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Matthew G. Burgess, Paula Brough, Mitchell J. Raper, and Xi Wen Chan

School of Applied Psychology, Griffith University, Brisbane, Australia

Author Note

Matthew G. Burgess https://orcid.org/0000-0002-9065-204X

Paula Brough https://orcid.org/0000-0002-0374-0026

Mitchell J. Raper https://orcid.org/0000-0002-5435-8505

Xi Wen Chan https://orcid.org/0000-0002-1301-4386

Matthew G. Burgess is now affiliated with the School of Psychology, University of Queensland.

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Correspondence concerning this article should be addressed to Matthew G. Burgess, School of Psychology, University of Queensland, Sir Fred Schonell Dr, St Lucia QLD 4072. Email: matthew.burgess@uq.edu.au

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Abstract

While research has increasingly investigated stressor-strain and adaptation relationships over timespans of months to years, surprisingly little attention has been focused on shorter mid-term stress reactions. The current research tests the repeated exposure hypothesis which predicts that stressors will produce a mid-term stress reaction; while adaptation occurs over longer timeframes and with repeated exposure. Study 1 adopted a natural experiment combined with intensive longitudinal data collection. Level change in positive and negative affectivity during and after exposure to a novel objective stressor over a 10-day period was modeled using piecewise growth modeling. Consistent with our hypotheses, results identified a decline in positive affectivity over time during stressor exposure, and a recovery after stressor cessation. Contrary to expectations, no such effect was identified for negative affectivity. Study 2 replicated results of the mid-term stress reaction in Study 1 with a novel stressor and expanded upon Study 1 by comparing the stress reaction of a second group exposed to a familiar stressor. Consistent with our hypothesis, the familiar stressor group demonstrated no stress reaction. Results support the repeated exposure hypothesis, while demonstrating that the dynamics of stress reactions over the mid-term can be differential and complex. Theoretical and practical implications are discussed.

Keywords: stress reaction model, natural experiment, repeated exposure hypothesis, positive affectivity, negative affectivity

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In work, study, home and other contexts, people invest time and energy into tasks demanded of them. Over time, tasks that were previously perceived as stressful become routine as people adapt to their environments. Stress research has primarily focused on the effects of long-term chronic stressors. Increasingly, however, there have been calls for more research investigating the dynamics of mid-term stress reactions—where strain increases during stressor exposure and subsequently declines in its absence (Dormann & Griffin, 2015; Frese & Zapf, 1988; Ganster, 2008; Guthier et al., 2020). This article reports two quasi-experimental studies of the effects of an objective task stressor on strain and adaptation over the mid-term. Stressors are defined as a class of psychosocial events and conditions that can lead to an immediate stress reaction. Mid-term is defined as a period of one day to one month (Dormann & Van de Ven, 2014).

Theoretical explanations of stress, specifically the conservation of resources (COR) theory and the allostatic load model propose that over longer timeframes, chronic exposure to stressors impacts both physical health and wellbeing (Hobfoll, 1989; McEwen, 1998). Adaptation theories and meta-analyses, however, demonstrate adaptation to stressors occurs over time. The repeated exposure hypothesis reconciles these opposing effects by examining the temporal nature of the phenomena. While numerous longitudinal studies of stressor-strain effects have been conducted, recent reviews (e.g., Guthier et al., 2020) have identified that these studies are dominated by time intervals of months to years. Longitudinal tests of the shorter-term stress reactions are exceedingly rare, despite these timeframes being more characteristic of the daily experience of stress. This gap has led to calls for an increase in "shortitudinal" studies (Dormann & Van de Ven, 2014; Ford et al., 2014; Guthier et al., 2020).

To advance knowledge of these issues, this article reports two natural experiments. The first study tested a mid-term stress reaction in response to an objective stressor over a ten-day period. Study 2 replicated and extended Study 1 with a natural experimental design comparing stress reactions within two groups with objective stressors that were both novel and familiar. Both studies operationalize stressors objectively by the group mean reaction to a common stressor (a university assignment for a sample of university students). In doing so, this article makes several contributions. First, it provides a rare direct test of a mid-term stress reaction model: the first to our knowledge that tests effects of a naturally occurring objective stressor with repeated daily measurements for 10 days. Second, it introduces a novel operationalization of dynamic resource gains and loss spirals over time using intensive longitudinal methods, analyzed within a piecewise latent growth modeling framework.

Theoretical Background

Stressors are defined as a class of psychosocial events and conditions that can lead to an immediate stress response and which, over time, impact physical health and wellbeing (Ganster, 2008). *Subjective stressors* refer to individuals' self-reported appraisals of a stressor (Ganster, 2008). *Objective stressors* are operationalized without reference to individual idiographic appraisals. Rather, they refer to the average or typical appraisal of whether a stressor would be considered stressful within a group or culture (Frese & Zapf, 1988; Ganster, 2008; Hobfoll, 1989). Stressors can be further classified by their temporal properties. *Discrete* stressors have a defined period of exposure within a given time period, whereas *chronic* stressors are frequently experienced over a longer-term time period. A recent meta-analysis identified that subjective operationalizations of long-term chronic stressors dominate the literature, while objective operationalizations of mid-term discrete stressors are rare, thus limiting

our understanding of the relative contributions of the short- and long-term effects of objective and subjective experiences within the stress process (Guthier et al., 2020). Consistent with this broader trend in the literature, tests of the repeated exposure hypothesis have only tested subjective stressors over a period of months to years (Matthews & Ritter, 2018; Matthews et al., 2014; Ritter et al., 2016). Given recent calls for more research assessing objective stressors, the current study employs an objective operationalization of stressors within a natural experiment.

