Research Article

Second-to-Second Affective Responses to Images Correspond With Affective Reactivity, Variability, and Instability in Daily Life

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Abstract: Two distinct literatures have evolved to study within-person changes in affect over time. One literature has examined affect dynamics with millisecond-level resolution under controlled laboratory conditions, and the second literature has captured affective dynamics across much longer timescales (e.g., hours or days) within the relatively uncontrolled but more ecologically valid conditions of daily life. Despite the importance of linking these literatures, very little research has been done so far. In the laboratory, peak affect intensities and reaction durations were quantified using a paradigm that captures second-to-second changes in subjective affect elicited by provocative images. In two studies, analyses attempted to link these micro-dynamic indexes to fluctuations in daily affect ratings collected via daily protocols up to 4 weeks later. Although peak intensity and reaction duration scores from the laboratory did not consistently relate to daily scores pertaining to affect variability or instability, the total magnitude of changes in affect following images did display relationships of this type. In addition, higher peaks in the laboratory predicted larger intensity reactions to salient daily events. Together, the studies provide insights into the mechanisms through which correspondences and noncorrespondences between laboratory reactivity indices and daily affect dynamic measures can be expected.

Keywords: affective dynamics, intensity, duration, variability, instability

Intraindividual processes have long been of psychological and scientific interest. Early research in human development, for instance, sought to understand the human condition by systematically observing the ways in which individuals change across the life span (Baltes et al., 1977; Freud, 1974). Perhaps unsurprisingly, the timescale of such examinations has gradually increased in resolution (Nesselroade, 1991), and, in modern affect dynamic research, it has come to encompass changes in subjective feeling states at the millisecond level (e.g., Robinson et al., 2021). Affective dynamics, which is the study of changes in affect over time (Kuppens, 2015), has yielded insights into mental health and human behavior. Individual differences in dynamic constructs such as affective instability reflect the extremity of intraindividual changes in affect across days or weeks, and these metrics have improved our understanding of the ways in which psychologically healthy affect generation systems function (Houben et al., 2015). In clinical domains, similarly, individual differences in affective instability have proven their worth in understanding the transition from psychological health to psychopathology (Panaite et al., 2020). Yet, as a research domain, affective dynamics remains a relatively new one, and fundamental methodological questions continue to emerge.

One key challenge follows from the different ways that affective change has been conceptualized and measured. Protocols using an array of techniques related to experience sampling have captured dynamics in affective experience across days or weeks, and these approaches have operationalized individual differences in affective change

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using metrics related to affect variability (e.g., intra-individual *SD*s in affect: Eid & Diener, 1999) and affect instability (e.g., the magnitude of successive affect change scores: Jahng et al., 2008). These macro-dynamic methods contrast sharply with laboratory-based protocols designed to elicit and measure affective change in that laboratory protocols elicit affective reactions using images or videos and often sample state affect repeatedly from second to second, thus focusing on affect changes with a high degree of temporal resolution (Dichter & Tomarken, 2008; Koval, Pe, et al., 2013; Robinson et al., 2021). In laboratory paradigms, a good deal of research has also focused on brain activation patterns or behavioral measures that are sensitive to affect change (e.g., Heller et al., 2015; Puccetti et al., 2021).

Macro (daily) and micro (laboratory) assessments can be tuned to affect change and it may be reasonable to expect some degree of convergence across these methods (e.g., Koval, Pe, et al., 2013), but fundamental questions remain (Davidson, 2015; Kuppens et al., 2022). For example, it is possible that daily indices related to variability and instability capture homeostatic processes rather than those pertaining to event reactivity (Watson, 2000), although the relevant indices are more typically interpreted in ways that implicate event reactivity processes (Houben et al., 2015; Koenigsberg, 2010; Thompson et al., 2012; Trull et al., 2015). Along these lines, Houben et al. (2015, p. 922) speculate that individuals displaying larger daily variability or instability coefficients experience more intense reactions to daily events coupled with low affect regulation skills, resulting in affect levels that fluctuate more extensively as new events (whether appetitive or aversive) are encountered. It is problematic in this context, though, that relatively few studies have attempted to link controlled laboratory reactions to macro indices of this type (Kuppens et al., 2022).

There are further reasons for wondering what variability and instability indices, computed on the basis of experience sampling methods, actually reflect. Acute affective reactions are likely to dissipate within 20–30 min (Hemenover, 2003) and would likely be characterized by a relatively brief peak followed by an eventual and gradual return to personal baseline (Verduyn et al., 2009). To capture peak reactivity, within these protocols, would require assessments that are precisely timed to index peak reactions. If measurements occurred outside of the narrow window of peak reactivity, the relevant indices may capture some uncertain combination of peak intensity and reaction duration, probably weighted toward the latter (Klein et al., 2022). From this perspective, it may be crucial to pair experience sampling or daily diary protocols with laboratory-based procedures that can disentangle peaks from durations due to their much greater temporal resolution.

Laboratory-based research can achieve tight control over activating events and measure affective intensity with a high degree of temporal resolution. Such procedures may allow laboratory protocols to capture elements of affective dynamics that ESM protocols cannot (e.g., Heller et al., 2014; Schaefer et al., 2013). However, laboratory paradigms also possess limitations related to ecological validity. They typically assess affective responses elicited by images or videos presented on a computer screen (Koval, Pe, et al., 2013; Robinson et al., 2021). Owing to this context and the elicitation methods that are used (standardized stimuli with little direct personal relevance), it remains unclear whether reactivity changes measured in the laboratory are meaningful approximations of affective change processes that occur in daily life (Kuppens et al., 2022; Wilhelm & Grossman, 2010). Indeed, in one relevant study, Koval et al. (2015) found that affect reactivity scores obtained using videos failed to converge with more idiographic assessments of affective reactivity to personal life events.

In sum, discrepant methods have been used to study affect change over time and such methods may or may not converge in capturing processes related to affective extremity in response to eliciting events. A better understanding of whether and when micro- and macro-dynamic indices correlate with each other would improve our ability to interpret previous research and capitalize on it. Given this background, the present investigation sought to speak to several key questions:

Research Question 1 (RQ1): Are affective dynamic constructs and measures with fundamentally different timescales related to each other? For example, does affective instability, calculated on the basis of consecutive changes in affect across days (Jahng et al., 2008), predict the extent to which an individual will exhibit more pronounced peak responses to affective stimuli presented in the laboratory?

Research Question 2 (RQ2): Conversely, do laboratory-based metrics allow us to make predictions concerning ecologically valid fluctuations in affective experience in daily life? In other words, is there a laboratory-to-life interface that can be observed and, if so, what is its nature?

Study 1

Study 1 was preliminary (first foray) one that examined possible links between micro-dynamic laboratory reactivity and within-person changes in affect across days. We explored both (1) links between dynamic measures assessed at fundamentally different timescales (Davidson, 2015) and (2) links between laboratory peak reactions and emotional experiences in daily life. In all analyses, measures pertaining to positive and negative affect were quantified in a valence-specific manner. This was done because the dynamics of positive and negative affect can be quite different (Norris et al., 2010) and because they are thought to be the product of biobehavioral systems with fundamentally different aims and purposes (Lang & Bradley, 2013; Watson et al., 1999). Indeed, making distinctions related to valence is fundamental to emotion science (Barrett, 2006). At the same time, reactivity parameters can be positively correlated (Klein et al., 2022) and the same is true concerning affect dynamic indices from daily life protocols (Koval, Ogrinz, et al., 2013). Furthermore, there are individual difference factors such as affect intensity that predict intense responses to both positive and negative events (Larsen & Diener, 1987). In sum, there were reasons for both distinguishing indices based on valence and examining potential crossover from one valence to the other. We adopted such procedures in both studies.

