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Stress-buffering effects of psychosocial resources on physiological and psychological stress response in pregnant women

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ABSTRACT

Sixty healthy pregnant women (aged 21–35 years), including 30 pregnant women at the beginning of second trimester and 30 women at the beginning of third trimester underwent a psychosocial stress test. Physiological (salivary free cortisol levels, salivary alpha-amylase levels) and psychological (perceived stress, mood, anxiety) responses to standardized psychosocial stress have been brought in association with psychosocial resources (self-efficacy and daily uplifts). Predictions revealed that higher resources predict lower physiological and psychological stress responses and higher mood levels. We conclude from our data that psychosocial resources appear to dampen psychological and physiological stress response during pregnancy.

1. Introduction

There is clear evidence that high levels of perceived stress and anxiety during pregnancy are associated with several negative health consequences, like gestational complications, spontaneous abortion, preterm labor, low infant birth weight, postpartum depression and negative developmental outcome in infancy (Goland et al., 1993; Hedegaard et al., 1993; Huizink et al., 2003; Killingsworth et al., 1997; Mancuso et al., 2004; O'Connor et al., 2005; Robertson et al., 2004; Van den Bergh et al., 2005; Wadhwa et al., 2001, 1993). Although these studies showed that stress is a significant risk factor, it has to be considered that not all pregnant women who report high levels of stress go on to develop complications. This raises the question of the determinants of vulnerability in the context of stress-related complications in pregnant women.

The majority of recent studies with pregnant women focus on chronic stress, major life events and anxiety related to complications or negative development outcome in infancy, suggesting that future studies should focus on the prevention of prenatal stress (Hedegaard et al., 1993; Huizink et al., 2003; Mancuso et al., 2004; Van den Bergh et al., 2005). However, in order to process effective stress prevention, it would seem that first of all, reliable basic information about influences on the stress response during healthy pregnancy is needed. In particular, there appears to be a demand for studies taking into consideration factors such as psychosocial resources which might play an important role in protecting the pregnant woman and her unborn child against harmful consequences of heightened stress levels. With regard to this issue, in a recent pilot study, Urizar et al. (2004) showed buffering effects of favorable coping strategies on psychological and physiological stress responses during pregnancy.

As described in a previous paper of our work group, attenuated physiological stress responses were found in pregnant women compared to non-pregnant women, indicating that healthy pregnant women have biological protection against negative consequences of heightened stress levels (Nierop et al., 2006). The immediate objective of the current paper was to identify the potential stress-protective effects of self-efficacy and daily uplifts during pregnancy.

In many studies *self-efficacy* has been associated with health (Altmaier et al., 1993; Bandura et al., 1988; Litt, 1988; Manning and Wright, 1983; Wiedenfeld et al., 1990). Self-efficacy can be defined as "people's beliefs about their capabilities to produce effects" (Bandura, 1982, 1997). Several studies with pregnant women found self-efficacy to be a resource in terms of desisting from substance abuse (alcohol, smoking, drugs) during pregnancy (Abrahamsson et al., 2005; DeVries and Backbier, 1994; Leonard-

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son and Loudenburg, 2003; Loudenburg and Leonardson, 2003). In addition, studies indicate that high self-efficacy is significantly related to lower intensity of perceived pain during childbirth (Callister et al., 2001). Women with high childbirth fears seem to have a significantly lower perceived self-efficacy, and low perceived self-efficacy was found to be a predictor of psychological trauma of childbirth (Soet et al., 2003). In a study by Rini and colleagues, it was demonstrated that higher self-efficacy resulted in higher birth weight. However, no stress-buffering effects of different psychosocial resources were found in this study (Rini et al., 1999).

Daily uplifts represent the second potential stress-buffering resource of interest in this study. Daily uplifts are positive and favorable experiences, and reflect small, pleasant daily occurrences, whereas daily hassles can be defined as daily annoyances (Kanner et al., 1981). The former concept does not appear to be merely the opposite of the latter. Daily hassles belong to the stress-provoking factors, whereas daily uplifts seem to be more of a stress-moderating factor (Huizink, 2000). In general, empirical research has focused mainly on the influence of daily hassles on negative health outcome (Da Costa et al., 1998; Huizink et al., 2003; Paarlberg et al., 1999), whereas only a small number of studies have examined the health benefits of daily uplifts (Edwards and Cooper, 1988; Twisk et al., 2000).

In summary, psychosocial resources such as self-efficacy and daily uplifts have been the subject of research in terms of health state during pregnancy and postpartum. However, the role of psychosocial resources *in the context of stress reactivity* in pregnant women has not yet been clearly elucidated. With regard to this issue, the aforementioned concepts seem to be well suited for an examination of their potential buffering effect on biological and psychological stress responses during pregnancy, with the aim of providing essential basic information for future research and the development of targeted early prevention programs.

