Original Papers

Polish Psychological Bulletin
2009, vol. 40 (1), 46-53
DOI - 10.2478/s10059-009-0007-1

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Resiliency, stress appraisal, positive affect and cardiovascular activity**

In accordance with the undoing hypothesis (Fredrickson, Levenson, 1998), evoked positive affect speeds up the cardiovascular system recovery in a stressful situation. An attempt was made to replicate this finding in an experimental study. Individuals characterized by high resiliency levels are capable of more efficient utilization of positive emotions in a stressful situation. Since in earlier research no relationship had been found between resiliency and a tendency to appraise stress as a challenge, this study investigated a possible mediating function of a more specific dimension of cognitive appraisal, i.e. that in terms of activity-oriented challenge appraisal (Włodarczyk, Wrześniewski, 2005). The study shows that evoked positive affect does not lead to a faster recovery. However, highly resilient individuals turned out to achieve higher levels of positive affect in a stressful situation; this effect was mediated by challenge-activity appraisals.

Keywords: *positive affect, resiliency, challenge, cardiovascular activity, undoing hypothesis*

Introduction

Cardiovascular activity patterns noted in the process of stress are associated with the development of ischemic heart disease. Both elevated resting blood pressure (Uchino, Cacioppo & Kiecolt-Glaser, 1996), and high reactivity, i.e. a tendency to a considerable increase in blood pressure and heart rate in a stressful situation (Bedi, Varshney & Babbar, 2000; Uchino et al., 1996) are regarded as risk factors. On the other hand, some studies put the adverse effect of high reactivity in doubt (Muldoon et al.; Gerin & Pickering, cited after: Roy, Steptoe & Kirschbaum, 1998). Research findings concerning an adverse effect of slow recovery are more univocal (Borghi et al., cited after: Roy, Steptoe & Kirschbaum, 1998). Positive emotions may protect the cardiovascular system, since one of their adaptive functions consists in speeding up the recovery from changes caused by negative affect both in the cognitive sphere and in physiological processes (Fredrickson & Levenson 1998; Levenson, 1999; Fredrickson, Mancuso, Branigan & Taugade, 2000).

Emotions and physical health

The currently seen upsurge of interest in the function of positive emotions was preceded by a period of extensive research into negative affect (Baumeister, Bratslavsky, Finkenauer & Vohs, 2001; Fredrickson, 1998, 2000). A review of the research literature by Kiecolt-Glaser and co-workers (2002) suggests that negative emotions are detrimental to physical health on many dimensions, including cardiovascular diseases. Only in some situations negative affect may have a health-promoting effect, e.g. short-term negative emotional episodes associated with the sympathetic nervous system arousal may improve the immune system functioning (Mayne, 1999; see also Epel, McEwen & Ickovics, 1998; McEwen & Lasley, 2003).

A similar meta-analysis concerning positive affect was conducted by Pressman and Cohen (2005). The authors proposed a model explaining the health-promoting function of positive affect. Evoked positive affect directly influences cardiovascular activity, and besides, acting as a buffer in association with resources (also social), protects the individual against strong stress responses. Steptoe, Wardle and Marmot (2005) provided evidence based on laboratory and field studies that confirms the direct (and not buffering via distress reduction) effect of positive emotions on cardiovascular activity reduction and decreased secretion of both cortisol and fibrinogen (factors involved in stress responses and associated with cardiac risks).

The health-promoting effect of positive emotions is relatively independent of favorable effects of negative emotions reduction (Larsen, Hemenover, Morris &

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**** This research was supported by the National Committee for ScientificResearch, Grant No. 1 H01F 053 27**

Cacioppo, 2004). Optimal coping with stress consists in skillful utilization of both positive and negative emotions (Folkman & Moskovitz, 2000; Larsen et al., 2004).

Resiliency

Persons characterized by a high resiliency have a great ability of utilizing positive emotions when faced with a difficult situation. Resiliency is defined as an adaptive flexibility resulting from the capacity to modify one's ego-control level in response to situational requirements (Letzring, Block & Funder, 2005). Persons with a high resiliency level more often experience positive emotions, are more self-confident and demonstrate a generally better psychological adjustment.

