*0.35*	*0.31*	*0.17*	*0.30*	*0.29*	*0.29*	*0.45*	*0.35*	*0.36*	*0.47*
a_{20}	0.67	0.80	1.01	1.23	1.35	1.32	0.89	1.26	1.40	1.24	1.16	1.02	0.85	1.04	1.29	1.53	1.45	1.44	2.18	3.65	*0.60*	*0.49*	*0.50*	*0.53*	*0.47*	*0.29*	*0.41*	*0.35*	*0.39*	*0.58*	*0.38*	*0.44*	*0.52*
a_{21}	0.89	1.19	0.97	0.92	1.49	1.20	1.10	1.49	1.27	0.92	1.04	0.95	0.30	1.16	1.09	1.18	1.00	1.26	2.28	2.32	4.30	*0.46*	*0.53*	*0.45*	*0.26*	*0.33*	*0.35*	*0.29*	*0.31*	*0.67*	*0.32*	*0.40*	*0.51*
a_{22}	1.08	1.33	1.12	0.69	1.43	1.24	0.94	1.28	1.68	1.01	1.08	0.83	0.72	1.11	0.97	1.10	1.21	1.26	1.47	1.71	1.72	3.31	*0.65*	*0.56*	*0.56*	*0.40*	*0.39*	*0.41*	*0.31*	*0.50*	*0.39*	*0.43*	*0.47*
a_{23}	1.62	1.35	1.28	1.50	1.70	1.55	1.60	1.55	1.22	1.12	0.73	1.13	0.45	1.29	1.09	1.46	1.42	1.33	1.61	1.88	2.21	2.28	3.96	*0.68*	*0.49*	*0.40*	*0.42*	*0.43*	*0.32*	*0.65*	*0.48*	*0.50*	*0.62*
a_{24}	1.31	1.38	1.13	1.27	1.43	1.47	1.49	1.40	1.27	1.12	1.39	0.96	0.71	1.46	1.33	1.64	1.69	1.24	1.32	2.06	1.96	2.16	2.69	4.24	*0.53*	*0.50*	*0.46*	*0.42*	*0.35*	*0.60*	*0.53*	*0.59*	*0.60*
a_{25}	1.17	0.98	1.14	1.07	1.35	1.39	0.66	1.36	1.51	1.30	0.99	1.05	1.09	1.28	1.37	1.19	1.51	1.23	1.24	1.82	1.15	2.10	1.99	2.23	4.21	*0.57*	*0.65*	*0.36*	*0.45*	*0.50*	*0.41*	*0.47*	*0.50*
a_{26}	1.18	0.65	1.13	0.99	1.11	1.14	0.82	1.31	1.18	1.08	0.84	0.92	0.63	1.03	0.80	0.99	1.28	1.21	0.63	1.12	1.34	1.45	1.57	1.92	2.37	3.97	*0.61*	*0.32*	*0.44*	*0.48*	*0.46*	*0.48*	*0.47*
a_{27}	1.12	0.98	1.26	0.89	1.17	1.53	0.82	1.30	1.11	0.77	0.92	1.17	1.18	1.44	1.01	1.21	1.37	1.33	0.93	1.22	1.27	1.21	1.40	1.65	2.35	2.07	2.86	*0.43*	*0.51*	*0.49*	*0.55*	*0.54*	*0.58*
a_{ls_1}	1.65	1.47	1.68	1.84	2.28	2.10	1.93	1.98	1.77	1.30	1.12	1.27	0.97	1.31	1.38	1.68	1.83	0.90	1.05	1.32	1.25	1.40	1.74	1.72	1.49	1.22	1.41	3.91	*0.45*	*0.32*	*0.65*	*0.51*	*0.51*
a_{ls_2}	1.16	0.67	1.27	1.60	1.72	1.43	1.44	1.54	1.69	1.38	1.51	1.72	1.61	2.04	1.63	2.31	2.10	1.72	1.05	1.34	1.25	1.05	1.26	1.39	1.80	1.64	1.71	1.68	3.65	*0.29*	*0.50*	*0.68*	*0.43*
a_{ls_3}	1.04	1.63	1.13	1.18	1.47	1.28	1.34	1.28	1.16	1.03	1.03	1.11	0.37	1.12	0.95	1.06	0.99	1.28	1.65	2.15	2.87	1.90	2.59	2.29	2.06	1.73	1.69	1.23	1.12	3.90	*0.38*	*0.46*	*0.66*
ls_1	1.68	1.21	1.53	1.53	1.84	2.09	1.43	2.02	1.76	0.96	1.20	1.23	1.21	1.58	1.49	1.49	1.70	1.62	1.23	1.38	1.33	1.31	1.93	2.07	1.64	1.71	1.79	2.45	1.77	1.38	3.68	*0.69*	*0.72*
ls_2	1.74	1.53	1.47	1.64	2.18	1.74	1.93	2.18	1.78	1.04	1.71	1.73	1.46	2.09	1.97	2.16	2.07	1.80	1.30	1.57	1.69	1.42	2.01	2.37	1.90	1.80	1.86	1.99	2.54	1.79	2.61	3.85	*0.74*
ls_3	1.56	1.83	1.17	1.40	1.81	1.62	1.40	1.76	1.45	0.84	1.39	1.30	1.04	1.57	1.48	1.31	1.68	1.37	1.66	1.86	2.05	1.65	2.28	2.20	1.98	1.60	1.88	1.84	1.54	2.43	2.43	2.69	3.49