COR theory proposes that to respond to stressors, individuals expend their *resources.* Resources are defined as those objects, conditions, energies, or other characteristics that are centrally valued and support goal attainment (Halbesleben et al., 2014; Hobfoll, 1989). Individuals are motivated to retain and foster the resources required to adapt to stressors within their environment. COR theory defines the loss of resources in response to a stressor as *strain*. Over time, resource gains and losses accumulate in a process referred to as *resource gain* and *loss spirals* respectively (Hobfoll, 1989, 2001). Central to COR theory is the notion that resources are dynamic over time, with gains and loss spirals occurring in response to the individuals' active attempts to manage stressors in their environment.

Adaptation theorists argue, however, that exposure to stressors leads to an adaptive process over time. After repeated stressor exposure, stressor reactions diminish and individuals naturally return to a neutral level of wellbeing. Brickman and Campbell (1971) argued that this process is relatively invariant, based on automatic biological and homeostatic processes. More recently, there has been increasing recognition of the cognitive and social elements of adaptation (Diener et al., 2006). Multiple types of adaptive responses can exist within a group exposed to the same type of stressor. Mancini et al. (2011) for example, identified numerous responses to stressors, including

individuals that experienced either temporary and sustained declines in wellbeing, but also individuals that experienced stable (i.e., no changes) and even improved wellbeing responses.

Within the literature, empirical studies provide evidence for both adaptation and resource loss spirals occurring over time. Consistent with adaptation theories, studies spanning time periods between six weeks to seven months have demonstrated that higher frequency stressors were positively associated with cross-sectional strain responses (i.e., shorter timeframes), but negatively associated with lagged strain responses (Matthews & Ritter, 2018; Matthews et al., 2014; Ritter et al., 2016). Meta-analyses of longitudinal stressor-strain research further demonstrates these lagged adaptation effects, over longer timeframes of months to years (Ford et al., 2014; Guthier et al., 2020). Much of the research is consistent with adaptation theorists and thus, offers minimal support for the occurrence of resource loss spirals. Longitudinal studies over a shorter timeframe, however, have demonstrated the opposite effect. In a daily diary study, Nicholson and Griffin (2015) found that stressors were positively associated with strain on the same day and the next morning. In a weekly study, Taylor et al. (2017) found evidence of resource loss spirals (i.e., increases in levels of burnout over time) associated with increases in incivility exposure (an interpersonal stressor) over six weeks.

The repeated exposure hypothesis integrates stressor-strain models, resource-based models, and hedonic adaptation theory, proposing that time is a central component of the stress process (Matthews & Ritter, 2018). Three premises underlie the hypothesis. First is that constant exposure to a stressor leads to a resource loss spiral (i.e., strain). Second, upon cessation of exposure to the stressor, resources gain spirals return resources to a set point (i.e., recovery). The third premise is that over repeated

cycles of resource loss and recovery, responses to the stressor are moderated by a process of hedonic adaptation (Brickman & Campbell, 1971). Thus, what distinguishes between the seemingly opposing processes of resource loss spirals (i.e., accumulation of strains) or hedonic adaptation (i.e., returning to a hedonic baseline) over time is the *timing* of stressor exposure (Matthews & Ritter, 2018). Constant or more frequent stressor exposure leads to resource loss spirals, while less frequent stressor exposure leads to recovery of resources and, over repeated exposures, a moderation of the stress response (i.e., hedonic adaptation). No study to our knowledge, however, has tested all three premises of the repeated exposure hypothesis (i.e., resource loss, recovery, and adaptation) in response to an objective stressor. This is the aim of the current research.

Dynamic Operationalizations of Strain

Investigations of stressor–strain effects have traditionally relied on self-reported static assessments of strains. Participants are asked to recall their experiences of strain over a defined period (e.g., four weeks). To assess resource spirals in these assessments, multiple static measurements of subjective stressors and strains and their interrelationships over time were included in a reciprocal longitudinal model to infer the existence of simultaneous causal and reverse-causal effects (Taris & Kompier, 2014). True assessments of resource spirals, however, require operationalizations of *level change* (Taris & Kompier, 2014). Traditional reciprocal longitudinal models only assess static *normative change* (i.e., changes in the rank orders of participants in a static variable at one point in time to a static variable at another point in time).

Methodologies to assess longitudinal level change within a sample rely on dynamic operationalizations — defined as inter-individual differences in intra-individual change over time — and use intensive longitudinal methods (cf. Mehl & Conner, 2012) and growth-modeling techniques (cf. Grimm et al., 2016). Chen et al.

(2011) for example, identified that dynamic affective outcomes were negatively associated with turnover intentions. Vandenberghe et al. (2011) identified similar dynamic relationships in a sample of participants undergoing a major transition (i.e., graduates starting a new job). Both studies demonstrated that static and dynamic operationalizations of affective outcomes uniquely predicted organizational outcomes, with dynamic variables predicting substantially greater variability than a static operationalization of the same variable.

Given the relative rarity of dynamic operationalizations, however, there is a lack of specific guidance on measures and metrics. To this end, the present study draws upon two approaches: COR theory combined with the broaden-and-build theory of positive emotions, and allostatic load theory. Positive and negative affectivity are states linked to the approach and fight or flight responses respectively, and are considered central to the stress and hedonic adaptation processes (Folkman & Moskowitz, 2000). The broaden-and-build theory of positive emotions (Fredrickson, 2001) contends that positive emotions are a functional affective state that facilitates adaptation through approach-based coping behaviors (Fredrickson, 2001). While positive affectivity (PA) is often considered an outcome variable, broaden-and-build theory contends that PA is also a key resource that facilitates the generation of positive emotions in the stress process. PA as a resource has been demonstrated to *broaden* thought–action repertories, facilitating shorter-term approach-based coping behaviors in response to stressors. Over the longer term, positive affective resources support the *building* of other resources, such as knowledge and skills to facilitate long-term adaptation, thereby creating substitutes for the use of (exhaustible) positive affective resources (see Lyubomirsky et al., 2005 for a meta-analysis of the outcomes of PA).

