Resilience as a Modulator of Pain and Stress

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Abstract

Objective: To study the predictive validity of the Resilience Scale for Adults (RSA) experimentally. It was hypothesized that subjects scoring high on the RSA would tolerate pain longer, report less pain and less stress. This protection was expected to be stronger when experimental stress was higher.

Method: The sub-maximum tourniquet method was used to induce ischemic pain and stress. 84 subjects were randomized to low and high stress groups, and selected to low and high resilience groups according to their scores on the RSA. Measures of pain and stress were repeated.

Results: A high degree of RSA-Personal strength and RSA-Social competence, increased protection strongly by increasing pain tolerance, and reducing perceived pain and stress. This protection was stronger when stress was higher. A high score on the interpersonal factors (Family cohesion and Social resources) also reduced pain and stress, but the effect was weaker and independent of stress.

Conclusion: The predictive validity of the RSA was firmly established. The clinical magnitude of scoring high on the RSA was strong. It is a significant predictor of personally experienced pain and stress, which may have great relevance for pain patients and pain interventions.

(191 words).

Key words: Resilience, pain and stress, experimentally induced, predictive validity.

Resilience as a Modulator of Pain and Stress

One of the first conceptualizations of resilience originated from clinical psychology (Garmezy, 1971) as a need to understand wellness amidst dysfunction. Today, resilience is a well-established construct for describing and explaining unexpected positive outcomes despite great risks for maladjustment when exposed to psychosocial adversities (Rutter, 1990; Masten, Hubbard, Gest, Tellegen, Garmezy, & Ramirez, 1999; Luthar, Cicchetti and Becker, 2000; Werner, 2001). After three decades of longitudinal research on resilience factors and mechanisms, three broad categories stand out as protective (Garmezy, 1993; Werner, 1989); (a) positive characteristics and resources of the individual, (b) a coherent, stable and supportive family environment, and (c) an external social network that supports and reinforce adaptive coping. To fill the need for scales to measure these aspects in the adult population, the authors developed the "Resilience Scale for Adults" (RSA), which consists of five factors (Hjemdal, Friborg, Martinussen, & Rosenvinge, 2001). Three factors measure degree of intrapersonal resources, i.e., Personal strength, Social competence and Structured Style. The remaining two factors indicate interpersonal resources, i.e., Family coherence and Social resources. The RSA has shown promising reliability and validity (Friborg, Hjemdal, Rosenvinge, & Martinussen, 2003, Friborg & Hjemdal, 2004; Friborg, Barlaug, Martinussen, Rosenvinge, & Hjemdal, 2005). In this study, the predictive qualities of the RSA were investigated experimentally as well.

While identification of protective factors has been the Achilles' heel of previous research, recent studies have focused more on what mechanisms such factors trigger, and how it modifies a person's response to a risk situation (Rutter, 1987). A protective factor may thus operate very differently across kinds of stressors, or severity of stress. Most studies support this model (Masten, Morison, Pellegrini, & Tellegen, 1990; Rutter, 1987). Against this, and with less support, is the compensatory model that argues for the same degree of protection irrespective of stress. By using an experiment to manipulate situational stress, it is possible to study whether the beneficial effects of scoring high on the RSA follows a protective or a compensatory model. As the connection between pain and stress is well documented (Gil et al., 2003), a procedure from pain research may be used for studying resilience in relation to both pain and stress. A tourniquet was fitted on the arm to occlude oxygen transportation, which cause intense pain as time passes due to accumulation of metabolites (Pertovaara, Nurmikko, & Pöntinen, 1984).

Anecdotal reports describing the immense changes in pain sensitivity among injured soldiers (Beecher, 1959), mentally ill patients cutting themselves, or masochists (Philips & Rachman, 1996), point to subjective factors like cognitions and emotions as determinative for the pain response. These reports are supported by gate control theory (Melzack & Casey, 1968), suggesting a neocortical-evaluative and a limbic-motivational/affective component in pain perception. Studies on patients with mood disorders, in which these two dimensions are strongly negatively affected, have confirmed that affective psychopathology increases pain (Dersh, Polatin, & Gatchel, 2002). Personality characteristics like neuroticism (Goubert, Crombez, & Van Damme, 2004) and introversion (Eysenck, 1967), which share similarities with depression, are also acknowledged to increase sensitivity for pain. Neuroticism is a well-known vulnerability factor for affective psychopathology (Roberts & Kendler, 1999), and the tendency to scrutinize bodily sensations for aches and pains (Gouberg et al., 2004), and to resort to passive pain coping strategies (Ramírez-Maestre, Martínez, & Zarazaga, 2003). Although less potent than neuroticism in predicting pain, psychophysiological studies have shown that introverts are more sensitive to physical stimuli than extroverts (Stelmack, 1990), and use more passive pain coping strategies (Ramírez-Maestre et al., 2003). Extroversion, the opposite of introversion, is related to active, social and optimistic ways of dealing with stress (Costa, Somerfield, & McCrae, 1996).

The above findings represent the basis for what kind of predictions that derive from using the RSA in predicting pain and stress. Previous studies have shown that the RSA-factors "Personal strength/Perception of self" (PS-self) and "Social competence" (SC) have been related to indices of affective psychopathology. PS-self has been the strongest factor in discriminating between health controls and patients having an affective mental disorder (Friborg et al., 2003), as well as correlating strongest in a negative direction with neuroticism (Friborg et al., 2005). Social competence, on the other hand, has proven most protective against psychiatric symptomatology if negative life events strike (Hjemdal, Friborg, Stiles, Rosenvinge, & Martinussen, 2005). Additionally, SC has shown moderate-to-strong positive correlations with BigFive/Extroversion (Friborg et al., 2005). Thus, these two resilience factors may strongly increase pain tolerance, reduce perceived pain, as well as perceived stress.