The higher the resiliency level, the greater the capacity to modify one's ego-control in keeping with situational needs and opportunities. Thus, a more effective course of affective regulation processes is possible, which in turn may contribute to evoking positive emotions. Fredrickson has shown in her studies (Fredrickson et al., 2003; Tugade & Fredrickson, 2004), that it is positive emotions that are utilized by highly resilient individuals as an active factor leading to their better functioning in the face of difficult situations. Positive emotions help such persons to distance themselves from negative experiences (cf. Heszen & Sęk, 2007; Sęk, 2007).

One of the main ways used by highly resilient individuals to generate positive affect under stressful conditions is their cognitive appraisal of stress. However, Tugade and Fredrickson (2004) have shown that resiliency, as expected, leads to less intense appraisals of stress in terms of threat, but is unrelated to challenge appraisals.

Activity- and passivity-oriented challenge appraisal

Cognitive appraisal of stress as a challenge is an issue particularly often dealt with in analyses of sources of positive affect in stressful situations (Folkman & Moskowitz, 2000; Lazarus, 2000; Tugade & Fredrickson, 2004). As a result of their studies concerning the transactional model of stress and its application in the research into coping with stress among persons after myocardial infarction, Kazimierz Wrześniewski and his team (Włodarczyk & Wrześniewski, 2005) proposed to distinguish two types of challenge appraisals: activity- and passivity-oriented. An assumption was made by the authors that stress appraisals are either dispositional or situational. A tendency to dispositional appraisals is a stable personality trait, while situational appraisals refer to concrete, defined and named situations that the individual participates in. In the development of a tool for the measurement of stress in terms of threat, loss and challenge, the so-called *Kwestionariusz Oceny Stresu – Stress Appraisal Questionnaire* (Włodarczyk & Wrześniewski, 2005), a factorial structure was obtained in exploratory analyses suggesting the presence of two types of challenge. One of them implies activity in response to stress, while the other does not involve activeness, but rather curiosity or taking interest in the stressful situation.

In a number of studies the two types of challenge appraisals were evidenced to differ from each other. Activity-oriented challenge appraisals predicted higher levels of positive emotions and greater life satisfaction at various stages of post-MI cardiac rehabilitation. In contrast, passivity-oriented challenge appraisals turned out to be associated with negative emotions, higher subjective complaints, and poorer adaptation to the cardiac condition (Włodarczyk, 2004).

Study objectives and hypotheses

The aim of the study was to replicate the research testing the hypothesis about restitution of changes under a high level of task-related stress. The other aim was to investigate interrelationships between resiliency, stress appraisals and affect in a situation of task-related stress.

On the grounds on the theoretical proposals outlined above the following research hypotheses were posed:

1. Positive emotions evoked after a stressful situation ending lead to a faster recovery.
2. A high resiliency level is associated with lower reactivity and faster recovery process in a stressful situation.
3. Stress appraisals in terms of activity-oriented challenge mediate between resiliency and the level of experienced positive affect.

An experimental paradigm was designed to test these hypotheses.

Method

Participants

Participants in the study were in the 21-29 age range (mean age 24.52 years; *SD* = 2.51), with education level defined as at least the first year of university study[1]. In this age group the prevalence of cardiovascular conditions is low. Therefore, there should be persons in whom patterns of the cardiovascular system functioning associated with a risk of developing cardiac conditions can be observed. The variable of gender was controlled by equating the proportions of men and women across groups. Due to the laboratory character of the study, it was not possible at present to enroll a sample large enough to allow testing with a sufficient statistical power the gender interaction as a confounding variable.

The study participants were recruited from among

1 The criterion of education was included so as to make the experimental situation more realistic. In a pilot study participants with a secondary education did not show any commitment to task performance. On the other hand, in the case of students, the performance of mental tasks that is to be evaluated constitutes a routine procedure and therefore seems to induce greater involvement.