The role of negative affectivity (NA) in the stress response can be defined by the concepts of allostasis and allostatic load (McEwen, 1998, 2007) The allostatic load model defines allostasis as the adaptive response to (negative) environmental stressors, including NA and associated physiological responses (e.g., elevated heart rate, release catecholamines and glucocorticoids). *Allostatic load* refers to the physiological wear and tear that accumulates over repeated allostatic responses to environmental stressors. Similar to the repeated exposure hypothesis, McEwen (1998) posited that environmental stressors prompt a stress reaction model response. Maintenance of allostatic responses, measured as the aggregate of individual experiences of NA over a time period, can over the long-term lead to a loss of resources (i.e., physical health). Resources such as PA, also measured as the aggregate of individual experiences of PA over a time period, are proposed to mitigate or reverse allostatic load (McEwen, 1998).

The Current Research

The current research takes advantage of a naturally occurring objective and discrete novel task stressor. Positive and negative activated affect are used to operationalize strain within a dynamic growth modeling framework which explicitly models time. Stressors are expected to produce an initial strain reaction, whereby with task exposure we expect to observe allostasis (i.e., increasing NA) and resource loss spirals (i.e., decreasing PA). Following the completion of the task, we would expect to observe a decline in the allostatic response (i.e., decreasing NA) and a recovery of resources (i.e., increasing PA).

To obtain a relatively controlled context, Study 1 focused on university students completing a challenging course assessment. A university course setting provides a reasonable level of control as courses are required, as far as practicable, to provide all students with equitable access to resources. A university assessment with an explicit due

date is a naturally occurring stressor with a discrete point in time in which all participants shift from stressor exposure to non-exposure (Folkman & Lazarus, 1985; Raper & Brough, 2021). Participants would be expected to lose positive affective resources (e.g., interest, enthusiasm) as they complete the task, and experience increases in allostasis (e.g., anxiety, nervousness) as the due date approaches. While there is likely some variability regarding when the tasks are completed, we expect that the effects are likely observable several days before and after an assessment. Finally, to control for the effects of prior task exposure on subsequent stress reactions, the university assessment selected was a first-year class highly specific to the field of study where university enrolment controls (e.g., prerequisites) prevent previous exposure to a similar task.

To assess the repeated exposure hypothesis, a stress reaction model (Frese & Zapf, 1988) was tested using piecewise growth-modeling methods, as recommended by Grimm et al. (2016). Multilevel growth modeling techniques rely on the collection of multiple measures of a variable from a participant over time. The relationship (i.e., growth, stability, or decline) between a variable and time is estimated for each participant in the sample and aggregated in a latent between-subjects variable to operationalize dynamic change. Piecewise growth modeling (also referred to as spline models) adds a further step, by separating the time variable into periods with specified knot points. Knot points are meaningful time points within the sample (such as a common due date for a task stressor), at which dynamic changes can be expected to alter (Dormann & Van de Ven, 2014). A separate growth model is estimated for all periods, which allows testing of a non-linear stress reaction model (Frese & Zapf, 1988) that forms the basis of the repeated exposure hypothesis (see Grimm et al., 2016 for a detailed tutorial on piecewise growth modelling).

The current study employs the assessment task due date as the knot point. Given the continuous nature of an assessment task, the first premise of the repeated exposure hypothesis is that (a) an allostatic response (increasing NA) will occur; and (b) there will be a loss of resources (decreasing positive affectivity) over time. Within the sample on average, we expect positive affective experiences to decline over time, while the allostatic response increases to the assignment due date. On submission (i.e., the knot point) the stressor is removed. We then expect allostatic response to decline and for recovery processes to result in a growth of positive affective resources (refer to Figure 1). It is therefore proposed:

> **Hypothesis 1 (H1).** PA exhibits a mean downward trajectory over time during stressor exposure (H1a) and a mean upward trajectory of PA over time after removal of the stressor (H1b).
>
> **Hypothesis 2 (H2).** NA exhibits a mean upward trajectory of NA over time during stressor exposure (H2a) and a mean downward trajectory of NA over time after removal of the stressor (H2b).

[Insert Figure 1 here]

In Study 2, we replicated and extended Study 1 by testing the third premise of the repeated exposure hypothesis, that prior exposure to a stressor will lead to adaptation and therefore moderation of the stress reaction. Like Study 1, Study 2 was also conducted within a university assessment context. However, a second, independent, natural experimental condition was also included: the novelty of the assessment. In the first condition, (replicating Study 1) the assessment was naturally controlled such that this was the first-time participants had been exposed to the task. This was compared to an assessment with similar requirements, but where (1) no such structural controls are in place, and (2) there have been previous opportunities to be exposed to similar tasks.

Multi-group piecewise linear growth modelling (Byrne, 2013; Grimm et al., 2016) was employed to assess between- and within-group differences. The repeated exposure hypothesis proposes prior exposure to a stressor would lead to adaptation and moderation of the initial stress reaction. It is therefore proposed:

> **Hypothesis 3 (H3).** The mean decline in PA during stressor exposure is greater for the novel stressor group than for the familiar stressor group, and the mean incline in PA after stressor removal is greater in the novel stressor group than in the familiar stressor group.
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> **Hypothesis 4 (H4).** The mean incline in NA during stressor exposure is greater for the novel stressor group than for the familiar stressor group, and the mean decline in NA after stressor removal is greater in the novel stressor group than in the familiar stressor group.