Psychosocial factors, like family cohesion and social support have also been linked to more depression among pain patients. In a study by Romano, Turner and Jensen (1997), the importance of five different facets of family functioning was compared between depressed pain patients and health controls, of which family cohesion came out as the strongest discriminator. Individuals from families characterized by discord and low cohesion, often have a learning history of dealing with stressors in unhelpful ways, e.g., passive coping styles, catastrophising, or scapegoating (Rutter, 1990). A plethora of studies also demonstrate the positive effects of social support on pain problems (Kerns, Rosenberg, & Otis, 2002; Evers, Kraaimaat, Geenen, Jacobs, & Bijlsma, 2003). Generally, it affects pain indirectly by promoting more effective pain coping strategies (Holtzman, Newth, & DeLongis, 2004). Although an experimental setting using physically well subjects is quite different from a day-to-day family milieu for a pain patient, it was yet expected that a high score on the resilience factors "Family coherence" (FC) and "Social resources" (SR) should reduce perceived pain and stress, although less strongly than the first two resilience factors.

Aims of the study

The overall aim was to test the RSA experimentally. A high score on the RSA was expected to benefit an individual in a protective rather than a compensatory manner, by increasing protection when situational stress was higher. A compensatory effect would be supported if the RSA factors only appeared as main effects. Furthermore, the experiment allowed testing of time effects as the measures of pain and stress were repeated. Finally, it was expected that the intra-personal factors (Personal strength, Social competence, and Structured Style) would reduce pain and stress scores more strongly than the interpersonal factors (Family cohesion and Social resources).

METHOD

Subjects

Eighty-four subjects (age range 20-36 years; $M = 24.8$, $SD = 3.7$), 47 women and 37 men, were recruited from lectures and by posters at the University of Tromsø, and through advertisement in the local newspaper. Four subjects were removed due to missing data (three) and extremely deviant questionnaire scores (one). The final sample thus constituted 80 subjects (age range 20-36 years; $M = 24.5$, $SD = 3.5$), 46 women and 34 men. All subjects received verbal and written description of the experiment, before deciding whether to participate or not. Subjects suffering serious somatic illnesses (e.g., diabetes, cardiac diseases, hypertension, asthma), using prescribed drugs, as well as women in the menstrual period, were not allowed to participate in the study as these factors are known to affect sensitivity for pain (DePascalis, Chiaradia, & Carotenuto, 2002). The study was approved by the Regional Committee for Medical Research Ethics in North Norway.

Procedure

The experiment was conducted at the Department of Clinical Research at the

University hospital of North Norway, Tromsø. All subjects underwent a screening procedure. They then read and signed an informed consent form. Everyone was instructed to be abstinent from intoxicating substances, nicotine, and caffeine, for a minimum of 12 hours prior to starting the experiment. They then received the questionnaire materials for completion at home, before returning to the lab. Subjects were run from 8 a.m. – 1 p.m.

The standardized sub-maximum tourniquet-method of Smith, Egbert, Markowitz, Mosteller and Beecher (1966) was used to induce ischemic pain. Blood was forced out from the forearm using an Esmarch bandage, and a pneumatic compression device (sphygmomanometer) was attached to the non-dominant arm, and inflated to 200 mm Hg, to occlude blood flow. Before putting the arm to rest, the subject pressed a hand trainer each second second 12 times. The experimental session lasted for a maximum of 45 minutes. However, the subjects were not informed about how long the tourniquet would be inflated, and not allowed to check the time during the experiment to avoid the use of compensatory strategies for withstanding pain and stress better.

To analyze whether the resilience factors affected pain tolerance, perceived pain and stress as a main effect only (the compensatory model), or in interaction with the stress factor (the protective model), situational stress was manipulated. Subjects were thus randomized to two groups using different methods for reducing stress. In the group receiving high stress reduction, hereafter named the low stress group, subjects received oral information about ischemic pain immediately after applying the tourniquet. Information about the pain stimulus was expected to decrease stress and pain. The experimenter told each subject: "*This method for inducing pain is a frequently used technique by surgeons to allow for surgical bloodless interventions in the arm or hand. It is not uncommon to use a tourniquet for up till two hours. It has not been reported any damage following the use of the tourniquet. In a couple of minutes your arm will start feeling numb and relaxed, it will turn pale, cold, and some specks* *may become visible. This is quite normal. In forcing most of the blood out of the arm, the color of the arm will disappear and the temperature will fall. After releasing the tourniquet, blood will return and the arm will feel completely normal and regain its color and temperature within a few minutes. Even though this feels unpleasant, it is completely safe*". The experimenter was instructed to convey this message in a personal rather than a formal style, and to express care and sympathy for the unpleasantness of the pain. The experimenter regularly probed for the subject's well being throughout the experiment, and repeated the safety of this procedure.

In the group receiving low stress reduction, hereafter named the high stress group, no further information regarding the tourniquet and ischemic pain were given. The experimenter was instructed to communicate with the subject in a more formal style. In case of questions, the experimenter only referred to previously given information and stated that they were not allowed to disclose anything more beyond this.

The experiment ended when, (a) the subject expressed a desire to terminate the experiment due to intolerable pain or unpleasantness, (b) gave a maximum pain intensity score (=10), or (c), 45 minutes had passed since the tourniquet was applied.

Materials

Measures of pain tolerance, perceived pain and stress.

Pain tolerance represented the amount of minutes the individual stayed in the experiment, from the beginning of pain stimuli (i.e., inflation of the tourniquet) to the point where the individual terminated the pain stimulus. If the subject did not terminate, the maximum pain tolerance was 45 minutes.

Subjective feelings of pain and stress were measured by using three visual analog scales (VAS) going from 0 (no pain/stress) to 10 (maximum pain/stress). Each subject rated themselves on these scales prior to starting the experiment (pre), every five minutes during the experiment (5, 10, 15, 20, 25 30, 35, 40 and 45 minutes), and five minutes after removal of the tourniquet (post). These 11 repeated measures of subjectively reported pain and stress represented an experimental within Time factor.