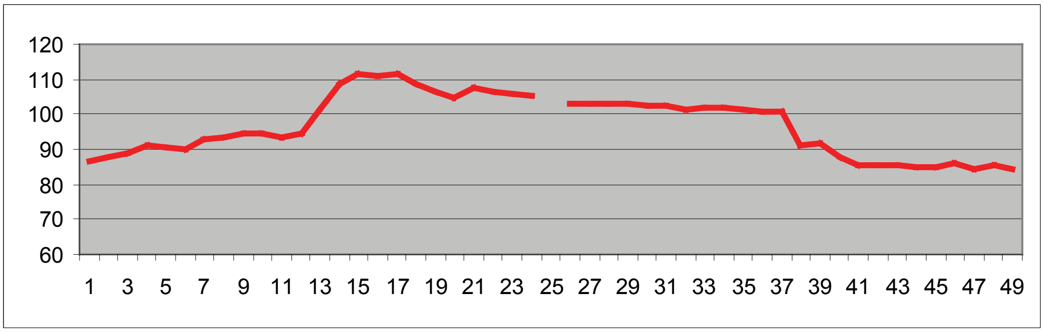


Figure 1. The effect of task on heart rate.
Heart rate values registered over the period of two minutes before the task and during the first two minutes of task performance (left), as well as during a minute at the recovery stage (right).
HR – heart rate per minute at 10 sec. intervals, T – time at 10 sec. intervals

passers-by in one of the city of Poznań main streets by pollsters from a certified firm that conducts, among other things, public opinion polls. University education was declared by 35.4% of the participants, while the remaining 64.6% were still students. Out of 77 examined participants 69 were entered in further analyses; the remaining 8 were excluded due either to their extreme and atypical systolic blood pressure and/or positive/negative affect levels, or to the measuring equipment faults. Because of missing data for all the three cardiovascular activity measurements at the three stages of the study the final sample for which the experimental hypotheses were tested contained 54 individuals. Allocation to the experimental or control group was random. Both conditions were equated in terms of gender proportions (Pearson chi-square = 0.02, $df = 1$, $p = 0.88$) and education level (Pearson chi-square = 0.03, $df = 1$, $p = 0.87$). The compared groups did not differ in respect of age ($t(53) = -0.145$; $p = 0.88$), or body mass index (BMI, $t(53) = -0.89$; $p = 0.37$).

Measures

Physiological parameters. The Heart Rate Monitor of the Lafayette Instruments Company and the DS-250 Pressure Holter by the Nissei Company were used for the cardiovascular activity measurement. Speed of the recovery process was operationalized as the difference in the blood pressure after a minute of restitution. This operationalization is based on an assumption about a relative linearity of the restitution process. The experimental design required that each of the participants undergoes the same procedure containing three stages: expectation (anticipation of stress), reactivity (task-induced stress) and rest (the cardiovascular system restitution). Each stage is different from the previous one. In the reactivity stage a distinctive physiological response should emerge and be maintained over the entire task performance period. Besides a systematic (relatively stable) tonic increase caused by the sympathetic system activity, in the first seconds of the latter stage a transition change can be expected, i.e. a relatively short additional increase due to the arousal withdrawal from the parasympathetic system (Sosnowski, 2002). Each of the stages should be characterized by a relative stability. The degree of this assumption implementation is illustrated by Figure 1.

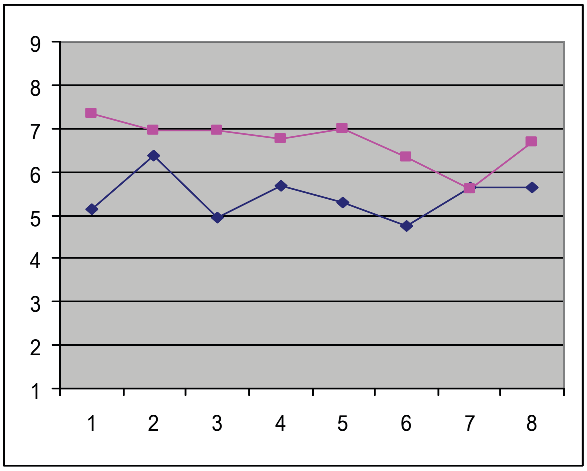
Controlling the experimental manipulation effectiveness

In order to control the experimental manipulation efficacy a *Questionnaire of Affective Value of Pictures* was developed. On the experiment completion the participants assessed on two rating scales the impact of each picture on their affective sphere during the experimental procedure, in the dimensions of valence and arousal intensity.