Study 1 Method

Participants and Procedure

Study 1 employed an interrupted time series quasi-experimental research design (Cook & Campbell, 1979). A within-person quasi-experimental design was assessed using the naturally occurring exposure and removal of a novel stressor. The novel stressor was a student assignment historically reported by students to be stressful. Data were collected using an intensive longitudinal design (Mehl & Conner, 2012) where participants' responses were recorded twice per day for the seven days prior to the assignment due date, and twice per day for three days after the assignment due date.

The participants were a convenience sample of 34 first-year undergraduate students enrolled in a 12-week introductory university course. Following research ethics approval (Ref: PSY/B7/14/HREC), students were invited to participate in this study in return for course credit. Participants were mostly female (n = 23, 67.6%) and ranged in

age from 17 to 36 years (M = 21.91 years; SD = 4.90 years). Most participants were full-time students (*n* = 23, 67.6%) with a smaller proportion studying part-time (*n* = 9, 26.5%). Participants were invited via email to complete *k* = 20 surveys via their smartphones, with each survey assessing the same items at each time point. An additional survey assessing demographic information was also administered post-stressor. The response rate was high, with a total of *n* = 529 from a possible 680 occasions (response rate = 77.8%; range: 3–20; *Mdn* = 17 responses). University course pre-requisite controls prevented prior exposure to the stressor. As a manipulation check to further verify stressor exposure, participants were independently confirmed as enrolled in the course (via the student course credit management system) prior to participating in the study.

Time Intervals

A study period of one week prior to the due date and three days after the due date was selected. This time period was selected following methodological guidance and the objective context. Dormann and Van de Ven (2014) for example, suggested that intensive longitudinal studies with shorter time intervals may be more appropriate to assess mid-term stress reaction. Within the context of the assessment, it was expected that most participants would be responding to the assessment task within the week prior to the due date. Bi-daily (morning and early evening) survey triggers were sent to participants.

Measures

Objective Stressor Presence (days) was measured as the number of days of stressor exposure ranging from -7 to 0 using the time and date of each measurement occasion prior to the assessment due date. Values were calculated using the survey

tool's timestamp feature minus the assignment due date. No participants reported receiving an extension of this date.

Objective Stressor Absence (days) was measured as the number of days after stressor exposure had ceased and ranged from 0 to 3. The value was calculated for each measurement occasion after the assessment due date using the timestamp value minus the assignment due date.

State PA and NA (within-person), Static PA and NA, and Dynamic PA and NA (*between-persons*) were assessed using repeated measures of the four item high-activation positive-affect subscale and the four item high activation negative-affect subscale of the multi-affect indicator (Warr et al., 2013). Participants indicated the proportion of time for which they had experienced each of the four emotional adjectives that day (i.e., enthusiastic, excited, inspired, joyful, anxious, nervous, tense, worried). Responses ranged from 1 (never; 0% of the time) to 7 (always; 100% of the time).

Data Analysis

Data were analyzed in Mplus 7.4 using multilevel structural equation modeling (Muthén & Muthén, 2012) with a maximum likelihood estimator and robust standard errors (MLR). Item-level missing data were estimated using a full information maximum likelihood procedure. In the first step, a MCFA was conducted with the study variable to assess the validity of the measurement of PA and NA at both the within-person and between-person levels of analysis. In the second step, a piecewise linear growth model was estimated. In the present study, a bi-linear piecewise model was selected, modeling linear dynamic changes in affectivity across two discrete phases: before and after the assessment due date, with the due date serving as the knot point for the present study. A multilevel growth approach was chosen over a latent growth approach because of the former's superiority in managing both a high number of waves

and the unbalanced data produced by participants missing on some occasions (See Grimm et al., 2016 for a detailed discussion of piecewise growth modelling).

Study 1 Results

The MLR-estimated latent means, standard deviations, and correlations for the within- and between-person analyses are presented in Table 1. The intra-class correlations of the eight items ranged from .41 to .52, indicating sufficient variability for multilevel analysis. The results of a MCFA in the first step of the analysis supported the hypothesized multilevel factor structure of the four items of PA, producing an excellent model fit (χ^2 = 2.4; df = 4; p = .65; CFI = 1; TLI = 1.01; RMSEA = .00; $SRMR_{within}$ = .01; $SRMR_{between}$ = .01). Results of a MCFA of NA support the hypothesized factor structure, producing an excellent model fit (χ^2 = 1.492; df = 20; p = .83; CFI = 1; TLI = 1.02; RMSEA = .00; $SRMR_{within}$ = .01; $SRMR_{between}$ = .01). Variance in the PA and NA models were separated into the within- and between-person levels, with co-variances between all item residuals constrained to zero. The factor loadings and item residuals produced in the MCFA models were carried over to the second step of the analysis (i.e., a two-step procedure; Anderson & Gerbing, 1988).

[Insert Table 1 here]

To test Hypotheses 1 and 2, piecewise linear growth models were constructed. Sample mean differences in dynamic changes in affect over time prior to the assessment due date (Condition 1) and after the assessment due date (Condition 2) are denoted by $\gamma 00$. Supporting Hypothesis 1 a stress reaction model was observed. A small, significant mean decline in PA was detected for the period prior to the assessment due date (H1a; $\gamma 00 = –0.06$; $p < .01$, $\gamma 01 = .01$, p = .08) and a small, significant mean incline in PA was found post-assessment due date (H1b; $\gamma 00 = 0.04$; $p = .04$; $\gamma 01 = .01$, p = .21). Partially supporting Hypothesis 2, there was evidence of an allostatic response that reduced after

the cessation of the stressor. A small, marginally significant incline in NA was found for the period prior to the assessment date (H2a; $\gamma 00 = .06$, $p = .08$; $\gamma 01 = 0.02$, $p = .03$) and a moderate decline in NA for the period after the assessment date (H2b; $\gamma 00 = -.29$; $p = .02$; $\gamma 01 = .07$, $p = .08$). While not hypothesized, it is noted that there was no significant variability in dynamic PA before the stressor, dynamic PA after stressor exposure, and dynamic NA after stressor exposure.