Perceived pain intensity was measured with a VAS telling the subjects to rate their pain from 0 (no pain) to 10 (unbearable pain). A change of 13 mm on this VAS scale has been found sufficiently to classify as a clinically significant change in acute pain (Todd, Funk, & Funk, 1996).

In measuring negative arousal/perceived stress, arousal ratings have proved more discriminative of negative emotions than valence ratings (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000). For this purpose, an adapted version of the VAS from O'Neill and Parrot (1992) was used, containing two pairs of adjectives (Relaxed (0) - Tensed (10), and Calm (0) – Nervous(10)). These two measures were then combined into a composite mean stress score.

The Resilience Scale for Adults (RSA).

The RSA consist of 33 items and was developed to measure intrapersonal and interpersonal protective resources that may facilitate adaptation and tolerance to stress and adverse negative life events (Friborg et al., 2003; Friborg et al., 2005). The RSA comprises five factors; (1) Personal strength, with two sub-factors; (1a) Perception of self, and (1b) Perception of future, (2) Social competence, (3) Structured style, (4) Family cohesion, (5) Social resources. Items are scored along a five-point semantic differential-scale, with the positive differentials to the right for half of the items to reduce problems of acquiescence-bias (Friborg, Martinussen, & Rosenvinge, 2004). The composite factor scores, i.e., the mean of the items belonging to a particular resilience factor, were dichotomized into a low (0) or a high (1) resilience status, using the median score as the cut-off point for classification.

Design

The experiment was a mixed factorial design containing three independent factors: 2 Resilience (low/high) x 2 Stress (low/high) x 11 Time (repeated measures of pain and stress). Due to six resilience factors, and two dependent measures (pain and stress), a total number of 12 models were fitted to the data. As the subjects were not randomly assigned to the resilience factor, but selected on the basis of their scores to the RSA-questionnaire (low/high), the design was quasi-experimental. All descriptive and inferential statistics were run on SPSS version 11.01.

Data Analyses

As the number of patients terminating the experiment increased as a function of time, due to intolerable pain and unpleasantness, the problem of missing data increased likewise. Missing data followed this pattern: Pre ($N = 0$), 5 min ($N = 0$), 10 min ($N = 1$), 15 min ($N = 2$), 20 min ($N = 6$), 25 min ($N = 13$), 30 min ($N = 19$), 35 min ($N = 25$), 40 min ($N = 39$), 45 min ($N = 50$), Post ($N = 0$). Using a repeated analysis of variance creates problems as it excludes all cases containing missing data, leaving only 30 subjects available for analysis. Replacing missing data are also problematic as it biases the estimates. A mixed linear modeling approach solves this problem by estimating the variance-covariance matrix on all data available, thus increasing the degrees of freedom considerably (Bagiella, Sloan, & Heitjan, 2000). Mixed modeling also handles the violation of sphericity better (i.e., lack of equal error variances), which was the case for these data. As the correlations between the repeated pain and stress scores decreased over time, the matrices were specified as first-order autoregressive. The restricted maximum likelihood method was used. Post-hoc tests were run using conventional *Student t*-tests with a reduced significance level of $p < .01$. All inferential tests were two-tailed. Hedge's g was used as effect size statistic (g), where .20, .50, and .80 represents a weak, moderate to strong effect, respectively.

RESULTS

As the subjects were selected to the resilience groups according to their resilience scores, the potential of introducing biased groups were present. Therefore it was tested whether these four groups, 2 Resilience (low/high) x 2 Stress (low/high), were similar in terms of gender, age and pre-test resilience scores. The proportion of women and men assigned to the four groups were not significantly different ($\chi^2 < 3.6$). No differences in the mean age across the four groups were found either ($F < 2.1$). Pre-test resilience scores were also similar across the stress groups, except for the factor "Structured style", indicating that individuals in the low stress group scored significantly higher on this factor than subjects in the high stress group (*M*-5.14 vs. 4.60) [$t(78) = 2.02, p < .05$]. Accordingly, only this resilience factor should be interpreted with caution in case of significant results.

Resilience and Tolerance to Pain

Pain tolerance was measured as the number of minutes the subject stayed in the experiment. Six factorial analyses of variance, one for each resilience factor, were run, with 2 Resilience (low/high) x 2 Stress (low/high) as independent factors. These analyses did not find any main effects of either the Resilience or the Stress factors on tolerance to pain. However, the resilience factor "Personal strength/Perception of self" (PS-self) showed up as a modulator by interacting significantly with levels of Stress [$F(3,76) = 4.14, p < .05$]. As illustrated in Figure 1, a high score on PS-self was only helpful in the high stress group. Subjects scoring high on this factor tolerated pain significantly longer than subjects scoring low ($M_{\text{diff}} = 7.3$ minutes, $SD = 10.4$) [$t(37) = 2.29, p < .05; g = .70$]. No other post-hoc tests were significant.

Resilience as a Modulator of Pain Intensity

In analyzing how each of the resilience factors affected perceived pain differently, six consecutive linear mixed models were fitted to the subjects' pain intensity scores. First off, all tests showed a strong and significant main effect for the Time factor (Fs > 178), indicating that perceived pain increased significantly throughout the experiment, and returned to baseline after terminating the pain stimulus. The main effect for the Stress factor was non-significant in all tests. The significance of all the main and interaction effects for the RSA is presented in Table 1.