Positive and negative affect was measured using the popular *Positive and Negative Affect Schedule* (PANAS) developed by Watson and Tellegen (1988), in the Polish adaptation by Brzozowski (1995). The instrument consists of two subscales containing ten highly emotionally loaded adjectives each. The subjects were asked to rate each adjective on a 5-point scale for the emotional impact. The positive affect subscale contains such terms as "lively" and "brisk", while the negative one – "apprehensive", "annoyed", etc. Depending on the instructions, the scale can be used for either the present or retrospective self-report. In the study sample the Cronbach alpha for the positive and negative affect subscales was 0.88 and 0.92, respectively.

Stress Appraisal Questionnaire – Laboratory Form (SAQ-Lab)(Kwestionariusz Oceny Stresu – Wersja Laboratoryjna (KOS-Lab). The *Stress Appraisal Questionaire* (KOS –MI), (Włodarczyk & Wrześniewski, 2005) was modified for the measurement of cognitive appraisal under laboratory stress conditions. SAQ-Lab was developed using a content analysis of the KOS –MI: the items that might serve to describe life events (such as e.g. myocardial infarction) rather than relatively milder stressful situations were eliminated. The reliability coefficients for the challenge-activity and challenge-passivity subscales were 0.81 and 0.77, respectively.

Resiliency. For the purposes of this study a Polish adaptation was prepared of the *Ego Resiliency Scale* developed by Block and Kremem, (1996), the authors of



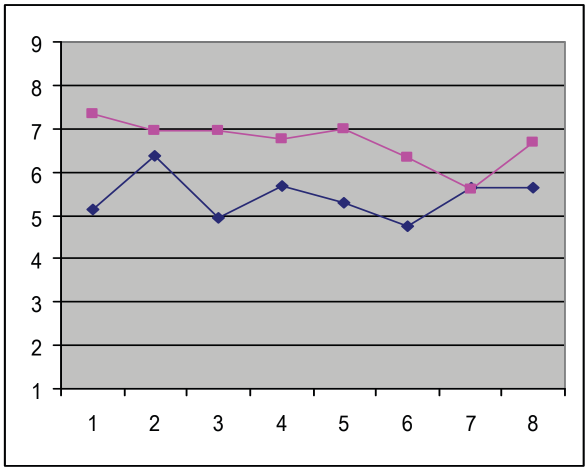


Figure 2. Effectiveness of the experimental manipulation.
The diagrams show valence (left) and strength (right) of affective responses in the experimental (light-colored line) and control (darker line) groups.
**p < 0.01, *p < 0.05,

the concept. The scale consists of 14 items coming from the *California Adult Q-sort*, an instrument for description of personality traits (e.g. "I quickly get over and recover from being startled", "I like to do new and different things"). Responses are given on a 4-point scale. The Polish version had a satisfactory psychometric equivalence with the original; moreover, its theoretical and criterion convergent validity. The translation accuracy was checked using the bilingual responses method (Kaczmarek, 2007). In the study sample the Cronbach alpha reliability coefficient was 0.78.

The experimental procedure

Following a 5-minute expectation period and physiological parameters measurement, each participant performed an Arithmetic Mental Task for the next five minutes. Then during a 5-minute restitution period a slide presentation was shown on the screen – with pictures evoking positive emotions (the experimental group) or affectively neutral (the controls). On the task completion each subject filled out a set of questionnaires in the following order: situational variables measurement (retrospective assessment of stress and affect at the three stages of the study), resiliency measurement, and finally, personal data.