Study 1 Discussion

Study 1 tested a mid-term stress reaction model in response to a novel objective task stressor. The results supported Hypotheses 1 and partially support Hypothesis 2. Consistent with COR theory (Hobfoll, 1989), a resource loss spiral of PA over time was observed in response to the stressor. After the due date (i.e., stressor removal), a recovery in PA was observed. Concurrently — and consistent with an allostatic response — there was a marginally significant increase in NA up to the stressor due date, followed by a significant decline in NA after stressor cessation. Overall, these results support the first two premises of the repeated exposure hypothesis: mid-term constant exposure to the stressor led to an allostatic response, an accumulation of resource loss until such time as the stressors ceased, where the allostatic response declined, and positive affective resources recovered.

Study 1 has three notable research limitations. The first methodological limitation was that only a relatively small between-person sample size was tested. Second, the small sample size required the use of a two-step procedure for the estimations of the structural equation model. While Anderson and Gerbing (1988) recommend such a practice as useful for small sample sizes and of limited practical difference in applied research, it is acknowledged that others (e.g., Fornell & Yi, 2016) disagree with this practice. Finally, this study did not test the third premise of the

repeated exposure hypothesis, that prior exposure to a stressor can moderate subsequent stress responses. Thus, Study 2 was conducted to test this premise.

Study 2 Method

Design

Building on Study 1, the second study employed a two-group interrupted time series quasi-experimental research design (Cook & Campbell, 1979). Consistent with the first study, the exposure to and removal of a task stressor (an undergraduate course assignment) was employed to create a natural within-person quasi-experiment. To reduce the burden on participants, the survey frequency and time intervals were adjusted. Data were collected once per day for the five days prior to the assignment due date and five days following the assignment due date. As in Study 1, timestamps were retained as a measured variable scaled in days.

As a test of the third premise of the repeated exposure hypothesis, a second between-group condition was included with two different assessments. The first assessment condition (the novel assessment) examined participants completing the same assessment piece, as was described above in Study 1. The discipline-specific nature of this first year assessment, combined with university enrolment constraints, ensured this was a novel task. The second assessment condition (the familiar assessment) was an undergraduate assignment that shared most of the objective features (i.e., scope, length, format) of the novel assessment condition, but the tasks were not discipline-specific and no enrolment controls existed. It was therefore expected that compared to the novel assessment group, this group would be exposed to a (relatively) familiar stressor. Refer to Table 2 for a detailed breakdown of the two conditions.

[Insert Table 2 here]

Participants, Procedure and Measures

The participants were 81 first-year undergraduate students enrolled in one of two university introductory psychology courses. University research ethics approval was obtained (Ref: 2017/279) and students received course credit in return for participation. A convenience sampling approach was utilized to invite research participants. Specifically, a general advertisement was issued to all enrolled students and interested students allocated their next available study window (determined by assessment due dates) for one of their university courses. Participants who had previously participated in Study 1 were not eligible for participation in this Study. Participants were mostly female (n = 55, 67.9%) and aged between 17 and 41 years (M = 22.29 years, SD = 6.89 years). Most participants were full-time students (n = 72, 88.9%) with a small proportion studying part-time (n = 2, 2.5%). Participants were invited via email to complete a survey each day via their smartphones, five days prior to the assessment due date and five days after the assessment due date (k = 10 surveys). The surveys employed the same scales for PA and NA in Study 1 and assessed the same items at each time point. The response rate was high, with a total of n = 640 from a possible 810 occasions (response rate = 79%; range: 2–10; *Mdn* = 9 responses).

Study 2 included one additional independent variable with two conditions: the novel assessment group (n = 39, 48.2%) and the familiar assessment group (n = 42, 51.9%). As in Study 1, independent confirmation of course enrolment (manipulation checks to ensure objective stressor exposure) was made via the student course credit management system. An additional survey was completed at the end of the study to assess demographic information. This included a post-hoc stressor hindrance appraisal measure (Searle & Auton, 2015) as a manipulation check for the between groups condition. Results of an independent groups t-test confirmed that the novel assessment

group's hindrance appraisal of the novel assessment task (M = 2.71) was significantly higher than the familiar assessment group's hindrance appraisal of the familiar assessment task (M = 2.14, $t(64)$ = -3.02, p = .004, d = .76).

Data Analysis

The analytical procedure from Study 1 was replicated for Study 2, with two differences. First, to overcome the limitations of the two-step procedure required for Study 1, the measurement models and the piecewise linear growth models were estimated simultaneously (i.e., a full structural equation model). As the just-identified estimation procedures for multilevel growth modeling preclude tests of an absolute model fit, a Satorra–Bentler χ^2 (TR_d) test of the loglikelihood difference (i.e., the relative model fit) was employed to determine whether the inclusion of estimates of dynamic affect before and after the assessment due dates improved the measurement model (Satorra & Bentler, 2010).

Second, to test Hypotheses 3 and 4, group mean differences in stress-reaction models were estimated via a multi-group latent means comparison model. Byrne's (2013) procedures for multi-group analysis were adopted. In the first step, all parameters except for mean static affect were constrained as equal across the two groups. In the second step, the means of dynamic affect over time for the period before the assessment due date and the period post assessment due date were freely estimated. A Satorra–Bentler χ^2 test of the loglikelihood difference was employed to test for differences in stress reaction between the two groups (see Supplementary materials for the Mplus model specifications of the final models).