Personal strength (PS)

A significant main effect of PS/Perception of self (PS-self) indicated that a high score on this factor reduced perceived pain (M_{diff} = 7.1 mm; SD = 28.1; g = .25) independently of other factors. However, PS-self was also part of a two-way and a three-way interaction, of which only the three-way interaction is presented. The results indicated that a high degree of PS-self modulated pain in the early and middle phase of the experimental session, but not at the end. As illustrated in Figure 2, this modulation was only present in the high stress group. Post-hoc t-tests in the high stress group confirmed that scoring high on PS-self reduced pain scores significantly at 5 minutes [M_{diff} = 19.2 mm, SD = 18.8; $t(37) = 3.16, p < .01; g = 1.02$], 10 minutes [$M_{diff}$ = 19.8 mm, SD = 22.1; $t(36) = 2.74, p < .01; g = .89$], 15 minutes [$M_{diff}$ = 22.9 mm, SD = 21.7; $t(35) = 3.20, p < .01; g = 1.06$], and 30 minutes [$M_{diff}$ = 21.3 mm, SD = 20.9; $t(28) = 2.80, p < .01; g = 1.02$]. At 20, 25 and 35 minutes the differences approached significance, ($p = .05; g = .70$), ($p = .08; g = .65$), and ($p = .06; g = .75$), respectively. In the low stress group, none of the pain scores were different across the low and high resilience groups (ts < 1.5), thus supporting the protective model.

No main effect was found for the second sub-factor "Personal Strength/Perception of future" (PS-future). However, a significant three-way interaction emerged, indicating that a high score on PS-future reduced pain intensity during the middle phase of the experiment, while augmenting pain intensity at the end. These differences were only present in the high stress group, thus partly supporting the protective model. This interaction was however weak, as no post-hoc analyses yielded any significant differences in pain scores, at any moment, for either of the groups.

Social competence (SC)

A significant main effect of SC was found, indicating that high SC reduced pain scores significantly (M_{diff} = 5.8 mm, *SD* = 28.1). The magnitude was however small (*g* = .21). The two-way interaction with Stress was non-significant, but tentative in the right direction (*p* = .19). In examining the variance of the pain scores more closely, the variance of the pre- and posttest scores were highly constricted (six times smaller than at other time points). By removing these two time points, which was acceptable as pain stimuli was absent, the three-way interaction with Stress and Time came out almost significant (*p* = .06). Post-hoc t-tests on the pain scores in the high stress group, revealed that a high vs. a low SC score reduced pain significantly at 30 minutes [M_{diff} = 20.7 mm, SD = 21.1; $t(28) = 2.67, p < .01; g = .98$] and 35 minutes [$M_{diff}$ = 22.4 mm, *SD* = 19.9; $t(25) = 2.93, p < .01; g = 1.13$], and approaching significance at 25 minutes (*p* = .08, *g* = .66). None of post-hoc t-tests in the low stress group were significant, thus supporting the protective model.

Social resources (SR)

The main effect of SR was not significant. However the SR x Time interaction was significant, indicating that high SR was protective in the beginning, but not at the end of the experiment (see Figure 4). However, post-hoc t-tests did not reveal statistically reliable differences at 5, 10 and 15 minutes, (*p* = .10; *g* = .37), (*p* = .09, *g* = .39), and (*p* = .05, *g* = .44), respectively. The unexpected and opposite differences at the end, 40 and 45 minutes, were not significant either, *p* = .12 and *p* = .34. These effects were thus regarded weak.

Family coherence and Structured style

As Table 1 demonstrates, these factors did not significantly affect pain intensity scores.

Resilience as Modulator of Perceived Stress

In analyzing the beneficial effects of resilience in reducing negative arousal, similar mixed linear models were fitted to the repeated measures of perceived stress. Again, levels of stress increased significantly throughout the experiment, then returned to the baseline (*F*s > 50). The main effect of the Stress factor was not significant, indicating that the stress manipulation was not as strong as anticipated. The main and interaction effects of RSA are presented in the lower part of Table 1.

Personal strength (PS)

The main effect of PS-self was highly significant, indicating that a high score on this factor reduced perceived stress independently of the other factors (M_{diff} = 8.8 mm, SD = 19.1, g = .46). A three-way interaction also showed up. As illustrated in Figure 5, a high score on PS-self protected against stress from the very beginning of the experiment, reaching its most protective effect somewhat beyond the middle phase. These differences were only present in the high stress group, thus supporting the protective model. Post-hoc t-tests confirmed that the differences in the high stress group were strongly significant from 5 to 35 minutes, ranging in significance from [M_{diff} = 14.1 mm, SD = 15.5; $t(35) = 2.76, p < .01; g = .91$] at 15 minutes to [$M_{diff}$ = 28.8 mm, SD = 16.3; $t(28) = 4.84, p < .001; g = 1.77$] at 30 minutes. As expected, post-hoc t-tests did not find significant differences in the stress scores in the low stress group.

A significant main effect of PS-future was also observed. No other interactions were significant. PS-future thus acted compensatory by reducing stress independently of other factors (M_{diff} = 28.8 mm, SD = 16.3), but the effect was weak (g = .22).

Social competence (SC)

The main effect of SC was not significant. As hypothesized, SC interacted significantly with Stress. Analogous to the findings in figure 3, SC had no influence in the beginning of the experiment, but became increasingly more protective as time passed, which is illustrated in Figure 6. In line with the protective model, these differences were only present in the high stress group. However, post-hoc t-tests indicated that the differences between the low and high stress group were of smaller magnitude. The only significant difference was at 35 minutes [M_{diff} = 21.5 mm, *SD* = 20.8, $t(25) = 2.69$, $p < .01$; $g = 1.03$], while the differences at 25, 30, 40 and 45 minutes approached significance, ($p = .03$, $g = .80$), ($p = .02$, $g = .93$), ($p = .09$, $g = .83$) and ($p = .04$, $g = 1.35$), respectively. As expected, none of the post-hoc tests in the low stress group approached significance.

Family coherence (FC)

A main effect of FC emerged, indicating that a high versus a low FC reduced perceived stress significantly (M_{diff} = 5.0 mm, *SD* = 19.4). This effect was however weak (g = .26).

Social resources and Structured style

These two resilience factors did not affect stress scores significantly (see Table 1).