Positive affect induction (experimental manipulation). The *International Affective Pictures System* (IAPS) (Lang, Bradley & Cuthbert, 2005) was used in he study. Although the IAPS was developed in the USA, it was applied in research in various parts of the world, including Brazil and Germany (Wolf, Mass, Ingenbleek, Kiefer, Naber & Wiedemann, 2005). Two sets of 8 pictures each were selected: one affectively neutral, and the other evoking pleasure or joy (Lang, Bradley & Cuthbert, 2005; Mikels, Fredrickson, Larkin, Lindberg, Maglio & Deuter-Lorenz, 2005). The pictures were exposed at 15-sec. intervals.

At the baseline persons allocated to the experimental group did not differ from the controls in terms of either positive and negative affect level, or cardiovascular activity parameters. A majority of stimuli (pictures) evoked in the experimental group the expected response that was closer to the positive extreme on the valence dimension than that in the control group, $t(53) = 4.23$, $p < 0.01$, $\omega^2 = 0.20$, but did not differ as regards the arousal intensity, $t(53) = 0.95$, n.s. (see Figure 2). Therefore, the experimental manipulation may be considered to be effective. Four persons who had assessed positive stimuli as negative, or neutral stimuli as positive ones were excluded from further analyses.

Stressful conditions. In order to increase the stress level the task was to be performed within a time limit. The participants were informed that: they would be eligible for a prize draw of PLN 400, their chances for winning the prize would depend on their results, and their performance would be compared with that of others – but no information about the criterion of an average performance was given. The participants were watched from the next room through a two-way mirror.

Results

Mean values of cardiovascular activity measures in relation to the experimental condition (induced positive affect vs. control) and resiliency level are presented in Table 1.

A general linear model with repeated measures was used to check whether evoked positive affect leads to a faster recovery (see Table 2). The stage of experiment was introduced as a within-subject factor with three levels: expectation, performance, restitution. The difference in the effect size between the reactivity and restitution stages was checked using the repeated contrast analysis, where each successive factor category is compared to the previous one. Group (experimental with evoked positive affect vs. control) and resiliency level (dichotomized via the median split) were introduced as between-subject factors.

Table 1
Mean values of cardiovascular activity measures by experimental manipulation and resiliency level.

Measure	Group				Resiliency level			
	Experimental		control		low		high	
	Mean	Standard deviation	Mean	*SD*	Mean	*SD*	Mean	*SD*
SBP-1	127.46	14.05	129.00	16.92	127.75	16.73	128.72	14.42
SBP-2	142.37	15.20	144.32	23.56	140.83	20.65	145.80	18.91
SBP-3	123.33	13.25	127.32	16.36	123.33	13.91	127.32	15.83
DBP-1	83.00	12.86	79.80	10.26	79.38	9.34	83.28	13.33
DBP-2	95.29	14.45	100.36	26.80	97.42	16.24	98.32	26.04
DBP-3	77.71	8.90	78.52	10.52	77.21	10.00	79.00	9.46
HR-1	84.46	11.94	85.92	14.95	84.71	13.81	85.68	13.35
HR-2	101.63	15.75	103.68	18.50	102.92	18.64	102.44	15.78
HR-3	82.17	8.18	83.00	13.53	82.25	11.75	82.92	10.72

SBP – systolic blood pressure; DBP – diastolic blood pressure; HR – heart rate. Successive numbers denote the stage at which the measurement was taken

Table 2
Test of within-subject effects (Wilks' lambda values).

Within-subject effects	F	Hypothesis df	Error df	p	Partial Eta square
Stage	20,17	6	176	0,00	0,41
Stage x Group	0,72	6	176	0,63	0,02
Stage x Resiliency	0,53	6	176	0,78	0,02

The effect of evoked positive affect on cardiovascular activity (hypothesis 1)

The three stages of the experiment were highly differentiated as regards systolic blood pressure (SBP). The experimental stimulus in the form of a mental arithmetic task produced the expected response. The expectation and task performance stages differed significantly from each other, moreover, a significant decrease in SBP was noted in the recovery stage.

The nature of change observed during the restitution stage was independent of the experimental manipulation. The repeated contrast analysis for stage 2 and 3 measurements did not show any interaction with the experimental manipulation either for systolic and diastolic blood pressure or for heart rate. Thus, it should be concluded that evoked positive affect did not influence the cardiovascular activity level during the recovery stage.