In this study, stress was induced by the Trier Social Stress Test, TSST (Kirschbaum et al., 1993), which is known for its naturalistic exposure to a socio-evaluative stressful situation. Numerous studies indicate that this standardized stress test induces a significant activation of physiological and psychological responses to stress in healthy females and patients (Domes et al., 2002; Gaab et al., 2002; Heim et al., 2000; Heinrichs et al., 2001; Kirschbaum et al., 1999; Young et al., 2000). The effects of self-efficacy and daily uplifts upon stress responses like mood, anxiety and perceived stress were examined. In addition, we focused on the extent of the impact of the aforementioned resources upon the hypothalamic–pituitary–adrenal (HPA) axis, by means of salivary cortisol, a reliable indicator of this stress system (Kirschbaum and Hellhammer, 1994; Vining and McGinley, 1987). Furthermore, the potential prediction of psychosocial resources upon the autonomic nervous system (ANS), measured by salivary alpha-amylase, was of interest. The latter was shown to be an interesting stress indicator (Nater et al., 2006; Rohleder et al., 2004). Women at the beginning of the second and third trimesters of their pregnancy were assessed, based on the knowledge that there are differences in physiological baseline levels and stress responses (Avery et al., 2001; Mastorakos and Ilias, 2003; Nierop et al., 2006; Petraglia et al., 2001; Wang et al., 1999), as well as evidence of differences in psychological stress responses (Glynn et al., 2001; Paarlberg et al., 1999) at different stages of pregnancy.

2. Methods

2.1. Subjects

Subjects (aged 21–35 years) were recruited through posted announcements, signs at the University of Zurich, the University Hospital of Zurich, and in obstetricians' offices in Zurich and the surrounding area. Exclusion criteria for participation were medical or psychiatric illness, substance abuse, medication, alcohol consumption of more than one glass of wine or beer per week, low level of school education, insufficient knowledge of the German language and artificial insemination. Sixty healthy nulliparous women with a singleton intrauterine pregnancy participated in the study, including 30 women at the beginning of the second trimester (week 13–18) and 30 women at the beginning of the third trimester (week 26–31). After the participants were provided with written and oral descriptions of the study, written informed consent was obtained prior to participation. The ethics committee of the state of Zurich formally approved the research protocol.

2.2. Study design

Psychosocial stress was induced by the Trier Social Stress Test (TSST) (Kirschbaum et al., 1993). Two weeks before the TSST, all subjects were personally interviewed and screened for psychological illness, using structured clinical interviews, DIA-X/M-CIDI (WHO, 1990; Wittchen and Pfister, 1997) and SKID-II (Wittchen et al., 1996). In addition, the women underwent a medical check-up (results taken by the women's physicians). All subjects were instructed to abstain from teeth brushing for 1 h and to eat nothing for 2 h prior to the psychosocial stress test. In addition, they were instructed to refrain from exercise, caffeine and alcohol on the day of the experiment. The experiments took place as individual sessions, lasting for 2 h in the afternoon (at some time between 2:00 pm and 5:00 pm). After an acclimation phase (10 min), each participant was given a 10-min preparation period for the speaking task. She was then taken into the TSST room, where she took part in a simulated job interview (5 min), followed by a mental arithmetic task (5 min) in front of a conspicuous video camera and an audience of two persons. After the stress test, the participant was taken into another room and a 60-min recovery phase began, followed by a debriefing and a payment of 150 Swiss francs.

2.3. Outcome measures

2.3.1. Psychological measures

Socioeconomic data, personal living situation and current critical life events were assessed according to a half-standardized interview protocol. In addition, questionnaires were provided, which were to be filled in at home and brought along to the psychosocial stress test 2 weeks later. Validated German versions of the following questionnaires were included: Zurich Inventory of Psychosocial Well-being in Pregnancy, ZIPS (Bratsikas et al., 2006), Questionnaire of Competence and Control, FKK (Krampen, 1991), Mood-Questionnaire, MDBF (Steyer et al., 1997), the trait-scale of the State-Trait Anxiety Inventory, STAI (Laux et al., 1981), the Global Symptom Index derived from the Hopkins Symptom-Checklist-90-Revised, SCL90-R (Franke, 1995), and the Trier Inventory for the Assessment of Chronic Stress, TICS (Schulz et al., 2004).