Study 2 Results

Descriptive Statistics

The MLR-estimated descriptive statistics for both groups are presented in Table 2. The results of the MCFA replicated the hypothesized factor structure of the items from Study 1 and produced a good model fit for PA (χ^2 = 25.7, p < .001; df = 4; CFI = 0.96; TLI = 0.88; RMSEA = 0.09; $SRMR_{within}$ = 0.02; $SRMRb_{etween}$ = 0.01)[1] and an excellent fit for NA (χ^2 = 13.35, p = .010; df = 4; CFI = 0.99; TLI = 0.96; RMSEA = 0.06; $SRMR_{within}$ = 0.02; $SRMRb_{etween}$ = 0.01). Results of measurement invariance testing identified full invariance for PA and scalar invariance for NA at the within level indicating the measures are comparable across the two groups (refer to Supplemental materials for full analysis). In the second step, a multi-group piecewise linear growth model was estimated for PA and NA. Two random slopes variables were generated per group, assessing dynamic changes in affect both before and after the assessment due dates (i.e., four in total for PA and four in total for NA). The Satorra–Bentler test of loglikelihood differences identified that adding dynamic estimates significantly improved model fit (refer to Table 4).

[Insert Table 3 here]

To assess Hypotheses 3 and 4, comparisons of the stress reaction models of the two groups were made. In one model, stress reaction model estimates were constrained as equal between groups, and in a second the stress reaction model estimates were

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[1] An excellent model fit could be achieved covarying the residuals of items 3 and 4 on the within-person level of analysis (χ^2 = 8.14*; df = 3; CFI = 0.99; TLI = 0.96; RMSEA = 0.05; $SRMR_{within}$ = 0.01; $SRMRb_{etween}$ = 0.01). The difference between the two models, however, was non-significant—TR_d = 1.91; df = 1—and the refined measurement model did not influence the qualitative interpretations of the results. The original measurement model with the relationship between residual variances constrained to zero was therefore retained.

allowed to vary. The results supported Hypothesis 3. The freely estimated model (i.e., where mean dynamic changes in PA before and after the knot point were different between the two stressor groups) performed significantly better than the constrained model (i.e., where mean dynamic changes in PA before and after the knot point were constrained as equal for the two groups). Hypothesis 4, however, was not supported. No significant differences were found between the more parsimonious constrained model and the model where mean dynamic changes in negative affect were allowed to vary (refer to Table 4). At this stage of the analysis, this more parsimonious model was retained.

[Insert Table 4 here]

For positive affect, the results of the piecewise linear growth model replicated the results from Study 1. Supporting Hypothesis 1a, in the novel assessment group, participants, on average, experienced a small, significant decline in PA (denoted by $\gamma 00$) in the period prior to the assessment due date ($\gamma 00 = –0.07$, $p = .045$; $\gamma 01 = .02$, $p = .13$). Supporting Hypothesis 1b, participants in the novel assessment group experienced, on average, a small, significant incline in PA post-stressor ($\gamma 00 = 0.08$, $p = .02$; $\gamma 01 = .02$, $p = .07$). Consistent with Hypothesis 3 — that stress reaction models will be moderated in the familiar group — no significant mean change in PA over time was identified, either before or after the due date (pre-assessment due date, $\gamma 00 = 0.04$, $p = .26$; $\gamma 01 = 0.02$, $p = .25$; post-assessment due date, $\gamma 00 = 0.04$, $p = .33$; $\gamma 01 = 0.02$, $p = .19$). While not hypothesized, it is noted that there was no significant variability in dynamic PA (denoted by $\gamma 01$) before and after stressor exposure for both stressor groups.

For negative affect, the results of the piecewise linear growth model did not replicate results from Study 1. Hypothesis 2 was not supported, in that there was a small mean *decline* in negative affect during stressor exposure ($\gamma 00 = -0.14$, $p = <.001$;

$\gamma 01 = 0.03$, $p = .50$) that was maintained post-stressor ($\gamma 00 = -0.11$, $p = <.001$; $\gamma 01 = 0.04$, $p = .01$). While not hypothesized, it is noted that there was significant variability in dynamic NA between persons (denoted by $\gamma 01$). While decline in NA post stressor was hypothesized (H2b), an additional test was run to determine if the decline in negative affect over time was influenced by stressor exposure. The constrained model was compared to a more parsimonious model where mean dynamic negative affect was further constrained as equal before and after the stressor (for both groups). Failing to support Hypothesis 2, no significant differences between the models were found ($TR_d = 0.24$, df = 1, p = .62) indicating that the mean decline in negative affect over time ($\gamma 00 = -0.126$, $p = <.001$) was not associated with stressor exposure.

General Discussion

This research assessed mid-term dynamic stress reactions in response to an objective stressor. Specifically, we sought to test the three premises of the repeated exposure hypothesis: (1) that in the mid-term, exposure to a stressor produces a resource loss spiral; (2) that removal of the stressor produces resource recovery; and (3) that prior exposure to a stressor leads to a moderation of mid-term stress reactions. To test this model, we employed a novel design combining a natural experiment to operationalize a common stressor. The stress response, conceptualized as resource loss (Hobfoll, 1989) and allostasis (McEwen, 1998), was operationalized with dynamic measures of PA and NA respectively and analyzed with piecewise growth modeling.