Preliminary Research Question (QA)

One question was whether laboratory-based assessments of reactivity would predict mean levels of affect across days. For example, individuals who exhibit stronger peak intensity reactions to negative images, in the laboratory, may be prone to higher levels of daily negative affect. Individuals who are prone to higher levels of negative affect (e.g., due to higher neuroticism levels) are often found to display greater reactivity to negative events (Suls & Martin, 2005), and similar rationales exist for predicting that reactivity to positive events can give rise to higher levels of positive affective experience (Gross et al., 1998). Other theorists and researchers, though, contend that reactivity phenomena cannot be equated with average levels of positive or negative affect (Oishi et al., 2007), and under some circumstances, greater reactivity can covary with lesser mean levels of a given affective type (Grosse Rueschkamp et al., 2020). Given such contradictory findings, we did not make directional predictions concerning relations between laboratory peak reactions and average daily affect levels.

Research Question 1 (RQ1)

The primary Study 1 research question focused on potential relations between laboratory peak reactions and daily quantifications of variability and instability (Trull et al., 2015). To the extent that the latter macro-dynamic parameters capture processes related to affective extremity (Houben et al., 2015), we might expect positive relationships of this type (Thompson et al., 2012). However, given the previously discussed methodological challenges in isolating peak reactions in macro-dynamic work, we were uncertain whether such relationships would be evident. Thus, the primary research question is essentially a question rather than an a priori hypothesis. As a procedural note, both studies were approved by the local institutional review board and informed consent was obtained in both studies. In addition, data and a codebook for this project are posted at OSF: https://osf.io/z54qu/?view_only=09db1a269fd940738fa218ce38c1fd81 (Klein, 2022).

Method

Participants and General Procedures

Power Considerations

Within-subject designs, which are powerful (Loersch & Payne, 2016), were used. Also, given the nested structure of data that was obtained, we employ a multilevel modeling (MLM) analysis approach, which should provide the most accurate estimates of key parameters (Nezlek, 2012). In specific terms, sample size decisions were based on recommendations in the MLM literature (Nezlek, 2012; Scherbaum & Ferreter, 2009), which suggest that sample sizes of 100 participants with at least 10 observations per person should provide sufficient power to detect medium effect sizes (Ohly et al., 2010; Scherbaum & Ferreter, 2009). To obtain sample sizes in this range, the laboratory portion of Study 1 was conducted for 2 weeks, as doing so had resulted in sample sizes of 100 or more in previous studies within the laboratory.

General Procedures

Study 1 consisted of two parts – an initial laboratory portion and a subsequent 14-day daily diary protocol. Participants ($n = 127$, $M_{age} = 19.08$, 62.99% women, 88.19% Caucasian) were undergraduates who were recruited using SONA management software and compensated with course credit. For the initial session, students arrived to the laboratory in groups of six or fewer. After completing informed consent, each participant was placed in a private room with its own personal computer. The affective reactivity task was programmed using E-Prime 2.0, and demographic information was collected using MediaLab software. All computers were equipped with 12.5″ × 16.5″ (1,280 × 1,024) monitors of an identical model (LG Flatron ME 20CR-BF). The daily protocol began immediately after

2 weeks of laboratory data collection and continued for 14 consecutive days.

Dynamic Affect Reactivity Task (DART)

Procedure Synopsis

The present iteration of the Dynamic Affect Reactivity Task (DART) paradigm was designed to capture subjective affective responses to controlled/normed stimuli while achieving the temporal resolution necessary to determine the precise time point and intensity at which affect reactions peaked. To accomplish such goals, the DART (Klein et al., 2022; Robinson et al., 2021) presented visual stimuli while recording micro-momentary changes in state affect 10 times per second. Previous research supports the validity of these procedures and the indices that result from them. Consistent with theorizing concerning the distinct dynamics of positive and negative emotional reactions (Taylor, 1991; Watson, 2000), research using the DART has shown that negative, relative to positive, reactions tend to be faster in their initiation, stronger at peak intensity, and more stereotyped in nature such that the waveforms for negative responses conform to prototypic patterns to a greater extent (Irvin et al., in press). Individual differences also moderate responding in predictable, and theory-consistent, manners. Women, who are thought to be more threat sensitive than men (Cross et al., 2011), exhibit stronger negative reactions in the task (Robinson et al., in press), and individual differences in Behavioral Activation and Behavioral Inhibition (Carver & White, 1994) also modulate responding in predictable ways. For example, participants with higher behavioral inhibition levels exhibit faster and stronger negative responses to aversive stimuli in the task (Robinson et al., 2021). Further validity evidence will be reported in Study 2 of the present paper.

In the current DART, participants viewed 10 pleasant and 10 unpleasant images drawn from the International Affective Picture System or IAPS (Lang et al., 2005). After viewing a “Get Ready!” image for three seconds, provocative images were randomly selected and presented for 5 s. After this 5-s exposure, the slide was replaced with a gray screen containing instructions to continue monitoring and rating one’s feelings. Participants were asked to continuously monitor and rate their feelings as they either changed or stayed the same. The instructions also emphasized the importance of continuing to monitor and rate feelings after the affective slide had disappeared. Figures 1 and 2 provide a screenshot of the DART environment and a trial schematic.

Affective Stimuli

Ten images of each valence/pleasantness were selected using IAPS Self-Assessment-Manikin norm data for image pleasure (1 = *very unhappy* experience while viewing, 9 = *very happy* experience while viewing) and arousal (1 = *a manikin/avatar appearing sleepy/listless*, 9 = *a manikin with an exploding stomach*: Bradley & Lang, 1994). On the basis of these norms, the selected pleasant stimuli (M pleasantness = 7.07) were more pleasant than the unpleasant images (M pleasantness = 2.96), $F(1, 18) = 2{,}570.21$, $p < .001$. Stimuli were matched, however, for affective extremity (distance from midpoint), $F(1, 18) = .14$, $p = .716$, and arousal, $F(1, 18) = .69$, $p = .416$. Pleasurable images featured scenes including cute animals and exciting sports and unpleasant images featured scenes such as physical attacks or crime scene photos.

Rating Procedures

While images were displayed, participants rated their feelings using a standard computer mouse which controlled a sliding visual rating bar located in a right-justified vertically oriented rectangle (see Figure 1). The top affect label (*very pleasant* or *very unpleasant*) was counterbalanced across participants. This rating procedure was partially based on a previously validated continuous rating system (Ruef & Levenson, 2007). Rating bar locations were recorded every 100 ms and ranged from −500 to +500 depending on the participant’s positioning of the bar.

Trial Procedures

The task included 20 total trials (that is, all participants saw the same 20 images, but in different computer-randomized orders). Each trial consisted of (1) a 3-s “Get Ready!” message, (2) 5 s of affective images sized 10.5 inches by 9.25 inches, and (3) 10 s during which images were replaced by a gray rectangle. Figure 2 displays a graphic representation of this trial sequence.

Peak Affect Intensity Quantification

Because rating bar location was recorded 10 times per second, each trial produced a stream of approximately 200 affect intensities. Given this volume of data, as well as the fact that reactions began and peaked at differing times for different participants, an autonomous coding scheme was developed. It consisted of two simple interlocking algorithms that were calibrated to determine the precise times at which (a) significant and consistent increases in affect intensity began (termed “React Start Time”) and (b) these increases ended (termed “Peak Time”). For each trial, the Peak Time point was associated with a corresponding affect rating that can be termed “Peak Intensity,” which was the parameter of key interest.