The lower triangle and the main diagonal show covariances and the upper triangle shows correlations. Rows/columns 1–27 show affect observations indexed by within-individual measurement occasion, but excluding observations measured simultaneously with life satisfaction. These are instead shown separately in rows/columns 28–30, indexed by weekly life satisfaction, which is shown in rows/columns 31–33. The total sample consists of 92,829 unique within-individual cross-products of affect and life satisfaction, based on 5378 measurements within 252 individuals. Estimates for each cell are computed using all available complete observation-pairs, within respective cell. The average number of observations per cell is 165.

Table 7: Correlations between life satisfaction (SILS) and different affect measures, test-retest correlations, and reliability-adjusted correlations

	$\hat{\rho}$	$\hat{\delta}_{ls}$	$\hat{\delta}_a$	$\tilde{\rho}$	n	N
SILS–happiness $\Delta(t,s) = 3$ w.	0.36 (0.23, 0.47)	0.70 (0.59, 0.79)	0.30 (0.16, 0.40)	0.79 (0.63, 0.93)	158	281– 558
SILS–happiness $\Delta(t,s) = 6$ w.	0.42 (0.27, 0.53)	0.72 (0.59, 0.80)	0.51 (0.40, 0.61)	0.69 (0.48, 0.85)	123	123– 246
SILS–sadness $\Delta(t,s) = 3$ w.	−0.46 (−0.53, −0.36)	0.70 (0.59, 0.77)	0.44 (0.32, 0.56)	−0.84 (−0.92, −0.73)	158	281– 558
SILS–sadness $\Delta(t,s) = 6$ w.	−0.47 (−0.57, −0.35)	0.72 (0.61, 0.83)	0.46 (0.29, 0.61)	−0.82 (−1.03, −0.67)	123	123– 246
SILS–stress $\Delta(t,s) = 3$ w.	−0.21 (−0.32, −0.11)	0.70 (0.56, 0.80)	0.42 (0.31, 0.54)	−0.38 (−0.55, −0.22)	158	281– 558
SILS–stress $\Delta(t,s) = 6$ w.	−0.11 (−0.27, 0.01)	0.72 (0.59, 0.82)	0.44 (0.25, 0.57)	−0.20 (−0.49, 0.02)	123	123– 246
SILS–tiredness $\Delta(t,s) = 3$ w.	−0.25 (−0.34, −0.14)	0.70 (0.59, 0.79)	0.35 (0.21, 0.45)	−0.50 (−0.70, −0.33)	158	281– 558
SILS–tiredness $\Delta(t,s) = 6$ w.	−0.28 (−0.37, −0.15)	0.72 (0.63, 0.82)	0.32 (0.13, 0.52)	−0.58 (−0.92, −0.31)	123	123– 246
SILS–pain $\Delta(t,s) = 3$ w.	−0.28 (−0.39, −0.20)	0.70 (0.59, 0.79)	0.44 (0.33, 0.57)	−0.51 (−0.69, −0.33)	158	281– 558
SILS–pain $\Delta(t,s) = 6$ w.	−0.23 (−0.34, −0.13)	0.72 (0.60, 0.79)	0.46 (0.28, 0.62)	−0.40 (−0.66, −0.21)	123	123– 246
SILS–net affect $\Delta(t,s) = 3$ w.	0.46 (0.34, 0.52)	0.70 (0.59, 0.78)	0.43 (0.31, 0.55)	0.84 (0.72, 0.98)	158	281– 558
SILS–net affect $\Delta(t,s) = 6$ w.	0.47 (0.33, 0.60)	0.72 (0.59, 0.80)	0.57 (0.45, 0.66)	0.73 (0.55, 0.87)	123	123– 246
SILS–u-index $\Delta(t,s) = 3$ w.	−0.31 (−0.42, −0.20)	0.70 (0.60, 0.80)	0.21 (0.05, 0.34)	−0.79 (−1.17, −0.58)	158	281– 558
SILS–u-index $\Delta(t,s) = 6$ w.	−0.32 (−0.44, −0.16)	0.72 (0.59, 0.82)	0.36 (0.17, 0.51)	−0.64 (−0.91, −0.40)	123	123– 246