DISCUSSION

The present results add to the incremental base of supporting evidence for the Resilience Scale for Adults (RSA). So far, the RSA has proven to differentiate psychiatric patients from health controls (Friborg et al., 2003), to protect mental health when life events strike (Hjemdal et al., 2005), and is related to other relevant psychological constructs (Friborg & Hjemdal, 2004; Friborg et al., 2005). What made this study stand out was the use of experimental control and manipulation of pain and stress. The results provided strong support for interpreting the intrapersonal resilience factors, Personal strength and Social competence, as protective rather than compensatory. The protective model argues that a high degree of resilience embody heightened protection as stress increases, while the compensatory model would argue that a given resilience resource would provide an equal degree of protection whatever levels of stress or adversity. Rutter (1987) and Masten et al. (1990) have published extensive evidence for understanding resilience as something that increases protection when the going gets tough. Otherwise, when life is untroubled, this extra protection is less needed, and subsequently do not show up as significant predictors of mental health or well-being. This validation study confirms that a high score on the intrapersonal resilience factors imply a buffering effect when stress increases.

These results converge with some recent findings from a prospective study on the RSA (Hjemdal et al., 2005). In assessing whether a high score on the RSA increased the likelihood of adapting well, despite experiencing stressful negative life events, a much stronger positive effect of the resilience factors was found among individuals that experienced negative life events than among those who did not experience any negative life events. This finding was evident for the factors Personal strength/Perception of future and Social competence.

As expected, the interpersonal factors Family coherence and Social resources were significant predictors of pain and stress as well, but they were much weaker. Contrary to the protective hypothesis, these factors only appeared as main effects, or in interaction with Time. These results are then in line with the compensatory model, indicating that a high degree of family coherence, or social resources, do not buffer pain and stress more if stress increases. Although these results confirmed the predictive validity of these two factors, they were not in line with the majority of previous work showing a protective effect (Luthar & Zigler, 1991; Masten et al., 1990; Rutter, 1987, 1990; Werner, 2001). The most likely explanation for this is that the protective effect of interpersonal resilience factors is more relevant for situations that involve real life problems that stretch over a longer time period. In a time-limited experiment, where the painful and stressful stimuli ceases to exist as soon as the individual leaves the laboratory, family and social resources may not have the same relevance. If the sample had constituted chronic pain patients in the measurement of resilience, pain and adaptation to pain problems, these factors would have been expected to impact stronger, and in a protective manner. Nevertheless, a high degree of Social resources and Family coherence helped reduce pain and stress, respectively, thus showing a beneficial effect in short timed stressful situations as well. Scoring high on these resilience factors may thus indicate presence of internal schemas that improve coping with negative stimuli. Individuals from families of high cohesion and good support may have a learning history of how to react to, cope with and adapt to negative situations in ways that are more functional and effective than individuals coming from families of low cohesion and support. This is an interesting perspective for further study.

Despite a strong case for interpreting the intrapersonal factors as protective, rather than compensatory, the support was not unequivocal. First off, the analysis on "Social competence" did not show a significant three-way interaction with Time and Stress until the pre- and posttest scores were removed. For this factor, these scores turned out highly constricted in variance, especially at pretest, which led to statistically significant differences despite minor group mean differences. The lack of significant three-way interaction, including all the time points, may also relate to the relatively low power of the stress manipulation. However, as less power increases the likelihood for type II-errors (to not find a true effect), rather than type I-errors (finding an untrue effect), the likelihood of finding significant interactions would have been higher in case of a larger sample or a stronger stress manipulation. In addition, the dichotomization of resilience scores may also have contributed to reduced power, also increasing the likelihood for weaker results. However, as the follow-up tests on mean SC in the high stress condition found significant differences in the pain scores, but not in the low stress condition, the interpretation of social competence as protective rather than compensatory was more substantiated. The factor PS-perception of future was the second factor that only affected stress scores as a compensatory effect. This was unexpected as it turned out tentatively protective factor in reducing pain scores.

The factor "Structured style" was insignificant in all tests. Although it has correlated significantly with related constructs (e.g., weakly negatively with psychiatric symptoms, and positively with sense of coherence) (Friborg et al., 2003), most of the studies so far has not provided any evidence of this factor. Furthermore, in comparing the RSA with a personality inventory, it correlated so strongly with conscientiousness (Friborg et al., 2005) that one may question the uniqueness of this factor. In total, structured style may be less relevant as a measure of resilience. However, and as a precaution, the lack of statistically reliable results could also relate to significant differences in the pre-test scores on this factor, showing that the individuals in the low stress condition scored significantly higher on this factor than those in the high stress condition.

Personal strength first, social competence thereafter

One striking feature of the results is that a positive perception of self and personal resources, seems to give immediate protection by reducing feelings of pain and stress, while social competence does not provide protection until the middle and final phases of the experiment. The resilience factor "Perception of self" may thus be interpreted as an indicator of front line protection resources for overcoming immediate stressors, while a high degree of social competence stands out as important for maintaining protection over time. The data do not offer an explanation of this postponed beneficial effect, but a nearby interpretation would be that socially competent individuals apply their social and communicational skills, e.g., by starting to relate or communicate with the experimenter in ways that may reduce feelings of uncertainty and lack of control in the situation. These results point to a dual and different protective function of personal and social competence. To our knowledge, such results have not been pubslihed previously on resilience. There have been some reports from psychotherapy trials, though, that patients often communicates needs for working on relationships issues soon after they have acquired the necessary personal skills and insights to achieve symptom relief (Yalom, 1995). These differential protective effects are very interesting for further research on resilience, as well as their relevance for individual and group therapy settings.