Algorithms

Before algorithms were applied to the data, difference scores were generated by subtracting each of the 200

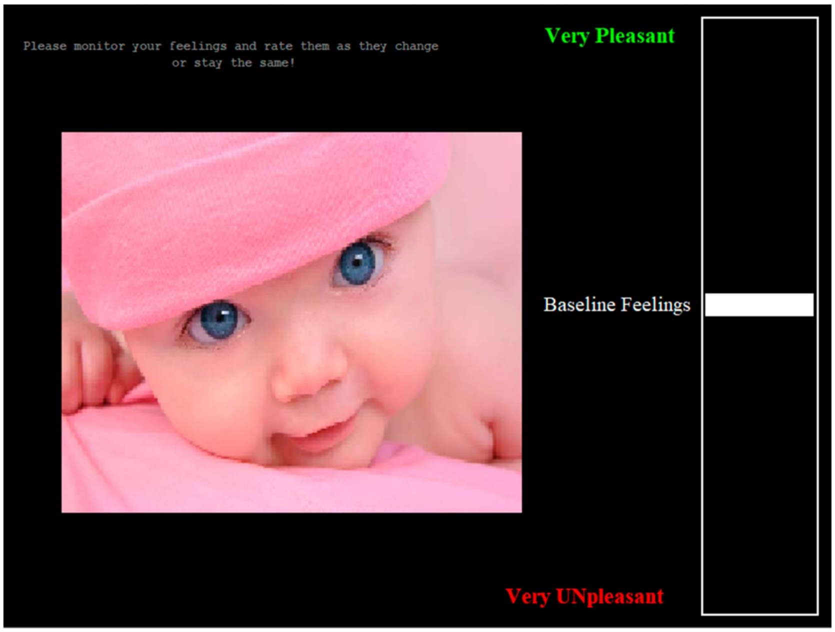

Figure 1. The Dynamic Affect Reactivity Task (DART) Environment. The rating bar toward the right of the screen was controlled using a computer mouse, and mouse position was recorded at 10 Hz.

affect ratings from the subsequent rating, with each difference score representing a change in affect. For computational purposes, trials involving positive and negative stimuli were placed on the same metric, with higher numbers indicating change in a stimulus-congruent manner. Of note, incongruent reactions – such as unpleasant reactions to positive stimuli – did not occur with any appreciable frequency.

The *Reaction Start* algorithm was developed in an iterative fashion, with multiple versions of the algorithm being tested and refined until outputs matched visually coded time/affect plots for 100% of randomly selected trials (Luck, 2012). The final reaction start algorithm targeted the first sample number following image onset that was associated with both (a) two successive change scores that were greater than zero and (b) three sequential change scores (two of which were included in the initial criterion) whose mean was >4, thus bypassing deflections that were not systematic. To be coded as a reaction start, change scores also needed to be positive, reflecting stimulus-congruent changes. Although reaction starts were not of primary interest, they set the stage for the peak intensity algorithm in that peaks should occur subsequent to starts. We reiterate that the algorithms were tested and refined until they matched visual coding such that the algorithms that were finally settled on worked (i.e., matched selected trial output) better than other candidate algorithms, which were either too sensitive, thus coding motor noise as a reaction, or too insensitive, thus failing to identify start times or peaks that were clearly evident in the data.

The *Peak Time* algorithm was developed in the same iterative fashion described above and matched to visual output for a randomly selected group of trials (Luck, 2012). The final peak time algorithm was defined as the first sample following reaction start time that began a plateau of at least eight samples without a further increase in reaction intensity. *Peak Intensity* was defined as the affect rating corresponding to the peak time sample number.

Finally, Peak Intensity algorithm outputs were averaged by image to estimate convergent validity between the DART intensity scores for a given image and the image's previously established valence norm. These average Peak Intensity scores showed strong convergence with previously published IAPS pleasantness norms (unpleasant slides: r = .75; pleasant slides: r = .50; both valences: r > .90).

Data Cleaning

The algorithms were not able to code reactions for 8.7% of trials. A visual inspection of a random subset of these trials suggested that these failed codes were caused by participants exhibiting no coherent reaction to a given image. Thus, uncodeable trials were considered faulty (perhaps due to inattention) and excluded from further analysis. The average participant had 18.16 codeable trials, and no participant had fewer than 13 codeable trials.

Peak Affect Intensity Quantification

Peak affect was quantified by subtracting start position from peak position. Peak negative (M = 316, SD = 102) and positive (M = 201, SD = 90.9) scores were then computed by

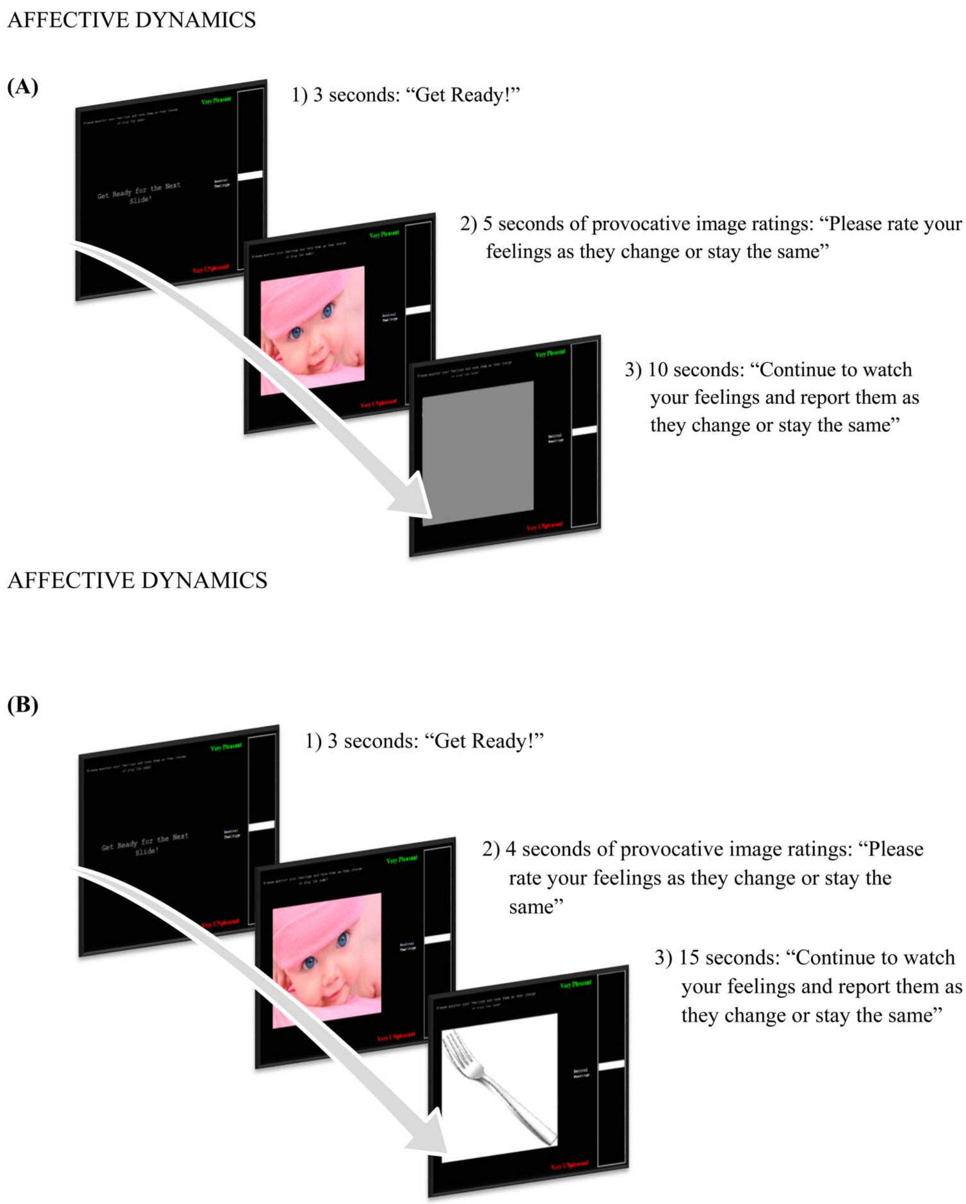

Figure 2. DART trial schematics for Study 1 (panel A) and Study 2 (panel B). In both experiments, participants used the computer mouse and the rating bar to continuously indicate their affective state, both during and after viewing provocative images.

averaging across slides of a given valence. Reliabilities for these averages were excellent (negative α = .93; positive α = .94), and the average correlation between an individual reaction and the relevant average score was .58. Note that peaks were more pronounced for negative than positive stimuli, which is a pattern consistent with the negativity bias (Cacioppo & Berntson, 1999) and with data suggesting that negative events tend to elicit more acute affective reactions than positive events do (Watson, 2000).

