Can positive affect "undo" negative affect? A longitudinal study of affect in studying

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Abstract

Drawing from the view that positive and negative emotions are incompatible within momentary experience, it was hypothesized that positive affect in studying would prevent subsequent negative affect in studying. A sample of 126 college students completed the Positive and Negative Affect Schedule – Short Form with reference to their current experience when studying on two occasions three months apart. Mediation modeling revealed a proximal indirect effect, in that positive affect prevents negative affect at baseline, and the reduction effect carries on over time, and a less enduring distal indirect effect, in that positive affect at baseline fosters subsequent positive affect, which in turn prevents negative affect. The findings support the hypothesis and provide indications for research and application aiming at reducing negative affect in studying.

Keywords: College Students; Emotions; Longitudinal Study; Mediation; Negative Affect; Positive Affect; Undoing Hypothesis.

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Introduction

Affect is a general term representing positive or negative subjective experience occurring at a given moment in time (Wyer, Clore, & Isbell, 1999), and it is a conceptual umbrella for both moods and emotions, mapping them onto a bipolar (positive-negative) *valence* dimension and differentiating them according to their level of *activation* (high-low) (Russell & Carroll, 1999). Positive affect includes emotions such as joy, love, and contentment, and negative affect includes emotions such as fear, anger, and sadness. Positive affect and negative affect were initially regarded as relatively independent constructs (Diener & Emmons, 1984). The interest in the relationship between the two affective states has recently grown as studies showed that positive emotions play an important role in the regulation of negative emotions (Tugade & Fredrickson, 2004), and buffer the aversive effects of stress (Folkman, 2008).

The Broaden and Build Model of Positive Emotions (Fredrickson, 1998, 2001) is the main theoretical approach that explains the relationship between positive and negative emotions. The model states that negative emotions narrow one's cognition and behavior, and this narrowing is adaptive only when one confronts a real and immediate threat (Cohn et al., 2009). The model advances three hypotheses: (1) the *broaden hypothesis*, which states that positive emotions expand one's attention (Gasper & Clore, 2002), cognition (Fredrickson & Joiner, 2002) and behavioral repertoires (Johnson & Fredrickson, 2005); (2) the *build hypothesis*, which advocates that even short-lived positive emotions may have long-term effects by enhancing physical, psychological, cognitive, and social resources (Cohn et al., 2009); (3) the *undoing hypothesis*, which contends that positive emotions function as an antidote for negative emotions in that they correct or diminish their deleterious influence (Fredrickson, 2001).

The undoing hypothesis was tested with regard to the physiological impact of negative emotions in experiments (Tugade & Fredrickson, 2004; Fredrickson et al., 2000; Fredrickson & Levenson, 1998). These experiments induced negative emotions in order to increase cardiovascular reactivity using a time-pressured speech preparation task. Participants were then randomly distributed in four groups in order to watch one of the films that elicited contentment, amusement, sadness, or neutrality. Consistent with the undoing hypothesis, films inducing contentment or amusement produced a faster cardiovascular recovery than those inducing sadness or neutrality. The undoing hypothesis was also tested using longitudinal study designs in real-life contexts. For example, a recent experience sampling study conducted on workers measured positive and negative affect at work for two consecutive weeks and job satisfaction at the end. Consistent with the undoing hypothesis, the study found that (a) negative affect was negatively associated with job satisfaction and (b) positive affect mitigated the association (Dimotakis, Scott, & Koopman, 2011).

This study investigates a more basic undoing process: Can positive affect in a specific domain of activity "undo" negative affect in the same domain of activity, so that, an increase in positive affect at time 1 will be followed by a decrease of negative affect at time 2? The rationale for this research question is threefold. First, although positive affect and negative affect are relatively independent variables when measured as means over repeated observations (e.g., gathered via experience sampling method or end-of-day diaries) they tend to be negatively associated within momentary experience (Russell & Carroll, 1999). Second, there is agreement among researchers that, within momentary experience, positive emotions are incompatible with negative emotions in that the affective system cannot be simultaneously broadened and narrowed, nor be both self-protective and self-expanding (Garland et al., 2010). Finally, the induction of positive affect when one experiences negative affect has been used for decades in the systematic desensitization of maladaptive negative

emotions (Wolpe, 1958), and found to be effective in reducing domain-dependent negative affect, including study-related anxiety (Zettle, 2003). Therefore, it is possible that experiencing positive affect in temporal proximity with negative affect in a context of activity such as study or work may result in experiencing less negative affect in that context at a later time.