Relationship between resiliency and cardiovascular activity (hypothesis 2)

The same procedure described above was used to test the hypothesis that resiliency should be related to a lower reactivity and faster recovery in a stressful situation (see Table 3). Repeated contrast analysis for stage 2 and 3 measurements did not show any significant interaction of cardiovascular activity with the resiliency group created by dichotomization at the median. Therefore, hypothesis 2 should be rejected in the light of the obtained data.

Stress appraisal as a mediator between resiliency and positive affect (hypothesis 3)

Testing of the hypothesis about a mediatory role of stress appraisal was based on the positive affect measurement in the expectation stage. Since both positive affect and stress levels were measured prior to the experimental manipulation, the analysis was conducted for the experimental and control groups jointly.

A procedure developed by Baron and Kenny (1986) was used to verify the mediatory role of activity-oriented challenge appraisals. Their mediation significance was estimated using the Sobel test and the bootstrapping technique (Preacher & Hayes, 2004). Successive steps and results of the analysis are presented in Fig. 3.

The effect of resiliency on the positive affect level was mediated by the activity-oriented challenge appraisal (the Sobel test: $z = 2.74$, $p < 0.01$; bootstrap 95% confidence interval <0.1392; 0.5193>). On the other hand, passivity-oriented challenge appraisals did not play a mediating role (the Sobel test: $z = 1.289$, $p = 0.19$; bootstrap 95% CI <-0.024; 0.3484>). Thus, there is no ground to reject hypothesis 3. Besides, there is no ground to assume that positive affect serves as a mediator between resiliency and stress appraisal. The path from resiliency stress appraisal remained significant ($\beta = 0.28$; $p < 0.05$) after positive affect had been introduced as a potential mediator.

Discussion

The findings described above suggest first and foremost that caution should be exercised when presenting any health-promoting functions of positive emotions as well as the personality traits that might be their determinants. Against expectations, evoked positive affect did not influence the cardiovascular activity level during the restitution stage. A

Table 3
Factors explaining differences in cardiovascular activity changes across stages (tests of within-subject contrasts).

Source of variability	Measure	Contrast	Type III sum of squares	*df*	Mean square	*F*	*P*
Stage	SBP	Reactivity	2752,04	1	2752,04	17,86	0,00
		Restitution	7381,36	1	7381,36	66,46	0,00
	DBP	Reactivity	6317,22	1	6317,22	31,09	0,00
		Restitution	8559,54	1	8559,54	58,94	0,00
	HR	Reactivity	8221,21	1	8221,21	37,89	0,00
		Restitution	11946,38	1	11946,38	57,61	0,00
stage* group	SBP	Reactivity	17,03	1	17,03	0,11	0,74
		Restitution	81,26	1	81,26	0,73	0,39
	DBP	Reactivity	237,07	1	237,07	1,16	0,28
		Restitution	71,13	1	71,13	0,49	0,48
	HR	Reactivity	42,55	1	42,55	0,19	0,66
		Restitution	0,09	1	0,09	0,00	0,98
		Restitution	17,32	1	17,32	0,08	0,77
stage * resiliency	SBP	Reactivity	534,23	1	534,23	3,46	0,07
		Restitution	141,86	1	141,86	1,27	0,26
	DBP	Reactivity	337,93	1	337,93	1,66	0,20
		Restitution	300,67	1	300,67	2,07	0,15
	HR	Reactivity	31,69	1	31,69	0,14	0,70
		Restitution	1,43	1	1,43	0,00	0,93

SBP – systolic blood pressure; DBP – diastolic blood pressure; HR – heart rate. Reactivity – difference between stage 1 and 2 measurements, Recovery - difference between stage 2 and 3 measurements