Daily Protocol

After a 2-week laboratory portion, the daily diary phase began. Participants received email reminders with Qualtrics survey links at 7 p.m. on each of 14 consecutive days. To limit retrospection, these links remained active for exactly 12 h. Following a priori convention, subjects completing less than nine surveys were excluded from analyses (West et al., 2011). The final data set included 1,607 daily reports.

Daily Positive Affect

Markers from the scale of positive and negative emotion (SPANE) (Diener et al., 2010) and the positive and negative affect schedule (PANAS) (Watson et al., 1988) were chosen to target daily experiences of positive affect. Each evening, participants were asked “To what extent did you feel each of the following today?” in relation to three positive affect markers (excited, positive, happy), and a 5-point scale was used (1 = *not at all*; 5 = *extremely*). The items were averaged to quantify day-specific positive affect (PA) (M = 3.60, SD = 0.95, α = .92).

Daily Negative Affect

The construction of the daily negative scale was parallel. Items, which were sad, negative, and distressed, were averaged to quantify day-specific NA (M = 1.88, SD = 0.86, α = .86).

Affective Dynamics Quantification

Affective Variability

Intraindividual affective variability was first quantified using the within-person SD of repeated daily affect assessments, which is the most common operationalization of the affective variability construct. Such measures have been shown to be reliable and valid in characterizing within-person affective changes (Eid & Diener, 1999). Given the interest in both within-valence and cross-valence associations, and following convention (Koval, Ogrinz, et al., 2013), separable measures of PA (M = 0.63, SD = 0.26) and NA (M = 0.57, SD = 0.31) variability were computed.

Relative Affective Variability

Recently, scholars have noted that intraindividual variability and instability coefficients can be confounded with mean affect, complicating the interpretation of results involving such indices (Dejonckheere et al., 2019). Consequently, new constructs termed relative variability and instability have been proposed (Dejonckheere et al., 2019; Mestdagh et al., 2018). To calculate relative affective variability, we used the relativeVariability package (Mestdagh, 2016) paired with R version 3.6 (R Core Team, 2019), which computes quantities that divide variability scores by the maximum possible variability that could be expected given person-specific means and measurement bounds (Mestdagh et al., 2018). Although we preferred these (positive: M = 0.42, SD = 0.18; negative: M = 0.46, SD = 0.18) scores to noncorrected ones, Mestdagh et al. (2018) do note that corrections can be somewhat extreme at upper and lower bounds of the rating scale that is used.

Affective Instability

Affective instability was quantified in terms of mean successive difference scores (MSSD), which sum successive change scores between adjacent measurements (here PA instability: M = 0.80, SD = 0.69; and NA instability: M = 0.80, SD = 0.80) in a data series (Jahng et al., 2008). Conceptually (and typically empirically), affective variability and affective instability are related (Koval, Pe, et al., 2013). Computationally, instability focuses on consecutive changes in affect, whereas variability indexes divergence from the mean for all data points within a given time series (Trull et al., 2015).

Relative Affective Instability

Because instability scores, such as variability scores, can be confounded with means (Mestdagh et al., 2018), we calculated relative affective instability scores as well. These scores adjust for person means and measurement bounds, and calculations were performed with the relativeVariability package (Mestdagh, 2016) paired with R software. The relative instability mean for positive affect (M = 0.13, SD = 0.17) was quite a bit lower than the relative instability mean for negative affect (M = 0.37, SD = 0.18), indicating a more substantial adjustment.

Results

Correlations

In the DART paradigm, means for positive and negative intensity peaks were positively correlated, r = .37, p < .001, implicating individual differences that matter for both valences (Klein et al., 2022). Correlations among variability and instability indices are reported in Table 1. As shown there, participants who displayed more variability in their positive affect levels also exhibited more variability in their negative affect levels, and the same was true concerning instability scores. These positive correlations encourage cross-valence analyses. Original and relative scores were modestly correlated with each other, even when pertaining to the same valence and the same construct (either variability or instability), suggesting that relative scores assess something quite different from nonrelative scores (Mestdagh et al., 2018).

Preliminary Question (QA)

Given that the present data structure included repeated assessments, we performed a series of multilevel models using SAS PROC MIXED (Singer, 1998). To examine questions concerning average levels of daily affect, DART means for positive and negative peak reactivity were z-scored and then entered as level 2 predictors of daily affect levels, which were nested within person in intercept-random models. DART negative peak scores did not predict daily positive affect (b = .08, t = 1.29, p = .199) or daily negative affect (b = .04, t = .81, p = .420). DART positive peak scores did not predict average levels of daily negative affect (b = −.04, t = −.76, p = .446) but did predict average levels of daily positive affect (b = .21, t = 3.72, p < .001). Estimated means (Aiken & West, 1991) revealed that daily positive affect levels were higher among individuals who exhibited stronger (+1 SD) laboratory-based peak intensities for positive images (estimated M = 3.80), relative to weaker (−1 SD) laboratory-based responses (estimated M = 3.37).

Table 1. Correlations among daily dynamic measures, Study 1

	1	2	3	4	5	6	7	8
1. iSD-pos	1	.64*	.21*	.01	.82*	.57*	.11	−.07
2. iSD-neg	.64*	1	.06	.13	.55*	.86*	−.02	−.01
3. riSD-pos	.21*	.06	1	.60*	.32*	.19*	.91*	.50*
4. riSD-neg	.01	.13	.60*	1	.08	.23*	.53*	.90*
5. MSSD-pos	.82*	.55*	.32*	.08	1	.62*	.33*	.03
6. MSSD-neg	.57*	.86*	.19*	.23*	.62*	1	.16	.22*
7. rMSSD-pos	.11	−.02	.91*	.53*	.33*	.16	1	.52*
8. rMSSD-neg	−.07	−.01	.50*	.90*	.03	.22*	.52*	1

Note. iSD = original variability scores; riSD = relative variability scores; MSSD = original instability scores; rMSSD = relative instability scores; pos = positive affect; neg = negative affect; * = $p < .05$

Research Question 1

Affective Variability

We desired to use MLM procedures for all key analyses, given that both designs (i.e., that from the laboratory and that from the daily protocol) obtained observations that were nested within participants (Nezlek, 2012). Calculations involving variability and instability were based on all daily data (Trull et al., 2015) and, when examining relationships involving these measures, we therefore used variability or instability scores to predict peak reaction intensities within the DART task, thus preserving trial-specific DART data. These MLMs were conducted in a manner parallel to those above, with *z*-scored predictors and random intercepts. As displayed in the top four rows of Table 2, none of the relationships involving original variability scores were significant. These results question the idea that within-person changes in daily affect can be understood in terms of reactivity processes.

Relative Affective Variability

Relative variability scores (Mestdagh et al., 2018) performed considerably better. As displayed in the second four rows of Table 2, all relationships involving relative variability scores were significant. All displayed the expected pattern such that higher levels of variability were linked to stronger peak reactions within the laboratory. In other words, relative variability scores – in Study 1 at least – do appear to capture processes related to event reactivity.