The research question is addressed on the emotions university students experience in studying. Research on *study burnout* – which signifies a tendency to experience negative affectivity while studying in the form of *exhaustion*, *cynicism*, and *inefficacy* – and *study engagement* – which signifies a tendency to experience positive affectivity while studying in the form of *vigor*, *dedication*, and *absorption* – suggest that positive and negative affect influence university students' commitment to their study program and academic performance (Salanova, Schaufeli, Martínez, & Bresó, 2010). Therefore, positive affect and negative affect experienced when engaged in study activities are practically relevant constructs in educational research.

This study adopted the simplest two-wave longitudinal design, in which positive and negative affect in studying were measured at two different points in time, whose temporal distance differed across participants and averaged around three months. Within such design, the undoing effect can be disentangled, with reference to the path diagram shown in Figure 1, into the following three hypotheses:

(H1) Time 1 positive affect will prevent time 2 negative affect through the mediation of time 1 negative affect (path a_1b_1);

(H2) Time 1 positive affect will prevent time 2 negative affect through the mediation of time 2 positive affect (path a_2b_2);

(H3) Time 1 positive affect will directly prevent time 2 negative affect (path c').

Hypothesis 1 states a proximal indirect effect, in that positive affect prevents negative affect at baseline, and the reduction effect carries on over time. Hypothesis 2 states a distal indirect effect, in that positive affect at baseline fosters subsequent positive affect, which in turn prevents negative affect. Hypothesis 3 states a distal direct effect in that baseline positive affect prevents subsequent negative affect; this hypothesis is not grounded in theories of emotions and hence is tested only for the sake of completeness.

The first goal of this study is to test the hypotheses in a single model. The second goal is to assess the duration of the hypothesized undoing effects, if present. The third goal is to assess whether the hypothesized undoing effects a_1 and a_2 are linear functions of time 1 positive affect and time 2 positive affect, respectively – and hence independent of baseline positive affect – or are concave down functions – and hence reduced for high levels of baseline positive affect.

Method

Participants

Potential participants were approached in common university areas such as libraries and cafeterias of a large London university belonging to the group of so called “new universities” that in the United Kingdom offer comparatively more enrollment opportunity to mature students. All participants were briefed individually, provided informed consent, and completed a demographic datasheet and a questionnaire pack including the instrument described in the next section (time 1). Participants were then invited by email to come to a lab to complete the same questionnaire pack a second time (time 2). The data collection was conducted in two consecutive semesters, each comprising 11 weeks of formal teaching plus one revision week, which is followed by a three-week examination period. In both semesters, data collection started on week 9 and ended on week 15. The follow-up time ranged from 17 days to 192 days (M = 95.90, SD = 32.76).

Because a single invitation for the time 2 participation was sent, non-response at time 2 was high. The time 1 sample comprised 419 students. The time 2 sample comprised 126 students. The time 2 sample and the non-respondent sample did not differ in the time 1 means of positive affect and negative affect, gender, ethnicity and subject of a degree. Yet, respondents were older (age of respondents: M = 28.87, SD = 10.13; age of non-respondents: M = 24.69, SD = 6.63; t = -4.27, p<.001) and more senior than non-respondents (year of studying of respondents: M = 3.64, SD = 1.49; year of studying of non-respondents: M = 3.01, SD = 1.45; t = -4.06, p<.001).