Relevance of Resilience for Pain Interventions

As the experience of pain is affected by cognitive and emotional factors, which, parenthetically, was the addition to gate control theory (Melzack & Casey, 1968; Melzack, 1988), psychological methods for reducing pain should have merit. In the study of Todd et al. (1996), a difference of 13 mm on the VAS for assessing pain, indicated a clinically significant difference. The strongest RSA-factor in discriminating pain intensity scores across the low and high stress groups was "Perception of self", which reached a difference of up to 23 mm. This is a substantial reduction in pain, both in terms of clinical and statistical magnitude. As studies on pain interventions have shown that combined psychological methods work better than single methods (Melzack, 1988), interventions on all four resilience aspects (personal and social competence, family coherence and social resources), could represent a promising course for future pain research. Patients in less pain also use less medication, which is also an interesting path for further study. In gate control theory, cognitive-evaluative and limbic-affective dimensions are presumed to affect pain through descending messages gates to the periphery, which modulates the pain ascending pain signals to the brain for better or worse. It would therefore be very interesting to study which of these gates, or dimensions, are most affected by the RSA.

During the last decade, research on resilience has been increasingly more focused on mechanisms than factors. If a factor is protective, the next question is what health beneficial mechanisms that factor involves? In this study, the intra-personal factors were strongly protective, but the beneficial mechanisms they trigger for the reduction of pain and stress, are unknown. How might a high degree of personal strength modulate the pain response, and how might a high score on social competence increase protection when painful stressors endure. These are interesting areas for further research using this scale in understanding resilience mechanisms involved in management of pain and stress.

Implications

The data give strong support to the RSA as beneficial, mostly in a protective manner for the intrapersonal factor, and in a compensatory manner for the interpersonal factors. Scores on the RSA may thus be used to draw valid inferences about a person's ability, or resilience, to tolerate pain and stress. The instrument seems to have versatile applications, as it has proven useful both as a predictor of positive outcomes to negative life-events, and as a predictor of strength and resilience in experiments of short time-frames. Furthermore, the strong and protective effect against pain also indicates that the scale may have good potential for studies on pain patients and how these factors affect use of pain medication. It would be interesting to study the importance of these resilience factors in relation to chronic pain, as well as the effect of group treatment trials on chronic pain patients that intervenes on these resilience factors to improve management of pain and pain related problems.

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Table 1

Summary of the Results from the Mixed Linear Model Analyses Investigating the Effects of the Resilience Factors on Perceived Pain and Perceived Stress (N = 80).

Dependent measure RSA factors	Main effect of RSA	Interaction terms: 2 Resilience x 2 Stress	2 Resilience x 11 Time	2 Resilience x 2 Stress x 11 Time
Perceived pain				
PS-self	$F(1,125) = 9.65$**	*n.s.*	$F(10,573) = 2.20$*	$F(10,573) = 2.02$*
PS-future	*n.s.*	*n.s.*	*n.s.*	$F(10,543) = 2.19$*
SC	$F(1,119) = 5.91$*	*n.s.*	*n.s.*	$F(8,440) = 1.88$ [a]
FC	*n.s.*	*n.s.*	*n.s.*	*n.s.*
SR	*n.s.*	*n.s.*	$F(10,542) = 1.94$*	*n.s.*
SS	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Perceived stress				
PS-self	$F(1,118) = 14.07$***	$F(1,118) = 4.42$*	*n.s.*	$F(10, 543) = 2.78$**
PS-future	$F(1,122) = 4.23$*	*n.s.*	*n.s.*	*n.s.*
SC	*n.s.*	$F(1,117) = 9.02$**	*n.s.*	$F(10,547) = 3.82$***
FC [b]	$F(1,124) = 6.34$*	*n.s.*	*n.s.*	*n.s.*
SR	*n.s.*	*n.s.*	*n.s.*	*n.s.*
SS	*n.s.*	*n.s.*	*n.s.*	*n.s.*

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

n.s. = non-significant.

[a] Approached significance if pre- and posttest scores were removed, $p = .06$.

[b] To achieve convergence, a maximum likelihood method had to be applied.

PS-self = Personal strength/Perception of self, PS-future = Personal strength/Perception of future, SC = Social competence, FC = Family cohesion, SR = Social resources, SS = Structured style.

Figure captions

Figure 1. Mean differences in minutes until a subject terminated the experiment due to intolerable pain and unpleasantness (PS self = Personal strength/Perception of self). 95% confidence interval bars attached.

Figure 2. Mean differences in perceived pain between subjects high and low on the resilience factor "Personal Strength/Perception of self" (PS self), in interaction with Stress (high/low) and Time (11 repeated measures). 95% confidence interval bars attached.

Figure 3. Mean differences in perceived pain between subjects high and low on the resilience factor "Social competence" (SC), in interaction with Stress and Time. 95% confidence interval bars attached.

Figure 4. Mean differences in perceived pain between subjects high and low on the resilience factor "Social resources " (SR) in interaction with Time. 95% confidence interval bars attached.

Figure 5. Mean differences in perceived arousal/stress between subjects high and low on the resilience factor "Personal strength/Perception of self" (PS self), in interaction with Stress and Time. 95% confidence interval bars attached.

Figure 6. Mean differences in perceived arousal/stress between subjects high and low on the resilience factor "Social competence" (SC), in interaction with Stress and Time. 95% confidence interval bars attached.

Figure 1.