Correlations on the same row are based on the same sample of individuals (n) who contribute at least one observation-pair to each correlation. Each row show correlations computed across all combinations of cross-week observation-pairs (N), across three and six weeks. $\hat{\rho}$ denotes the unadjusted cross-measure correlation, $\hat{\delta}_{ls}$ and $\hat{\delta}_a$ are test-retest correlations (reliability ratios), and $\tilde{\rho}$ is the reliability-adjusted correlation, computed as $\tilde{\rho} = \hat{\rho}/\sqrt{\hat{\delta}_{ls} \cdot \hat{\delta}_a}$. The 95% confidence intervals in parentheses are based on a non-parametric cluster-bootstrap procedure.

Table 8: Correlations between life satisfaction (SWLS and sub-item "I am satisfied with my life") and different affect measures, test-retest correlations, and reliability-adjusted correlations

	$\hat{\rho}$	$\hat{\delta}_{ls}$	$\hat{\delta}_a$	$\tilde{\rho}$	n	N
SWLS-4–affect	0.39	0.74	0.34	0.78	229	18,549–
$\Delta(t,s) = 6–9$ w.	(0.33, 0.46)	(0.67, 0.78)	(0.29, 0.39)	(0.69, 0.89)		29,853
SWLS–happiness	0.38	0.80	0.50	0.60	158	158–
$\Delta(t,s) = 6–9$ w.	(0.22, 0.48)	(0.69, 0.88)	(0.34, 0.60)	(0.38, 0.77)		316
SWLS-4–happiness	0.37	0.74	0.50	0.61	158	158–
$\Delta(t,s) = 6–9$ w.	(0.25, 0.49)	(0.67, 0.81)	(0.37, 0.62)	(0.41, 0.76)		316
SWLS–sadness	−0.43	0.80	0.46	−0.71	158	158–
$\Delta(t,s) = 6–9$ w.	(−0.54, −0.32)	(0.69, 0.87)	(0.31, 0.59)	(−0.91, −0.55)		316
SWLS-4–sadness	−0.47	0.74	0.46	−0.80	158	158–
$\Delta(t,s) = 6–9$ w.	(−0.56, −0.36)	(0.66, 0.80)	(0.28, 0.61)	(−0.98, −0.66)		316
SWLS–stress	−0.25	0.80	0.50	−0.39	158	158–
$\Delta(t,s) = 6–9$ w.	(−0.37, −0.11)	(0.67, 0.86)	(0.35, 0.58)	(−0.61, −0.16)		316
SWLS-4–stress	−0.27	0.74	0.50	−0.45	158	158–
$\Delta(t,s) = 6–9$ w.	(−0.37, −0.14)	(0.66, 0.81)	(0.37, 0.63)	(−0.58, −0.24)		316
SWLS–tiredness	−0.18	0.80	0.29	−0.37	158	158–
$\Delta(t,s) = 6–9$ w.	(−0.32, −0.05)	(0.65, 0.86)	(0.14, 0.46)	(−0.68, −0.12)		316
SWLS-4–tiredness	−0.22	0.74	0.29	−0.47	158	158–
$\Delta(t,s) = 6–9$ w.	(−0.32, −0.07)	(0.66, 0.81)	(0.17, 0.43)	(−0.65, −0.19)		316
SWLS–pain	−0.27	0.80	0.44	−0.45	158	158–
$\Delta(t,s) = 6–9$ w.	(−0.38, −0.16)	(0.70, 0.86)	(0.31, 0.60)	(−0.61, −0.25)		316