Affective Instability

None of the results involving original instability scores were significant (see rows 9–12 in Table 2). Affective instability scores may thus capture processes aside from event reactivity, such as greater fluctuation in affect for endogenous rather than exogenous reasons (Watson, 2000).

Relative Affective Instability

Recall that adjusting for mean levels of affect and measurement bounds resulted in a more pronounced change in scores pertaining to positive than negative affect instability. These adjustments rendered relative instability scores for positive affect predictive of emotional reactivity in the laboratory (see rows 13–14 in Table 2). A similar trend was evident for relative instability scores for negative affect, but these relationships were not significant (see rows 15–16 in Table 2).

Table 2. Multilevel modeling results involving variability and instability, Study 1

Predictor	Outcome	*b*	*t*	*p*	−1 *SD*	+1 *SD*
iSD-pos	DART-pos	−41.44	−1.51	.134		
	DART-neg	13.08	0.38	.708		
iSD-neg	DART-pos	−24.46	−1.05	.296		
	DART-neg	30.41	1.04	.300		
riSD-pos	DART-pos	22.13	2.47	.015	307	351
	DART-neg	22.38	2.50	.014	306	351
riSD-neg	DART-pos	18.98	2.13	.035	313	351
	DART-neg	19.70	2.23	.027	312	351
MSSD-pos	DART-pos	−3.67	−0.35	.728		
	DART-neg	9.61	0.73	.466		
MSSD-neg	DART-pos	−5.71	−0.64	.523		
	DART-neg	20.79	1.88	.062		
rMSSD-pos	DART-pos	17.62	2.06	.042	311	347
	DART-neg	17.68	2.06	.041	311	346
rMSSD-neg	DART-pos	15.30	1.79	.076		
	DART-neg	16.04	1.89	.061		

Note. iSD = original variability scores; riSD = relative variability scores; MSSD = original instability scores; rMSSD = relative instability scores; pos = positive affect; neg = negative affect

Study 2

The results of Study 1 were encouraging, and Study 2 sought to replicate and extend the analysis. It is our view that nearly continuous assessments of state affect are needed to differentiate peak reaction intensity from related parameters such as the duration of an emotional reaction (Brans & Verduyn, 2014). If peak intensity within the laboratory is not linked to untransformed scores for variability and instability (see Table 2), it is possible that tendencies toward affective variability and instability tap processes related to duration (elongated affective responses) rather than, or in addition to, tendencies to react to events more intensely. Possibilities of this type were investigated by creating a version of the laboratory reactivity task that allowed us to compute both affective duration and total response magnitude. The duration parameter will quantify the duration of affective peaks, and the total response parameter will jointly consider peaks and durations in a manner similar to area under the curve calculations, which are often performed in psychophysiological studies (Pruessner et al., 2013).

In addition, the daily protocol of Study 1 did not assess reactivity to daily events in any direct manner. Following precedent (Hicks & Diamond, 2008; Larsen et al., 1986), we therefore asked Study 2 participants to report on the intensity of their reactions to the best and worst events of each day, within the daily protocol. Recognizing that some of these events might not be that consequential (because some days are more mundane than others), we also asked individuals to rate the importance of the relevant events. For more important events, we hypothesized correspondences between DART peak scores and daily event reactivity tendencies. Altogether, the following questions were pursued.

Initial Research Question

As in Study 1, we were interested in whether reactivity tendencies assessed in the laboratory would predict means for daily positive and negative affect. Relations of this type were not necessarily expected, given that affect means focus on stable rather than dynamic components of affect (Kuppens et al., 2022).

Research Questions 1 and 1A

As in Study 1, RQ1 asked whether daily tendencies toward variability and instability would relate to laboratory-assessed peak intensities. RQ1A then asked whether better correspondence might be obtained by considering DART scores focused on duration or total response magnitude.

Research Question 2

Individuals who exhibit stronger peak intensities in response to DART events should display stronger responses to important daily events. Study 2 permitted us to focus on this question in a relatively direct way.

Method

Participants and General Procedures

Study 2 again consisted of two parts – an initial laboratory portion and a subsequent 14-day daily diary protocol. General recruitment and laboratory procedures were parallel to those described in Study 1. Participants (n = 133, M_{age} = 18.90, 67.67% women, 87.97% Caucasian) completed the DART in the laboratory, after which they completed the daily diary protocol.

Dynamic Affect Reactivity Task (DART)

Procedure Synopsis

Pretask instructions asked participants to continuously monitor and rate their feelings as these feelings changed or stayed the same. In a computer-randomized order, participants viewed 30 pleasant and 30 unpleasant IAPS images (Lang et al., 2005); relative to Study 1, having more affective images could, we reasoned, result in more reliable estimates of key parameters. After viewing a "Get Ready!" image for three seconds, a randomly selected image was presented for 4 s (see Figure 1). Each affective image was then replaced with a neutral IAPS image for additional 15 seconds, which allowed us to quantify lingering reactions to affective images in the context of a subsequent image that possessed some psychological significance. During this neutral image time period, onscreen instructions reminded participants to continue to monitor and rate their feelings. Feeling intensity was again assessed with a computer mouse whose position was echoed by a rating bar (−500 = *extremely unpleasant*, +500 = *extremely pleasant*).

Images

Thirty images of each valence and 15 neutral images were selected on the basis of IAPS norms. The pleasant images were more pleasant (M = 7.51, SD = 0.24) than the neutral images (M = 4.88, SD = 0.21), $F(1, 44) = 1{,}079$, $p < .001$, and the unpleasant images were also more unpleasant (M = 2.49, SD = 0.23) than the neutral images, $F(1, 44) = 1{,}251$, $p < .001$. Pleasant and unpleasant images did not differ by extremity, $F(1, 59) = 0.00$, $p = .996$, or arousal, $F(1, 59) = 0.06$, $p = .813$.

Trial Procedures

Each trial consisted of (1) a 3-s "Get Ready!" message during which the rating bar position was automatically centered, (2) 4 s of rating affect while viewing a provocative positive or negative image, followed by (3) 15 s of continuing to rate experienced affect after the provocative image was replaced with a neutral one (see Figure 1 for a graphic display concerning trial structure). The use of neutral images rendered all portions of each trial a subjectively meaningful experience, which allowed us to capture emotional response patterns as they both ascended in intensity and descended in intensity, as will be further described below.

Algorithms

For each trial, the Study 2 algorithm calculated a *reaction start time*, a *reaction baseline position*, a *peak time*, and a *peak intensity* (see the Study 1 Method section). An additional objective in the development of the Study 2 DART procedures was to quantify peak reaction durations. Owing to the use of a more robust recovery period, we were able to quantify a third time point termed *peak end time*. Peak end time was defined as the moment at which a given reaction began to significantly return to baseline. The peak end time component of the algorithm was developed using an iterative procedure identical to the one described in Study 1. Algorithmically, peak end time was defined as the first sample, following peak time, that was associated with (a) three negative (toward baseline, away from peak intensity) affect change scores in a row, (b) whose mean was <-4. These rules bypassed single-sample blips in mouse position that were not systematic.

Data Cleaning

Among the participants who completed the task successfully, algorithms were not able to code all three key time points on 9.05% of trials. A visual inspection of a random subset of these trials indicated that most missing data were the result of the participants reporting no coherent affect reaction to a given image. In addition, all participants had at least 29 coded trials (with a mean of 51.4 coded trials per person). We therefore dropped uncodeable trials, which could not be used to define reactivity or recovery processes.