Only the participants who completed both study waves were included in the data analysis of the present study. The age range was 17 to 62 years (M = 28.87, SD = 10.13); 23 (18.3%) were males, 103 (81.7%) were females. There largest ethnic group in the sample was White (81 participants; 64.3%), followed by Black (12 participants; 9.5%), Indian (7 participants; 5.6%) and other or mixed ethnic groups (26 participants; 20.6%). There were 44 science students (34.4%), 31 business students (24.2%), 29 humanities students (22.7%), 14 social science students (10.9%) and 10 students withheld the information about their course of studying (7.8%).

Measures

Participants completed the Positive and Negative Affect Schedule (PANAS) – Short Form (I-PANAS-SF; Thompson, 2007). The I-PANAS-SF consists of a list of ten adjectives, five measuring positive affect (e.g., “Attentive”) and five measuring negative affect (e.g., “Nervous”). The instructions used in this study were: ”Please read the following adjectives in detail and think if you have those feelings. Please respond thinking of your current experience and behavior when you engage in study activities”. Adjectives were scored on a five-point scale ranging from 1 (“None”) to 5 (“Very Much”). The positive affect and negative affect scale scores were calculated by averaging the scores of their constituent

adjectives. There were only 5 missing values for any item over both waves of data collection totaling 2520 measurements; in those instances the affect scores were calculated by averaging the scores of the non-missing item scores. I-PANAS-SF scale scores correlate strongly with the scale scores of the original PANAS (Watson, Clark, & Tellegen, 1988); the 8-week test-retest reliabilities were 0.84 for both scales, and the internal consistency of the scales were 0.74 for negative affect and 0.80 for positive affect in the original validation study (Thompson, 2007).

Statistical Analysis

The models were estimated using standardized latent variable scores (Jöreskog, 2000) in order to control for measurement error. The standardized scores of the four latent variables (time 1 positive affect, time 1 negative affect, time 2 positive affect, and time 2 negative affect) were estimated for each participant using LISREL 8.8 (Jöreskog & Sörbom, 1996), based on a confirmatory factor model (CFA) with correlated factors in which the I-PANAS-SF items were defined as the indicators of the latent variables. The standardized scores of the four latent variables were then used in lieu of the observed variables in all the analyses.

The hypothesized mediation model was estimated using Preacher and Hayes' (2008) approach to multiple mediation and Hayes' (n.d.) *INDIRECT* SPSS macro, which provides bootstrap estimates with bias corrected confidence intervals of the indirect effects.

The curvilinear trends of the a_1 and a_2 paths were estimated using Hayes and Preacher's (2010) approach to non-linear mediation and Hayes' (n.d.) *MEDCURVE* SPSS macro, which provides bootstrap estimates with bias corrected confidence intervals of the indirect effects. The curvilinear trends of the a_1 and a_2 paths were modeled using a linear and a quadratic term each. Because the macro accepts only one mediator, the hypothesized indirect effects were tested in two separate model runs, one for each mediator.

Results

Data Description

Table 1 shows the means, standard deviations, reliability coefficients (Cronbach's alpha), and intercorrelations of the study variables. All variables had reliability coefficients greater than the satisfactory standard of 0.70. Positive affect had weak and negative correlations with negative affect both at time 1 and at time 2. Time 1 positive affect had a weak and negative correlation with time 2 negative affect. Time 1 negative affect had a fair and positive correlation with time 2 negative affect, and time 1 positive affect had a strong and positive correlation with time 2 positive affect. In all, the pattern of correlations is consistent with all three hypotheses.

Test of the Effects of School Year Timing

Because the data were collected at different weeks of the semesters for different participants, we first tested whether the school year timing of data collection influenced the mean scores of affect. This was done by fitting a mixed-effects ANOVA model separately for positive affect and negative affect. Due to the relatively small sample size, semester phase was coded as 0 for observations made during the learning phase (weeks 9-12) and as 1 for observations made during the performance phase (weeks 13-15) of each of the semesters. In each model affect was the dependent variable, time was the within-participants factor, and semester phase of the first assessment and semester phase of the second assessment were two between-participants factors. In both models neither the main effects of time, semester 1 phase, and semester 2 phase nor their interactions were significant at the $p < .05$ level. As such, the school year timing of the observations was not included and controlled for in the following analyses.