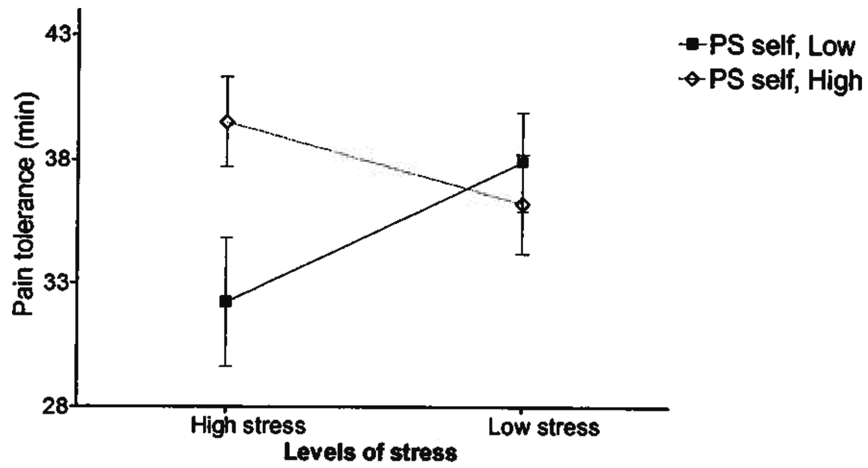
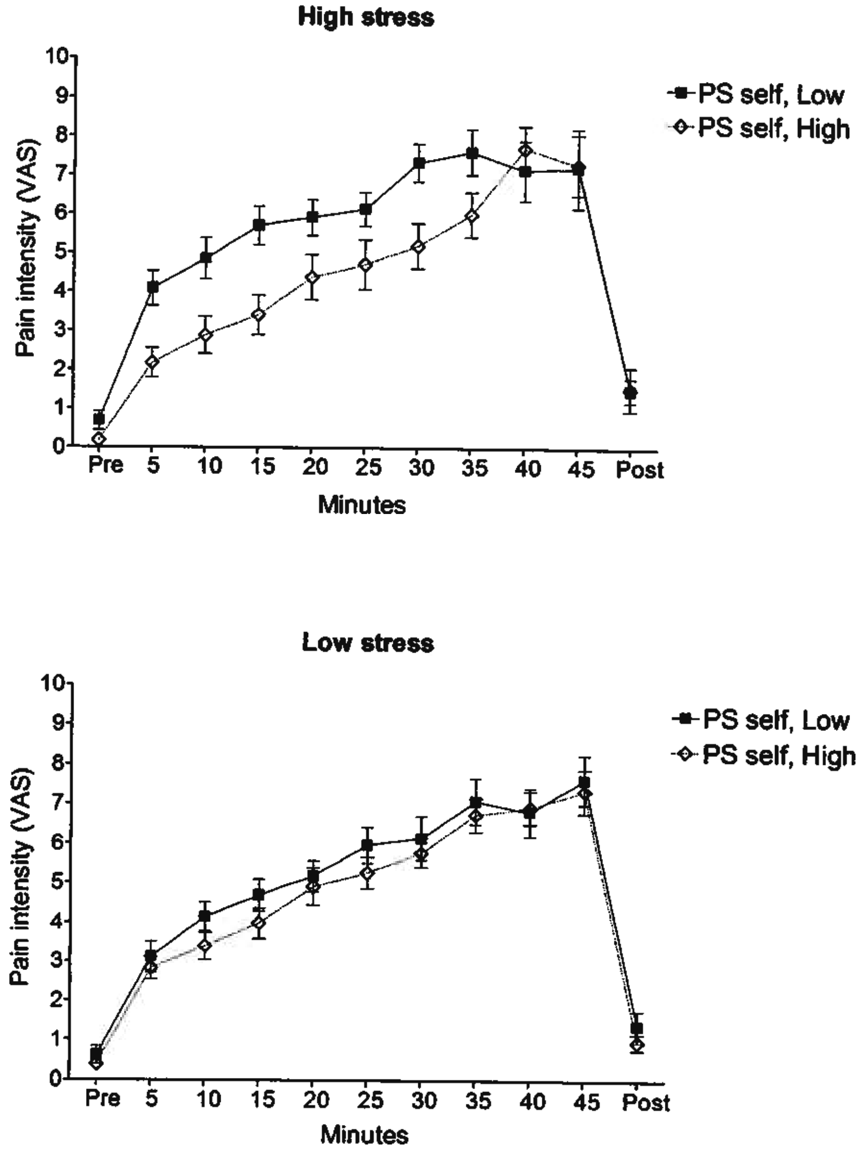


Figure 2.



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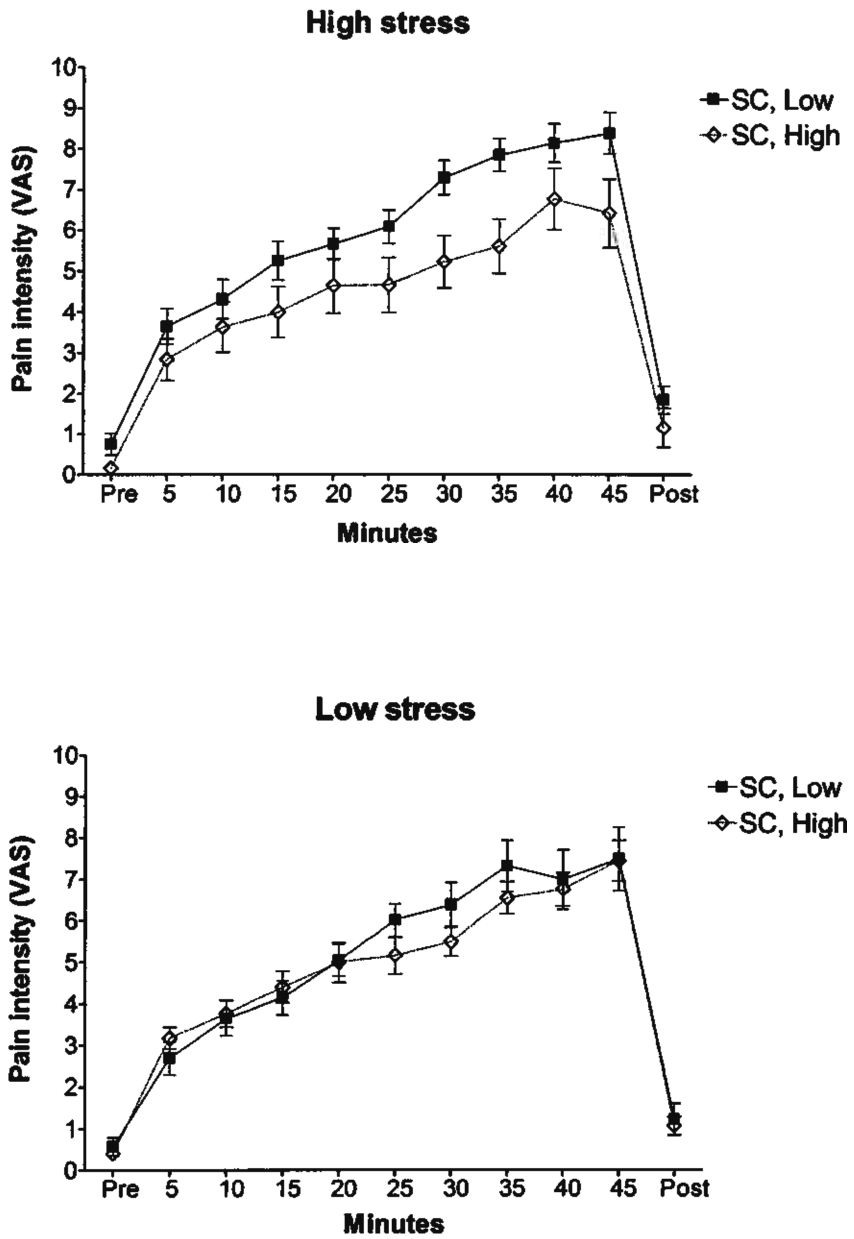