Theoretical Implications

Results provide rare longitudinal empirical support for the stress reaction model (Hypothesis 1) replicated in two quasi-experimental studies. Constant exposure to a novel objective stressor produces a resource loss spiral in PA which, once removed, recovers via a resource gain spiral. In Study 2, we extended this to test the third premise

of the repeated exposure hypothesis: that novel stressors will have a greater initial impact than more familiar stressors. While we replicated the stress reaction model for the novel stressor, supporting Hypothesis 3, we found no evidence of a stress reaction model in the more familiar stressor even though it was ostensibly similar (in terms of task features and consequence). These results are in accordance with, and offer support to, the long-term adaptation effects identified in previous tests of the repeated exposure hypothesis with subjective stressors (e.g., Matthews & Ritter, 2018; Matthews et al., 2014; Ritter et al., 2016). The results also contribute to growing evidence that similar stressors do not necessarily elicit the same strain reactions within a person over time (Biggs et al., 2017; Brough et al., 2018).

The results support the conceptualizing of PA as a resource. While wellbeing is typically conceptualized as an outcome variable, meta-analytic evidence demonstrates that positive affect predicts other resources such as physical health, social relationships, and creativity (Lyubomirsky et al., 2005). COR theory proposes that: (1) resources are those objects, conditions or energies that are valued and support goal attainment; and that (2) resources are lost and gained in resource spirals as people respond to stressors in their environment. In observing both resource loss spirals and resource gain spirals in dynamic positive affect in response to an objective stressor, this research further supports the operationalization of PA as a resource.

While not conceptualized as a resource, negative affect was operationalized as a marker of allostasis, which when sustained over time, was theorized to lead to the accumulation of allostatic load (i.e., equivalent to the concept of resource loss spirals; McEwan, 1998). A similar stress reaction model and adaptation effect was expected for dynamic NA, however, Hypotheses 2 and 4 were not supported. In both studies, while

we did detect some level change in NA, there was little evidence that this level change occurred in response to the stressor.

The differing support for PA and NA raises interesting questions about the temporal features of the stress reaction model. With the current data, it cannot be precluded that there was no effect for NA, or that the stress reaction effect for NA was too small to be detected. In addition, we observed a moderate decline in NA over time in Study 2 not associated with the objective task stressors. This effect is likely attributable to an unmeasured third variable and so may have masked any changes in NA associated with the task stressor.

Beyond these explanations, an interesting consideration is whether the temporal design was sensitive enough to detect dynamic changes in NA. Higher instability within a time period reduces the required intervals to detect effects (Dormann & Griffin, 2015). It is noted that significant variability was identified in dynamic NA. Limited theoretical guidance is provided on issues of temporal research design within psychological variables, however, our results raises the question of whether dynamic NA in response to task stressors may be more optimally detected with shorter timeframes (Dormann & Griffin, 2015). Discussions on time-intervals in stressor-strain models have suggested that some effects may be more appropriately modelled by a short-term stress reaction model (i.e., time periods of one hour to one day; Dormann & Griffin, 2015; Dormann & Van de Ven, 2014; Frese & Zapf, 1988).

Practical Implications

This study also has important practical implications. First, our results demonstrate that stressors that are novel for that person will produce greater stress reactions, compared to stressors that may be objectively similar but are familiar to the individual. When new tasks or work processes are introduced, organizational changes

occur or employees or hired or promoted, it can be expected that employee resources will decline over time. Once stressors are removed, however, increases in resources can occur. The differential results we found for positive and negative affect also indicates that stress reactions can be complex. While traditionally high levels of anxiety, tension and worry are most strongly associated with negative stress, results of this study indicate that declining positive affect (e.g., enthusiasm and interest) associated with positive approach based coping behaviors (Folkman & Moskowitz, 2000) are also indicators of a stress reaction (see also Drummond & Brough, 2016).

Our results also indicated that stress reactions are not inevitable and that through adaptation, stress reactions can be moderated. According to the repeated exposure hypothesis, however, these adaptation processes are neither assured nor do they occur automatically (Matthews & Ritter, 2018). Constant exposure to stressors over time can prevent adaptation and lead to resource loss spirals and their associated impacts on health and wellbeing (Hobfoll, 1989; McEwen, 1998). Demand interventions that moderate the quantity and frequency of stressor exposure, and recovery interventions that support individuals to regain lost resources can have both short and long-term benefits (Burgess et al., 2020). Our results suggest that managing stressor exposures while providing opportunities for recovery in the mid-term can improve wellbeing and reduce stress (e.g., Raper & Brough, 2021). Over the longer term, as the individual adapts, stressor quantity and frequency can begin to be increased, facilitating further adaptation.

Research Strengths, Limitations and Future Directions

The integration of adaptation theory with resource-based approaches to examine longitudinal stressor–strain relationships is a relatively new approach and remains in an early “phenomena detection” phase (Ritter et al., 2016). By testing the hypotheses with

an objective stressor via a quasi-experimental design, this research contributes to this approach, thereby supporting and extending previous research employing subjective stressor operationalizations (Matthews & Ritter, 2018; Matthews et al., 2014; Ritter et al., 2016).

However, achieving the desired level of control and specificity to detect such relationships comes at the cost of assessing a broader range of objective stressors and changes in resources. The quasi-experimental design is limited in that unmeasured third variables may explain the observed effects. Further, to achieve a level of control over the context and timing of stressor exposure led to the assessment of a naturalistic stressor in a homogenous non-work (e.g., student) sample. Shen et al. (2011) acknowledged that student samples can be appropriate in studies that seek to demonstrate whether a phenomenon *can* be detected. With the scarcity of research on shorter-term stress reactions combined with our novel design, we considered a student sample to be appropriate in this context. We acknowledge, however, that generalizability is limited by the sample choice, and further research is required to identify if the results can be replicated within a workplace context to assess the impact of occupational stress. Acknowledging the need for time to be operationalized so that participants can be directly comparable, it is suggested that situations such as employees beginning a new job role (e.g., Gai et al., 2022), returning to work, and undergoing other key transition points, provide suitable assessment contexts for further validation of the results reported here (see Dormann & Van de Ven, 2014 for a discussion of this issue).