Peak Affect Intensity Quantification

Peak intensities were calculated by subtracting start position from peak position. To examine valence-specific processes, we then calculated one mean for positive images (M = 283, SD = 106, α = .90) and another for negative images (M = 333, SD = 108, α = .86). That peak reactions were of a higher magnitude when negative events were involved replicates Study 1 and supports the idea of a negativity bias (Cacioppo & Berntson, 1999). Of further note, average peak intensity scores correlated highly with IAPS norms for pleasantness (unpleasant images: r = .75; pleasant images: r = .53; both valences: r = .89).

Affect Reaction Duration Quantification

For each trial, reaction duration was defined as peak end time minus peak (start) time. Peak durations tended to be longer when positive (M = 3.69 s, SD = 1.87, α = .71), relative to negative (M = 3.05 s, SD = 1.76, α = .78), reactions were involved, consistent with Taylor's (1991) mobilization-minimization framework.

Total Response Magnitude Quantification

Total response magnitude was defined in terms of peak magnitude times reaction duration. Such computations revealed that total reactivity was similar for positive (M = 9,307, SD = 4,396, α = .76) and negative (M = 9,378, SD = 5,102, α = .77) events (i.e., negative reactions had higher peaks but shorter durations: Taylor, 1991).

Daily Protocol

The 14-day daily diary study phase began immediately following the laboratory portion of the study. General daily diary procedures were identical to those reported in Study 1.

Daily Positive Affect

Participants rated their overall level of positive affect on each day using the same markers used in Study 1 (M = 3.43, SD = 0.64).

Daily Negative Affect

Daily negative affect was reported in a manner parallel to Study 1 (M = 2.07, SD = 0.56).

Daily Event Importance and Affective Reactions

At the end of each day, participants recalled the best and worst events that had happened to them that day ("think about the event that happened to you that other people would probably agree is the ["BEST" or "WORST"] THING that happened to you today"). Participants then rated the objective importance of the event ("If you told other people about this event, how important would they think it was?" 1 = *not important at all*; 5 = *quite important*) as well as "how strong" their reaction to each event was (1 = *not strong at all*; 5 = *very strong*). These procedures yielded four scores for each day: positive event importance (M = 2.47, SD = 0.56), negative event importance (M = 2.05, SD = 0.56), reaction magnitude to the daily positive event (M = 2.57, SD = 0.65), and reaction magnitude to the daily negative event (M = 2.25, SD = 0.61). These measures focus squarely on reactivity processes, and they were expected to correspond with peak intensities from the laboratory (i.e., participants displaying larger peaks in the laboratory should exhibit stronger reactivity to daily events, particularly when those events are important).

Affective Dynamics Quantifications

As described in Study 1, variations in affect across days were translated into valence-specific scores for affective variability (positive affect: M = 0.68, SD = 0.25; negative affect: M = 0.72, SD = 0.28), affective instability (positive affect: M = 0.86, SD = 0.63; negative affect: M = 0.99, SD = 0.84), relative affective variability (positive affect: M = 0.38, SD = 0.13; negative affect: M = 0.45, SD = 0.16), and relative affective instability (positive affect: M = 0.27, SD = 0.10; negative affect: M = 0.34, SD = 0.15), with relative scores computed using the relativeVariability program (Mestdagh, 2016).

Results

Correlations

Table 3 reports correlations among DART scores. Individuals who displayed more pronounced (more intense, longer, and in terms of total magnitude) reactions to positive images also displayed more pronounced reactions to negative images, implicating processes that are valence-general. Such findings suggest the value of examining cross-valence associations, which we will continue to do. Higher peak intensities were associated with shorter rather than longer reaction durations, suggesting the need to distinguish these parameters of emotional responding (Verduyn et al., 2009). Finally, the three parameters (intensity, duration, and total response) were not redundant with each other.

Table 4 reports correlations among daily variability and instability scores. Again, individuals who displayed greater variability or instability in their positive feelings also displayed greater variability and instability in their negative feelings, justifying the examination of cross-valence associations. Unlike Study 1, all indices were substantially correlated with each other, and original and relative indices might be expected to function similarly for this reason.

Preliminary Question (QA)

The preliminary question focused on mean levels of daily affect. DART scores for peak intensity, duration, and total response magnitude were averaged by valence and entered as level 2 predictors of daily levels of either positive or negative affect using a random intercept MLM structure (Nezlek, 2012). As shown in Table 5, none of these models resulted in significant results. Thus, the laboratory-based measures, which were designed to capture reactivity processes rather than stable tendencies toward a given type of affect, do not in fact predict stable tendencies toward a given type of affect.

Table 3. Correlations among laboratory (DART) measures, Study 2

	1	2	3	4	5	6
1. Peak-pos	1	.81*	−.36*	−.21*	.57*	.40*
2. Peak-neg	.81*	1	−.28*	−.33*	.44*	.47*
3. Duration-pos	−.36*	−.28*	1	.58*	.49*	.25*
4. Duration-neg	−.21*	−.33*	.58*	1	.27*	.65*
5. Total response-pos	.57*	.44*	.49*	.27*	1	.55*
6. Total response-neg	.40*	.47*	.25*	.65*	.55*	1

Note. pos = positive images; neg = negative images

Table 4. Correlations among daily dynamic measures, Study 2

	1	2	3	4	5	6	7	8
1. iSD-pos	1	.64*	.81*	.47*	.90*	.60*	.72*	.43*
2. iSD-neg	.64*	1	.47*	.62*	.57*	.86*	.43*	.46*
3. riSD-pos	.81*	.47*	1	.58*	.69*	.46*	.88*	.52*
4. riSD-neg	.47*	.62*	.58*	1	.36*	.56*	.45*	.90*
5. MSSD-pos	.90*	.57*	.69*	.36*	1	.58*	.76*	.34*
6. MSSD-neg	.60*	.86*	.46*	.56*	.58*	1	.44*	.58*
7. rMSSD-pos	.72*	.43*	.88*	.45*	.76*	.44*	1	.45*
8. rMSSD-neg	.43*	.46*	.52*	.90*	.34*	.58*	.45*	1

Note. iSD = original variability scores; riSD = relative variability scores; MSSD = original instability scores; rMSSD = relative instability scores; pos = positive affect; neg = negative affect; * = p < .05

Table 5. Multilevel modeling results involving mean daily affect, Study 2

Predictor	Outcome	b	t	p
DART-peak-pos	Daily PA	0.07	1.07	.285
	Daily NA	0.04	0.71	.476
DART-peak-neg	Daily PA	0.08	1.36	.178
	Daily NA	0.05	1.01	.314
DART-duration-pos	Daily PA	0.00	0.04	.972
	Daily NA	0.03	0.48	.635
DART-duration-neg	Daily PA	0.04	0.60	.549
	Daily NA	−0.02	−0.33	.739
DART-total-pos	Daily PA	0.09	1.62	.108
	Daily NA	0.06	1.11	.269
DART-total-neg	Daily PA	−0.01	−0.19	.846
	Daily NA	−0.05	−0.99	.325

Note. total = total response magnitude; pos = positive images; neg = negative images; PA = positive affect; NA = negative affect

Research Question 1

When examining relations between DART peaks and daily variability and instability scores, we flipped the analysis structure such that a single daily variable (e.g., variability of negative affect across days) was used to predict trial-specific peaks, of a given valence, within the DART task. These results were less consistent than in Study 1, and the original/relative distinction was not linked to differential success in prediction (see Table 6). Accordingly, there may be reasons to doubt the contention that variability and

Table 6. Predicting DART peaks on the basis of daily variability and instability scores, Study 2

Predictor	Outcome	*b*	*t*	*p*	−1 *SD*	+1 *SD*
iSD-pos	Peak-pos	23.08	2.33	.022	265	311
	Peak-neg	17.88	1.77	.080		
iSD-neg	Peak-pos	31.54	3.22	.002	257	320
	Peak-neg	18.72	1.84	.069		
riSD-pos	Peak-pos	22.01	2.25	.027	266	310
	Peak-neg	18.51	1.86	.065		
riSD-neg	Peak-pos	19.49	1.95	.054		
	Peak-neg	12.36	1.21	.227		
MSSD-pos	Peak-pos	19.88	1.91	.059		
	Peak-neg	18.31	1.74	.085		
MSSD-neg	Peak-pos	31.20	3.29	.001	256	318
	Peak-neg	18.17	1.84	.068		
rMSSD-pos	Peak-pos	23.99	2.36	.020	264	312
	Peak-neg	20.64	2.00	.048	310	352
rMSSD-neg	Peak-pos	17.59	1.77	.079		
	Peak-neg	11.31	1.12	.266		

Note. iSD = original variability scores; riSD = relative variability scores; MSSD = original instability scores; rMSSD = relative instability scores; pos = positive affect; neg = negative affect

instability scores can be viewed in terms of individual differences in peak reaction intensity (although some positive findings hinted at this possibility).