SWLS-4–pain	−0.32	0.74	0.44	−0.56	158	158–
$\Delta(t,s) = 6–9$ w.	(−0.43, −0.20)	(0.65, 0.80)	(0.31, 0.58)	(−0.73, −0.33)		316
SWLS–net affect	0.47	0.80	0.60	0.68	158	158–
$\Delta(t,s) = 6–9$ w.	(0.36, 0.56)	(0.70, 0.87)	(0.51, 0.68)	(0.53, 0.78)		316
SWLS-4–net affect	0.49	0.74	0.60	0.74	158	158–
$\Delta(t,s) = 6–9$ w.	(0.37, 0.59)	(0.64, 0.79)	(0.49, 0.69)	(0.61, 0.87)		316
SWLS–u-index	−0.31	0.80	0.34	−0.60	158	158–
$\Delta(t,s) = 6–9$ w.	(−0.42, −0.21)	(0.68, 0.87)	(0.18, 0.48)	(−0.85, −0.43)		316
SWLS-4–u-index	−0.33	0.74	0.34	−0.65	158	158–
$\Delta(t,s) = 6–9$ w.	(−0.42, −0.20)	(0.63, 0.82)	(0.18, 0.49)	(−0.92, −0.46)		316

Correlations on the same row are based on the same sample of individuals (n) who contribute at least one observation-pair to each correlation. Each row show correlations computed across all combinations of cross-week observation-pairs (N). $\hat{\rho}$ denotes the unadjusted cross-measure correlation, $\hat{\delta}_{ls}$ and $\hat{\delta}_a$ are test-retest correlations (reliability ratios), and $\tilde{\rho}$ is the reliability-adjusted correlation, computed as $\tilde{\rho} = \hat{\rho}/\sqrt{\hat{\delta}_{ls} \cdot \hat{\delta}_a}$. The 95% confidence intervals in parentheses are based on a non-parametric cluster-bootstrap procedure.

Table 9: Correlations between life satisfaction and affect, net of response effects

	$\hat{\rho}$	$\hat{\delta}_{ls}$	$\hat{\delta}_a$	$\tilde{\rho}$	n	N
SILS–affect $t = s$	0.66 (0.60, 0.71)				246	599
SILS–affect $\Delta(t, s) = 3$ w.	0.41 (0.34, 0.48)	0.71 (0.61, 0.78)	0.31 (0.25, 0.37)	0.89 (0.82, 0.95)	190	26,406– 48,159
SILS–affect $\Delta(t, s) = 6$ w.	0.43 (0.35, 0.50)	0.72 (0.62, 0.79)	0.32 (0.25, 0.39)	0.89 (0.80, 0.97)	163	13,203– 22,320

These results replicate those for SILS in Table 2, except that they are based on life satisfaction and affect scores net of measurement context effects. These are obtained as residuals from OLS estimations in which life satisfaction and affect are regressed on a quadratic function of response time and a set of indicator variables capturing hour of the day, day of the week, survey week and type of query (which questions were included).