Mediation Modeling

Table 2 shows the standardized direct and indirect effects of the hypothesized mediation model for the whole sample. Looking at the direct effects of the independent variable on the mediators, time 1 positive affect was a negative and significant predictor of time 1 negative affect, and it was a positive and significant predictor of time 2 positive affect, supporting the hypothesized paths a_1 and a_2, respectively. Turning attention to the direct effects of the mediators on the dependent variable, time 1 negative affect was a positive and significant predictor of time 2 negative affect, supporting the hypothesize path b_1, whereas time 2 positive affect was not a significant predictor of time 2 negative affect, not supporting the hypothesized path b_2.

The direct effect c' of time 1 positive affect on time 2 negative affect was negative, as hypothesized, but non-significant; therefore, Hypothesis 3 is not supported. The indirect effect of time 1 positive affect, through the combined mediation of time 1 negative affect and time 2 positive affect, on time 2 negative affect was negative and significant at the $p < .05$ level, in that the upper bound of its 95% confidence intervals did not include the 0 value; therefore, Hypotheses 1 and 2 are supported as a whole. Looking at the separate mediation processes, the indirect effect a_1b_1 of time 1 positive affect, through the mediation of time 1 negative affect, on time 2 negative affect was negative and significant at the $p < .05$ level; therefore, Hypothesis 1 is supported. The indirect effect a_2b_2 of time 1 positive affect, through the mediation of time 2 positive affect, on time 2 negative affect was negative, as hypothesized, but non-significant; therefore, Hypothesis 2 is not supported.

Sensitivity Analyses on Length of Follow-up

In order to assess the extent to which the results depend on the length of follow-up the sample was split in two sub-samples based on the median follow-up time of 94 days. The mean follow-up time in the shorter follow-up sub-sample was 71.22 days and its standard

deviation was 18.60 days. The mean follow-up time in the longer follow-up sub-sample was 121.39 days and its standard deviation was 23.30 days.

Table 2 shows the standardized direct and indirect effects of the hypothesized mediation model estimated separately on the two sub-samples. The model for shorter follow-up reveals a non-significant direct effect, and significant indirect effects through both time 1 negative affect and time 2 positive affect. Therefore, Hypothesis 3 is not supported, whereas both Hypothesis 1 and Hypothesis 2 are supported. The model for longer follow-up reveals a non-significant direct effect, a significant indirect effect through time 1 negative affect, and a non-significant indirect effect through time 2 positive affect. Therefore, Hypothesis 3 is not supported, Hypothesis 1 is supported, and Hypothesis 2 is not supported. In all, these findings suggest that the indirect effect a_2b_2 stated by Hypotheses 2 exists but it is less durable than the indirect effect a_1b_1 stated by Hypothesis 1, and further disconfirm the direct effect c' stated by Hypothesis 3.

Assessment of the Goodness of Fit of the Models

The goodness of fit of the hypothesized mediation model was assessed estimating it as a path model using LISREL 8.8 (Jöreskog & Sörbom, 1996). When the model was fitted to the whole sample, the shorter follow-up sub-sample, and the longer follow-up sub-sample the Goodness of Fit Index was .99, .98, and 1.0, the Comparative Fit Index was .99, .98, and 1.00, and the Root Mean Square Error of Approximation was .12, .17, and .01, and in all three cases the test of close fit was not significant at the $p < .05$ level. In all, the model fitted reasonably well.