Research Question 1A

The DART task in Study 2 was designed to extend Study 1 findings by quantifying duration and total response magnitudes (peaks times durations) in addition to peak intensity. Thus, in Study 2, we ran additional analyses. Given that there were eight predictors (e.g., relative affective instability for daily negative affect) and four outcomes (valence-specific versions of duration and total response magnitude), a total of 32 MLM analyses were performed, the results of which are reported in Table 7. The pattern of results was informative in suggesting that daily dynamic parameters appear to capture a combination of peak intensity and duration (i.e., total response magnitude) rather than peak intensity alone. In fact, 11 of the 16 models focused on total response magnitude were significant.

Research Question 2

Question 2 focused on the capacity of DART peak intensity means to predict reactivity to the best and worst events of the day in the daily life protocol. In these cross-level (Singer, 1998) MLM models, the level 2 predictor was a particular *z*-scored DART peak intensity mean and the level 1 predictor was a person-centered importance rating.

Table 7. Predicting DART duration and total response magnitude on the basis of daily variability and instability scores, Study 2

Predictor	Outcome	*b*	*t*	*p*	−1 *SD*	+1 *SD*
iSD-pos	Duration-pos	0.01	0.94	.347		
	Duration-neg	0.03	1.79	.076		
	Total-pos	685.96	2.22	.029	5,900	7,272
	Total-neg	875.66	2.49	.014	6,682	8,434
iSD-neg	Duration-pos	0.02	1.30	.196		
	Duration-neg	0.03	1.72	.088		
	Total-pos	968.32	3.17	.002	5,630	7,567
	Total-neg	945.28	2.67	.009	6,616	8,506
riSD-pos	Duration-pos	0.02	1.08	.282		
	Duration-neg	0.03	2.28	.025	1.16	1.23
	Total-pos	622.02	2.04	.044	5,950	7,194
	Total-neg	867.69	2.53	.013	6,666	8,419
riSD-neg	Duration-pos	0.01	0.98	.328		
	Duration-neg	0.03	2.21	.029	1.16	1.23
	Total-pos	736.10	2.39	.018	5,847	7,194
	Total-neg	716.72	2.02	.046	6,828	8,262
MSSD-pos	Duration-pos	0.01	0.66	.510		
	Duration-neg	0.01	0.45	.650		
	Total-pos	528.78	1.62	.106		
	Total-neg	711.88	1.92	.057		
MSSD-neg	Duration-pos	0.02	1.52	.132		
	Duration-neg	0.03	2.22	.028	1.16	1.23
	Total-pos	975.23	3.31	.001	5,590	7,541
	Total-neg	887.48	2.59	.011	6,638	8,413
rMSSD-pos	Duration-pos	0.02	1.13	.259		
	Duration-neg	0.02	1.64	.105		
	Total-pos	528.78	1.62	.106		
	Total-neg	711.88	1.92	.057		
rMSSD-neg	Duration-pos	0.02	1.18	.240		
	Duration-neg	0.04	2.73	.007	1.16	1.24
	Total-pos	719.35	2.36	.020	5,851	7,290
	Total-neg	646.51	1.83	.070		

Note. iSD = original variability scores; riSD = relative variability scores; MSSD = original instability scores; rMSSD = relative instability scores; pos = positive affect; neg = negative affect; total = total response magnitude

We hypothesized systematic interactions, and both intercepts and slopes were allowed to vary at random. Statistics for these models are reported in Table 8.

Daily Positive Event Reactions

The first MLM, which involved positive DART peaks and reactivity to the best events of the day, resulted in a significant interaction. To interpret this interaction, we calculated estimated reaction intensity means (Aiken & West, 1991) as a function of low (−1 *SD*) versus high

Table 8. DART peak intensity means as a predictor of event-contingent reactions to best and worst daily events, Study 2

Model, predictor, and outcome	*b*	*t*	*p*
Positive peaks and best event reactivity			
Positive peaks	.11	1.80	.075
Importance	.67	22.01	<.001
Interaction	.09	3.11	.002
Positive peaks and worst event reactivity			
Positive peaks	.14	2.34	.021
Importance	.69	22.60	<.001
Interaction	.06	2.09	.037
Negative peaks and best event reactivity			
Negative peaks	.13	2.23	.028
Importance	.67	21.41	<.001
Interaction	.07	2.38	.018
Negative peaks and worst event reactivity			
Negative peaks	.21	3.67	<.001
Importance	.69	22.86	<.001
Interaction	.07	2.20	.028

Note. See text for estimated means.

(+1 *SD*) levels of each of the predictors. The interaction revealed that higher peaks in the laboratory were associated with stronger reactions to important daily events (estimated *M*s = 3.03 vs. 3.42), but not unimportant daily events (estimated *M*s = 1.88 vs. 1.91). A similar interaction occurred when positive DART scores were replaced with negative DART scores. Again, the interaction was such that high DART scorers reacted more strongly to important events (estimated *M*s = 3.02 vs. 3.43), but this main effect (which was significant) was less consequential when events were unimportant (estimated *M*s = 1.84 vs. 1.96).

Daily Negative Event Reactions

We then ran two cross-level models focused on daily reactions to negative (WORST) events. In the first analysis, which included positive DART scores, the interaction was significant and estimated means for it indicated that the main effect for DART tendencies was particularly evident when events were important (estimated *M*s = 1.53 vs. 1.68) relative to unimportant (estimated *M*s = 2.79 vs. 3.19). Parallel results occurred when the positive DART mean was replaced with the negative DART mean. In this analysis, too, there was a main effect for DART tendencies (see Table 8) that was particularly pronounced when events were important (estimated *M*s = 2.72 vs. 3.27) relative to unimportant (estimated *M*s = 1.48 vs. 1.75). Overall, these results indicate a consistent link between micro-momentary reactivity processes and affective reactivity processes in daily life, confirming a laboratory-to-life interface.

General Discussion

The present results are informative in multiple ways. In the General Discussion section, we will begin by revisiting some of the major questions that were investigated. We will then broaden the discussion, ending with a consideration of limitations and future directions.

Preliminary Question

Dynamic assessments of reactivity within the laboratory were not consistent predictors of average levels of daily positive or negative affect. These results, in conjunction with the Q2 results showing consistent links between affective reactivity in the laboratory and reactivity in daily life, suggest a dissociation between acute reactivity processes and personal baselines for positive and negative affect. These personal baselines may represent temperament-related defaults rather than more dynamic components of affective responding (Kuppens et al., 2010; Sheldon & Lyubormirsky, 2021; Watson & Clark, 1984). Although the lack of relations involving mean affect may be inconsistent with some models (e.g., Suls & Martin, 2005), they are consistent with adaptation level and set-point theories of positive and negative affect (Luhmann & Intelisano, 2018). From such perspectives, dynamic measures would be of particular value in predicting deviations or changes in affect, in response to recent events (Frederick & Loewenstein, 1999), relative to processes that determine affective states in the absence of precipitating events.