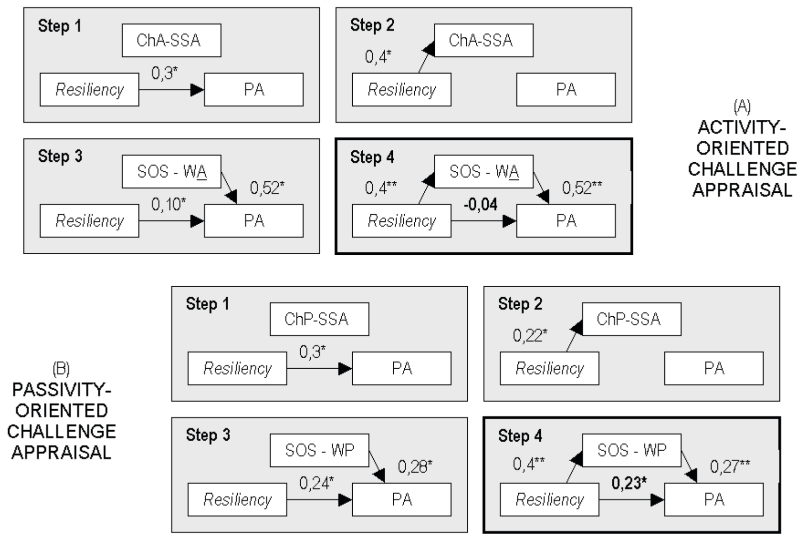


Figure 3. Activity-oriented challenge appraisal (A) and passivity-oriented challenge appraisal (B) as a mediator between resiliency and positive affect.
ChA-SSA – Challenge-Activity Situational Stress Appraisal; ChP-SSA – Challenge-Passivity Situational Stress Appraisal; PA – positive affect
Step 1: Initial variable is a predictor of the outcome variable. Step 2: The initial variable is a predictor of the mediator. Step 3: The mediator is a predictor of the outcome variable with the initial variable simultaneously introduced as a predictor. Step 4: The direct relationship between the initial and outcome variables disappears when controlled by the mediator.

stressful situation may induce intensive emotions, and on their background a relatively weak emotogenic stimulus that triggers the process of undoing changes may turn out to be not strong enough to be effective. Fredrickson and Levenson (1998) investigated the undoing of cardiovascular responses elicited by viewing films: in their study one film induced anxiety and anxiety-related physiological changes, while the other evoked positive emotions and speeded up the process of recovery. Thus, change-inducing and change-undoing responses were comparable in terms of their intensity and quality.

This effect may suggest that the results reported by Fredrickson and Levenson (op. cit.) have a limited generalizability. This limitation may be interpreted in terms of equivalence between negative response and positive counteraction undoing. In order to produce a notable effect, a positive stimulus must be appropriately strong, or perhaps even stronger than the negative (Baumeister et al. 2001). This hypothesis would bring a new perspective into the debate on limitations of external validity of laboratory research into cardiovascular activity (Schwarz et al. 2003).

The obtained data extended our knowledge about the role of positive affect resulting from the processes of inner emotional regulation. While the effect of external stimuli is short-term (e.g. someone viewing an amusing picture may soon get bored), inner regulatory processes may be a stable source of positive emotions. Perhaps positive emotions have a health-promoting effect due to their stability rather than intensity (cf. Baumeister et al. 2001; Folkman & Moskowitz, 2000). It is above all inner psychological processes that can be expected to provide such a stable effect.

If resiliency, construed as an ability of flexible adaptation based on evoking positive emotions, is so important to health, then a question arises what mechanism leads to the emergence of positive-valence emotions. In the modal model of emotion by Gross and Thompson (2007) the role of cognitive appraisal in the affective regulation process is emphasized. This factor turned out also in the present study to be pivotal for understanding the relationship between resiliency and positive affect. Resilient individuals appraised stressful situations as a challenge; in this way only (i.e. by mediation) – at least as regards the obtained data – the predominance of positive emotions can be explained in their case despite the experienced stressful conditions. Not every challenge appraisal serves the function of a mediator. Challenge-passivity appraisals do not have a mediating role, although they paradoxically implicate the most positive evaluation of the situation. It is an attempt at getting involved and actively responding to a challenge that leads to strong positive emotional responses.

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