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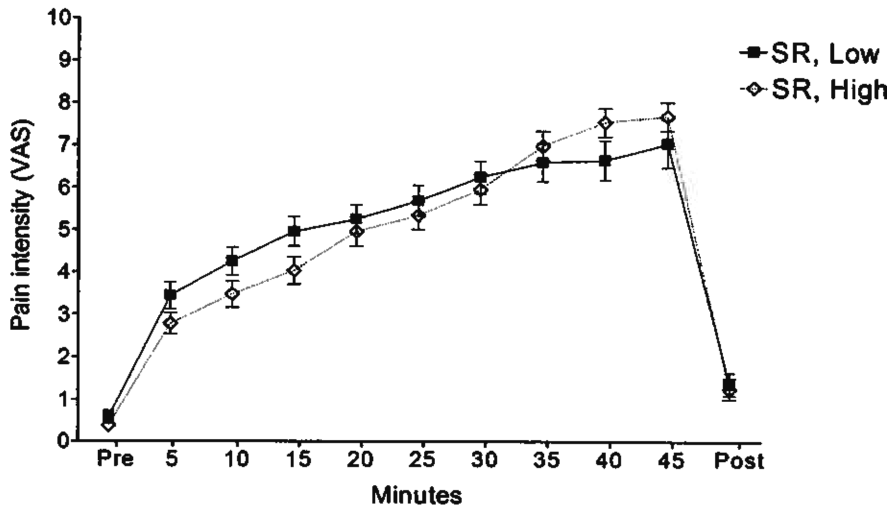

Figure 5.

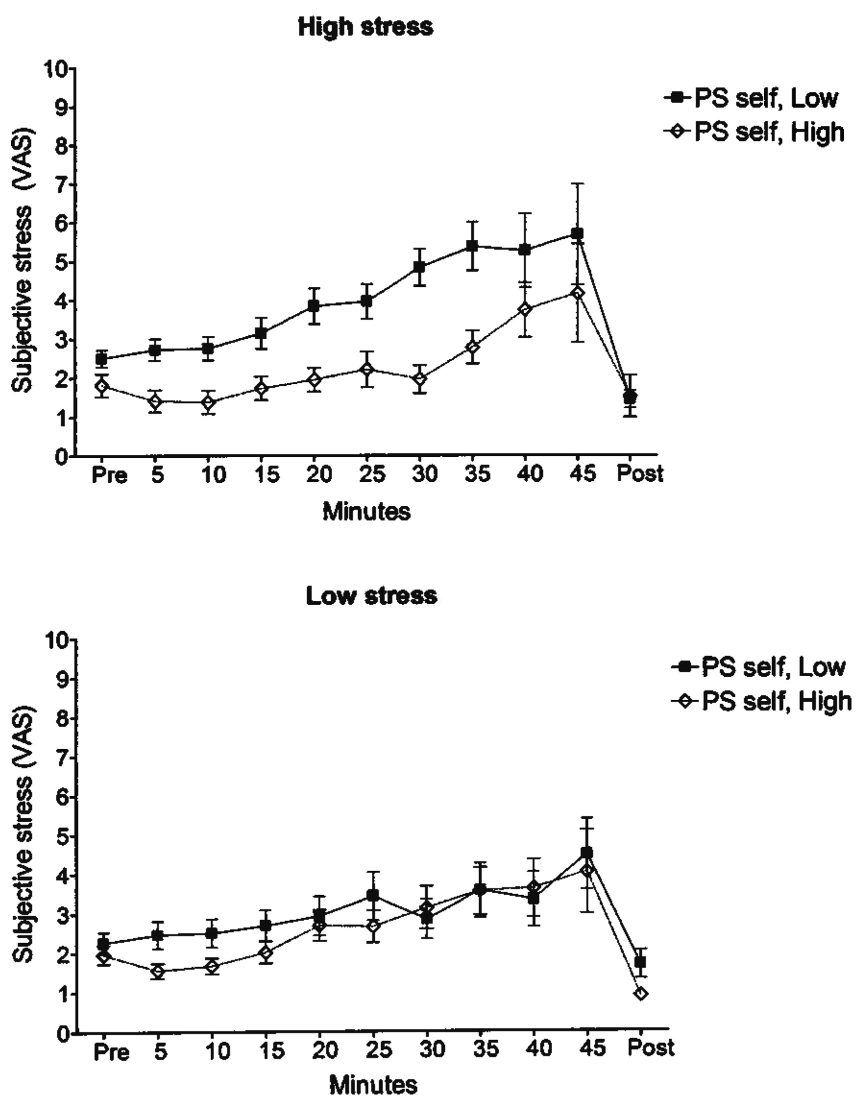

Figure 6