Self-efficacy was assessed by the respective subscales of the FKK and consisted of 16 items ranked on a 6-point scale, ranging from "totally false" to "completely true" (e.g., "Sometimes I feel inactive and devoid of ideas" or "Whether I will have an accident or not depends solely on my own behavior").

Assessment of *daily uplifts* was performed with one subscale of the ZIPS, consisting of 10 items asking "To what extent do the following positive daily occurrences apply to you?" (e.g., "receive compliments", "laugh"), ranked on a 6-point scale from "totally false" to "completely true".

Mood, state anxiety and perceived stressfulness were repeatedly assessed before (−20, −10 min) and after (+1, +20, +60 min) stress exposure (TSST): *Perceived stressfulness* was measured using the question "Can you indicate on the following scale the degree of stressfulness of the present situation?" followed by a visual analog scale (VAS) from 0 to 10, with 0 indicating no stress experienced at all and 10 indicating highly stressed. *Mood* was assessed by the MDBF, a validated mood questionnaire consisting of an adjective list, which addresses current mood (e.g., "exhausted", "nervous", "uneasy", "awake", "happy", "good") using 12 items ranked on a 5-point scale from "not at all "to "very much". The sum scores vary from 12 to 60 with higher scores indicating better mood.

State anxiety was measured before and after stress by the respective scales of the STAI, which consists of 20 items indicating the presence or absence of anxiety symptoms in the present situation, e.g. "I am nervous", "I feel tense".

2.4. Physiological measures

Saliva was collected by chewing for 1 min on cotton rolls. A total of nine samples were taken, with the first three samples taken before the stress test (−20, −10 and −1 min) and the six remaining samples collected following stress (+1, +10, +20, +30, +45 and +60 min).

Saliva was collected by using Salivette collection devices (Sarstedt, Sevelen/Switzerland). Samples were stored at −20 °C after completion of the session until biochemical analysis took place. After thawing, saliva samples were centrifuged at 3000 rpm for 5 min. Salivary free cortisol was analyzed by using a commercial chemiluminescence immunoassay (LIA) (IBL Hamburg, Germany). Intraassay and interassay coefficients of variation were below 10%. To reduce error variance caused

by imprecision of the intraassay, all samples of one subject were analyzed in the same run. For the determination of alpha-amylase activity, an assay as previously described was used (Nater et al., 2006). Basically, an automatic analyzer Cobas Mira and assay kits obtained from Roche were used. The reagents in the kit contain the enzyme alpha-amylase and alpha glucosidase, which convert the substrate ethylidene nitrophenyl to *p*-nitrophenol. The rate of formation of *p*-nitrophenol is directly proportional to the amylase activity. The activity is determined by measuring the absorbance at 405 nm. The assay is a kinetic colorimetric test. Inter- and intraassay variance was below 1%.

3. Data analysis

Data were tested for normal distribution and homogeneity of variance using a Kolmogorov-Smirnov and Levene's test before statistical procedures were applied. Data are presented as means ± S.E.M. All reported results were corrected by the Greenhouse-Geisser procedure where appropriate (violation of sphericity assumption). Results were considered statistically significant at the $P \leq 0.05$ levels, and all tests were two-tailed. In case of missing data, cases were excluded listwise.

Repeated assessment of the dependent physiological parameters cortisol and alpha-amylase as well as of the dependent psychological parameters perceived stress, mood, and anxiety were computed as area under the total response curve with respect to increase (AUC_i), using the trapezoid formula, according to Pruessner et al. (2003). The AUC_i is related to the sensitivity of the biological system, pronouncing changes over time, and is characterized by accumulation of the error of the baseline, since the formula is based on the difference between the baseline and the subsequent measures (Pruessner et al., 2003).

Across the two trimester groups, *t*-tests for independent samples were calculated for group characteristics as well as for dependent psychological parameters and psychosocial resources. To assess whether stress elicited changes in the three psychological and two physiological TSST parameters we calculated repeated measure analyses of variance (ANOVA) across the two trimester groups.