The comparison of stressor–strain effects across short timeframes is also an important contribution of this study. In assessing the effects of a single task stressor across a short timeframe, however, we found only small effects. This was not

unexpected, as Frese and Zapf (1988) noted that most people are faced with numerous small stressors (i.e., daily hassles; Brough, 2004) that accumulate to produce the overall experience of strain. There is, therefore, a clear need to assess additional timeframes to assess whether the accumulation of resource loss occurs over shorter and longer periods.

Examination of the timing of different stressors and their impacts on the accumulation of losses in different resources is an important future direction for occupational stress research. As Dormann and Van de Ven (2014) argued, the nature of some stressor–strain relationships may change across different timespans. While this research supports the repeated exposure hypothesis in a mid-term (i.e., 10 days) timeframe, resources may be differentially gained and lost across shorter and longer timeframes. The patterns of gains, losses and adaptations may also be more complex then presented here. Thus other longitudinal models of shorter-term stress reactions and longer-term adaptive processes are also recommended to be assessed (Frese & Zapf, 1988). Overall, we support and reinforce calls for increased research into the dynamics of stress reactions across different timespans (Dormann & Van de Ven, 2014; Guthier et al., 2020; Taylor et al., 2017).

Conclusion

This paper describes two studies testing the repeated exposure hypothesis against objective stressors. The results offer evidence in support of the repeated exposure hypothesis in that mid-term stress reactions and long-term adaptation occur in response to objective tasks stressors. This research also offers several methodological contributions. We provide support for operationalizing dynamic positive affect as a resource and demonstrating how level change in resources can be modeled using piecewise growth modeling. Dynamic assessments provide the opportunity to advance knowledge of the stressor–strain relationship. Most pertinent, however, is that our

research demonstrates both the value in extending research into further investigation of mid-term stress reactions, raises interesting questions about the complexity of these reactions, and suggests that future research investigating both shorter and longer stress reactions to objective stressors can advance our understanding of stress as a dynamic process.

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Table 1

Multilevel means, standard deviations, correlations, and omega reliability coefficients for the latent variables for Study 1

	M	SD_b	1.	2.	3.	4.
SD_w	-	-	0.75	1.03	2.45	0.79
1. Positive Affect	3.36	1.12	(.97; .99)	-.57***	-.15*	.00
2. Negative Affect	4.15	1.14	-.65***	(.97; .99)	.04	-.14
3. Time—Stressor (days)	4.42	-	-	-	-	0.54***
4. Time—Post-stressor (days)	7.52	-	-	-	-	-

Note. * $p < 0.05$, *** $p < .001$. $N_{between} = 34$, $N_{within} = 529$. SD^w refers to standard deviation of the variables at the within-level. SD_b refers to standard deviation of the variables at the between-level. Within-level values are presented in the upper quadrant, between-level values in the lower quadrant. Within and between Omega reliability coefficients are presented on the diagonal in parentheses.

Table 2

Comparison of the features of the novel and familiar objective task stressors

Attribute	**Novel Stressor**	**Familiar Stressor**
Assessment	Lab Report	Lab Report
Tasks	Operate statistics software, generate descriptive statistics, interpret and report statistical results	Search academic databases, read journal articles, write a summary of research on a topic
Consequences	30% of course/unit grade	30% of course/unit grade
Familiarity of Stressor (Manipulation)	First course in sequence (prerequisite for all other statistics courses). Enrollment restrictions apply such that students have not had the opportunity to complete these tasks at university previously.	Second in a sequence of two courses with similar requirements (different topics). Tasks (e.g., literature search) more likely completed previously (relative to novel stressor condition)
Teaching Staff Observations	Students historically report this assessment as more challenging	Students historically report this assessment as less challenging

Note. Course/Unit refers to the individual subjects' students enroll in during a Semester, with a typical full-time student load comprising four courses/units per semester.

Table 3

Multilevel means, standard deviations, correlations, and omega reliability coefficients for the latent variables for Study 2

	M	SD_b	1.	2.	3.	4.
SD_w	-	-	0.72	0.90	1.71	1.89
1. Positive Affect	2.61	0.79	(.99; 1.00)	-.16*	.10	.04
2. Negative Affect	3.13	1.21	-.08	(.97; .99)	-.42***	-.40***
3. Time—Stressor (days)	-1.45	-	-	-	-	68***
4. Time—Post-stressor (days)	1.52	-	-	-	-	-

Note. * $p < 0.05$, *** $p > 0.001$. $N_{between} = 81$, $N_{within} = 640$. SD^{w} refers to standard deviation of the variables at the within-level. SD_b refers to standard deviation of the variables at the between-level. Within-level values are presented in the upper quadrant, between-level values in the lower quadrant. Within and between Omega reliability coefficients are presented on the diagonal in parentheses.

Table 4

Multigroup χ^2 difference test of the measurement and piecewise growth models for Study 2

Model Comparison	**Positive Affect**			**Negative Affect**		
	TR_d	*df*	*p*	TR_d	*df*	*p*
1. Measurement model v. multigroup piecewise growth model (latent means constrained)	26.75^{***}	8	.001	215.11^{***}	8	<.001
2. Measurement model v. multigroup piecewise growth model (latent means freely estimated)	33.19^{***}	10	<.001	218.01^{***}	10	<.001
3. Multigroup piecewise growth model (latent means constrained v. latent means freely estimated; hypotheses 3 and 4)	6.29^{*}	2	.043	0.707	2	.70

* $p < .05$, ** $p < .01$ *** $p < .001$.

Figure 1

Hypothesized Stress Reaction Model