Research Question 1

The RQ1 results were inconsistent across studies. Study 1 showed no significant connections between daily affective variability scores and peak intensities within the laboratory. However, Study 1 did reveal positive associations between peak intensities and relative variability scores, which corrected for personal means and measurement bounds (Mestdagh et al., 2018). By contrast, Study 2 showed mixed results for both the original and relative variability metrics and similar mixed results were obtained when attempting to link affective instability scores to peak intensities obtained within the laboratory. Thus, it may be that the relationship between event-contingent *peak* affective intensities and macro-dynamic affective change across days may be insufficiently robust to consistently appear either within or across studies.

The RQ1A results, by contrast, were more consistent. Although peak durations were not consistently linked to variability or instability of affect in daily life, most of the models involving total response magnitude resulted in significant relationships. The relations were always in the same direction, with larger total magnitude responses being linked to higher levels of variability and instability.

Taken together, the RQ1/Q1A findings suggest that macro-dynamic indexes of affective dynamics may indeed be related to micro-dynamic changes in affect, but macro-dynamic fluctuations may be more related to the overall magnitude of one's affective responses than to peak extremity per se. This suggestion makes sense given that macro-dynamic fluctuations across days are likely reflective of multiple emotional reactivity processes, including both the intensity and duration of one's affective changes (Brans & Verduyn, 2014; Kuppens et al., 2022). Of note, the RQ1A findings were evident both within a valence and across valences, implicating processes (such as a general responsiveness to the events of one's life) that matter irrespective of the valence of events that one encounters.

These findings should aid affective dynamics researchers as they interpret their findings and construct theories surrounding macro-dynamic changes in affect over time (Kuppens et al., 2022). For example, borderline personality disorder has often been linked with increased affective instability (Santangelo et al., 2014; Trull et al., 2008), but there are questions concerning the specificity and nature of this relationship (Nica & Links, 2009). Rather than conceptualizing this relationship in terms of a single parameter or process, our results suggest that borderline personality may be characterized by a combination of processes (e.g., combining both peak intensity with difficulties returning to baseline).

In this connection, a critical implication of the RQ1/RQ1A findings is the importance of differentiating between peak intensity, affective duration, and total response magnitude. It is our view that these constructs (1) are often conflated but (2) represent distinct processes with distinct implications for mental health (Davidson, 1998, 2015). If so, it may be important for affective scientists to use more precise terminology when referring to phenomena such as *affective reactivity*. Although longer-lasting reactions to events have somewhat consistently been linked to lower levels of well-being (Derryberry & Reed, 2002; Houben et al., 2015; Schaefer et al., 2013), results involving peak intensity have exhibited both positive (Gross et al., 1998; Höflich et al., 2019) and negative (Grosse Rueschkamp et al., 2020; Wichers et al., 2015) correlations with well-being indicators. Thus, as new methods are developed to assess affect reactivity with precision (like the DART does), it has become clear that not all forms of affective reactivity can be equated with each other. In this context, precise methods are key and overly general terms like *reactivity* may need to be refined.

Research Question 2

The RQ2 results showed that laboratory peak intensities were prospectively predictive of more extreme event-contingent affective responses. These results speak to a central question in affect science – that is, whether laboratory-assessed tendencies toward affect reactivity possess ecological significance. The present results provide a positive answer to this question, and these results are novel to the literature. By extension, the Q2 findings should enhance confidence in the validity of previously-published micro-dynamic affective reactivity research (e.g., Schaefer et al., 2013) that has sometimes been criticized for relying on artificial laboratory paradigms (Kuppens et al., 2022).

The Q2 findings also lend empirical support to day reconstruction procedures, at least of a certain type. Nesting day reconstruction elements within a daily diary paradigm mitigates concerns related to extended retrospection (Conner & Barrett, 2012), especially when targeted on particularly salient events like the best or worst occurrences on a given day (Larsen et al., 1986). Peak reactivity within the laboratory matters, but it does so particularly in predicting event-contingent reactions to consequential daily events, particularly as those events become more important or significant (also see Heller et al., 2015).

General Implications

In broader terms, the present results suggest a dissociation between mean levels of daily affect and the manner in which affect changes. This dissociation is fascinating in pointing to fundamentally different mechanisms. In particular terms, the present results suggest that affect generation processes (measured by the DART) are reliant on processes (such as appraisal or flexibility) that overlap with those that produce changes in daily affect. Future work might strengthen these ties, for example, through techniques or questions that better pinpoint the daily processes that produce affect variability and instability.

The present results were somewhat consistent across affective dynamic parameters (variability and instability) as well as computations of those parameters (standard and relative). This observation is consistent with previous research (Dejonckheere et al., 2019) and suggests that these measures may not reflect meaningfully distinct constructs. In fact, although affective variability and instability differ computationally, the two constructs have been interpreted similarly (Houben et al., 2015) and the present findings offer support for doing so, especially in Study 2. Nonetheless, there may still be reasons for preferring measures of instability to measures of variability in that instability measures better capture time-dependent variations in affect due to intervening changes in life circumstances or events that change from one day to the next (Trull et al., 2015).

Another, perhaps somewhat surprising, finding was that positive and negative dynamic measures do not seem highly differentiated by valence (e.g., positive correlations rather than negative correlations across valence were generally observed). As a consequence, macro-dynamic changes in daily positive affect *crossed over* to predict DART performance involving negative, as well as positive, stimuli (and vice versa). These findings, to us, suggest that affective dynamics may be regulated by a single system that modulates affective state in manners consistent with the events that one is exposed to, whether those events are positive or negative (Koval, Ogrinz, et al., 2013; Larsen & Diener, 1987).

Limitations and Future Directions

An important limitation of the present conclusions is that micro-momentary changes in affect assessed in the laboratory may fail to map onto emotional experiences in daily life because induction stimuli are not commensurate with daily life events. This limitation is, of course, balanced by the benefits afforded by the use of eliciting stimuli of known intensity and location in time. An additional limitation relates to the use of undergraduate student samples such that the results may or may not generalize to other populations. The present work is also limited in that Study 1 was conceptualized and executed as a pilot study and we could not calculate laboratory-based parameters related to duration or total magnitude. The study was, however, a critical proof of concept that established potential links between micro- and macro-dynamic methods for assessing affect over time. Study 1 also sparked further developments in both the DART and the daily protocol the proved to be informative.

Although we did not find consistent links between DART reactivity indexes and mean daily affect (QA), future studies could examine additional aspects of affect reactivity in an attempt to understand processes related to affective set point. For example, tendencies to experience affective response in relation to low intensity stimuli, or ambiguous stimuli, could contribute to one's mean level of affect (Davidson, 1998). Relatedly, cognitive factors such as appraisal bias could also predict individual differences in mean daily affect (Kuppens et al., 2008). From both threshold and appraisal bias perspectives, the key feature of mean levels of affect may pertain to the frequency rather than the intensity of affective responses (Diener et al., 1991).

Conclusions

The present findings provide additional knowledge concerning key questions in affective dynamics research. Different components of reactivity can be isolated using carefully constructed laboratory paradigms. These components can then be linked to macro-dynamic daily measures in ways that inform our understanding of both measurement systems and the latent forces that guide the affect system.

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Open Data

To the best of my ability and knowledge, I have provided all original materials and clear references to all other materials via a stable online repository. Data and a codebook for this project are posted at OSF: https://osf.io/z54qu/?view_only=09db1a269fd940738fa218ce38c1fd81 (Klein, 2022).

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