Test of Curvilinear Trends

The model used to test the curvilinear trend of the a_1 path revealed a negative and significant linear effect ($\beta = -.29$, $p < .002$) and a positive and significant quadratic effect ($\beta = .13$, $p < .040$), indicating that the relationship between time 1 negative affect and time 2

positive affect is concave down. The estimated indirect effect of time 1 positive affect on time 2 negative affect through time 1 negative affect was -.37 (95% CI: -.57 to -.20) for low (-1 SD) time 1 positive affect, -.19 (95% CI: -.34 to -.08) for mean (0 SD) time 1 positive affect, and -.01 (95% CI: -.27 to .21) for high (+ 1 SD) time 1 positive affect, suggesting that positive affect does not prevent negative affect when the baseline level of positive affect is high. The model used to test the curvilinear trend of the a_2 path revealed a negative and significant linear effect ($\beta = -.14$, $p < .034$) and a virtually null and non-significant quadratic effect ($\beta = .00$, $p < .972$), indicating that the trend is linear. In all, these findings suggest that the preventive indirect effect a_1b_1 is negatively related to baseline level of positive affect and fades away for high levels of baseline positive affect.

Discussion

This study tested three hypotheses that conjointly constitute the simplest type of mediation model of negative affect as a function of concurrent positive affect and past positive and negative affect. Hypothesis 1 – stating a contingent indirect effect such that time 1 positive affect prevents time 1 negative affect, which in turn fosters time 2 negative affect – was supported on the whole sample, the shorter follow-up sub-sample, and the longer follow-up sub-sample. Hypothesis 2 – stating a distal indirect effect such that time 1 positive affect fosters time 2 positive affect, which in turn prevents time 2 negative affect – was supported only on the shorter follow-up sub-sample. Hypothesis 3 – stating a distal direct effect such that time 1 positive affect prevents time 2 negative affect – was disconfirmed. Finally, the contingent indirect effect is concave down in such a way that time 1 positive affect does not prevent time 1 negative affect for individuals who have high baseline levels of positive affect. In all, the findings of this study provide partial support to the hypothesis that positive affect can undo negative affect and indications for future research.

The finding that the prospective effect of time 1 positive affect on time 2 negative affect is mediated entirely by time 1 negative affect and time 2 positive affect indicates that undoing occurs by experiencing positive affect in temporal proximity with negative affect when a student engages in study activities. These findings are broadly consistent with the *control value theory* of achievement emotions (Pekrun, 2006), which views students' emotions as being directly linked to either achievement activities (achievement emotions) or to achievement outcomes (outcome emotions). The former represent emotions that students experience in response to their engagement in a study activity, such as boredom or enjoyment. The latter represent emotions that students experience when thinking of performance outcomes obtained in the past (retrospective outcome emotions), such as shame or pride, or expected in the future (prospective outcome emotions), such as anxiety or hope. The scale used in the present study to measure positive affect includes adjectives such as "active" and "inspired" that are likely to measure primarily positive achievement emotions. Because these emotions imply an attentional focus on the activity, and not on the outcomes, they have the potential to take away attentional resources from negative outcome emotions and hence "undo" them. Future studies should test such possibility by assessing students' discrete achievement emotions (Pekrun et al., 2011) in addition to affect.

The original undoing hypothesis and the more basic undoing hypothesis tested in this study differ in underlying psychological processes. On one hand, the original undoing hypothesis can only be justified by invoking secondary appraisal processes. For example, a plausible explanation is that when positive affect is experienced in conjunction with negative affect, it will enhance the appraisal of negative affect; so that, the latter will become less indicative of a threat and more indicative of a challenge. On the other hand, the indirect undoing effects identified in this study are grounded in classic conditioning, and hence do not

necessarily require secondary appraisal. It is possible that both undoing hypotheses hold and are complementary; this possibility needs to be tested in future research.

The findings of this study have methodological implications as to how the original undoing hypothesis should be tested. The simplest design for testing the original undoing hypothesis requires baseline (time 1) measures of positive and negative affect and subsequent (time 2) measures of a relevant outcome that is thought to be predicted by negative affect. Within such design, the original undoing hypothesis is supported if (a) negative affect predicts the outcome, and (b) positive affect moderates (buffers) the effect that negative affect has on the outcome. Yet, conditions a and b will not be sufficient to support the original undoing hypothesis if the contingent and distal indirect effects identified in this study exist. Therefore, the original undoing hypothesis should be tested controlling for time 1 negative affect and time 2 positive affect.

The findings of this study must be considered with regard to five key limitations. First, participants were left somewhat free to choose the time framework for "current experience and behavior" within which to evaluate their affect. Second, varying follow-up times were chosen to assess the duration of the hypothesized undoing effects resulting in more error variance. Third, the sample was constituted mostly by female students. Fourth, the time 2 dropout rate was high and linked to age and seniority. Finally, repeated administration of the same questionnaire might have sensitized respondents.

Despite its limitations, this study shows preliminary support for a more basic undoing hypothesis on the preventive effects that positive affect has on negative affect in the domain of study activities. Moreover, it outlines directions for future research aimed at reducing negative affect in studying. Finally, it proposes a methodological improvement to test the original undoing hypothesis controlling for the more basic undoing processes identified in this study.

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Table 1

Means, standard deviations, Cronbach's alpha coefficients (in parentheses) and intercorrelations of the study variables.

Variable	*M*	*SD*	1.	2.	3.	4.
1. Time 1 Positive Affect	3.68	0.79	(0.83)			
2. Time 1 Negative Affect	2.08	0.87	-0.35*	(0.84)		
3. Time 2 Positive Affect	3.60	0.78	0.70*	-0.35*	(0.82)	
4. Time 2 Negative Affect	2.06	0.91	-0.34*	0.65*	-0.34*	(0.86)

Note. n = 126. All variables were measured using the I-PANAS-SF.

* $p < 0.001$

Table 2

Adjusted coefficient of determination, direct effects, and indirect effects (with bootstrap bias corrected and accelerated 95% confidence intervals) of the multiple mediator model of the standardized latent score of Time 2 Negative Affect (dependent variable) as a linear function of the standardized latent scores of Time 1 Negative Affect (mediator variable), Time 2 Positive Affect (mediator variable), and Time 1 Positive Affect (independent variable), estimated for the whole sample and the median-split shorter follow-up and longer follow-up sub-samples.

	Sample		
	Whole Sample (n = 126)	Shorter Follow-up Sub-Sample (n = 64)	Longer Follow-up Sub-Sample (n = 62)
Adjusted R-Square	0.54	0.69	0.47
Outcome Variable	*Direct Effects of Independent Variable on Mediators (Paths a_1 and a_2)*		
Time 1 Negative Affect	-0.37***	-0.31*	-0.42***
Time 2 Positive Affect	0.84*	0.76***	0.92***
Predictor	*Direct Effects of Mediators on Dependent Variable (Paths b_1 and b_2)*		
Time 1 Negative Affect	0.67***	0.64***	0.74***
Time 2 Positive Affect	-0.05	-0.25	0.09
Predictor	*Direct Effects of Independent Variable on Dependent Variable (Path c')*		
Time 1 Positive Affect	-0.11	-0.01	-0.17
Mediator	*Indirect Effects of Independent Variable on Dependent Variable through Mediators (Paths a_1b_1 and a_2b_2)*		

Total	-0.28	-0.40	-0.21
	(-0.51 to -0.08)	(-0.61 to -0.18)	(-0.68 to 0.17)
Time 1 Negative Affect	-0.24	-0.20	-0.31
	(-0.36 to -0.14)	(-037 to -0.06)	(-0.51 to -0.18)
Time 2 Positive Affect	-0.04	-0.20	0.10
	(-0.25 to 0.14)	(-0.40 to -0.01)	(-0.29 to 0.43)

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Figure 1

Hypothesized multiple mediator model of Time 2 Negative Affect stating that (H1) Time 1 Negative Affect partially mediates the undoing effect of Time 1 Positive Affect on Time 2 Negative Affect, (H2) Time 2 Positive Affect partially mediates the undoing effect of Time 1 Positive Affect on Time 2 Negative Affect, and (H3) Time 1 Positive Affect has a direct undoing effect on Time 2 Negative Affect.

Note. The + and - signs represent positive and negative relationships, respectively.