To assess the impact of psychosocial resources on the dependent physiological and psychological parameters, we employed the following procedure. First, we exploratively computed Pearson product–moment correlations for assessment of associations between psychosocial resources (daily uplifts and self-efficacy) and AUC_i's of two physiological and three psychological TSST parameters. For these exploratory analyses we set a liberal significance level of .30 following previous methods (Wirtz et al., 2006). For significant associations between dependent physiological parameters and psychosocial resource variables ($P < .30$), we second calculated moderator analyses by linear regression modeling following Baron and Kenny (1986). As dependent variable we entered the AUC_i of the respective physiological parameter. As independent variables we simultaneously entered the group variable (second vs. third trimester), the continuous psychosocial resource variable, as well as the interaction thereof. A psychosocial resource variable was considered to be a significant moderator if the interaction term turned out to be a significant predictor of the respective physiological AUC_i. Third, because of the intercorrelations between the three psychological TSST variables (Table 2), we calculated multiple analyses of variance (MANOVA's) with the three AUC_i's of the dependent psychological TSST variables mood, anxiety, and perceived stress. As independent variables we again entered the group variable (second vs. third trimester), the continuous psychosocial resource variable, as well as the interaction thereof. We decided for the MANOVA procedure in order to further reduce the number of analyses. For significant psychosocial resource variables, post-hoc tests in terms of moderator analyses by means of linear regression modeling were calculated with the AUC_i of the respective psychological TSST parameter as the dependent variable. As independent variables we simultaneously entered the group variable (second vs. third trimester), the continuous psychosocial resource variable, as well as the interaction thereof. To allow computation of interaction terms, we centered the group variable to the means following previous methods (Wirtz et al., 2006). In case of significant interaction effects we performed post-hoc tests by comparing the highest and the lowest tertile of the significant psychosocial resource variable rendering four subgroups of women in second and third trimester with either high or low values in the particular psychosocial resource variable. We then calculated univariate ANOVAs with the AUC of the respective physiological or psychological stress variable as the dependent variable and the four-group variable as the independent variable.

In order to visualize significant main effects but not used for modeling and testing we similarly computed four groups of women in second and third trimester with either highest or lowest tertile values in the particular psychosocial resource variable.

4. Results

4.1. Sample characteristics

There were no statistical differences in age and body mass index among the groups, with weight values of the state shortly before pregnancy included in the calculation. Subjects of the two comparison groups did not differ with respect to trait anxiety or chronic stress, with psychopathological symptoms being in the normal range of the population. In addition, second- and third-trimester pregnant women did not differ with regard to daily uplifts (ZIPS) and self-efficacy (FKK). No differences of perceived stress (VAS), state anxiety (STAI) and mood (MDBF) between the two groups were obtained (Table 1).

4.2. Inter- and intra-correlations of independent and dependent variables

High correlations between perceived stress, mood and state anxiety were obtained, indicating that high perceived stress is related to high levels of state-anxiety ($r = .573$; $P = .000$) and low mood levels ($r = -.607$; $P = .000$). In addition, lower mood levels are closely associated with higher state anxiety ($r = -.794$; $P = .000$). No significant correlations between cortisol stress response and alpha-amylase stress response were achieved, indicating that both stress parameters are independent from each other.

Pearson correlations between self-efficacy and the psychological AUC's of the TSST revealed that higher self-efficacy is related to lower perceived stress ($r = -.349$; $P = .007$) and lower anxiety ($r = -.436$; $P = .001$), as well as better mood ($r = .394$; $P = .002$). Correlations of self-efficacy and the physiological AUC's of the TSST revealed that higher self-efficacy is related to lower cortisol ($r = -.202$; $P = .128$) and alpha-amylase stress responses ($r = -.293$; $P = .026$) (Table 2).

4.3. Psychological stress response

Results obtained by 2-way ANOVA with repeated measures indicated that the stress paradigm induced significant decreases in mood (MDBF: $F(3.21, 186.49) = 16.93$, $P < .001$) and increases in state anxiety (STAI: $F(2.76, 160.10) = 34.49$, $P < .001$) and perceived stressfulness (VAS: $F(2.76, 160.11) = 38.90$, $P < .001$) over time. There were no significant time × group interactions found

Table 1
Baseline characteristics

Characteristic[a]	Second trimester pregnant women ($N = 30$)	Third trimester pregnant women ($N = 30$)	P-value[b]
Age (years)	29.0 (3.5)	30.0 (3.1)	.25
BMI[c]	22.2 (2.7)	21.3 (2.4)	.23
Chronic stress total (TICS)	119.0 (29.2)	126.9 (19.1)	.22
Screening scale (TICS)	24.4 (8.6)	26.2 (4.9)	.22
Anxiety (STAI-trait)	33.0 (7.1)	31.0 (5.4)	.22
Depression (SCL90-R)	.67 (.38)	.64 (.38)	.75
Anxiety (SCL90-R)	.26 (.27)	.38 (.35)	.14
Phobic anxiety (SCL90-R)	.20 (.20)	.21 (.24)	.87
Daily uplifts (ZIPS)	2.1 (.52)	2.2 (.53)	.66
Self-efficacy (FKK)	63.1 (9.3)	62.6 (8.3)	.81
Visual analog scale (VAS), baseline	1.55 (1.58)	1.72 (1.49)	.66
Anxiety (STAI-state), baseline	30.8 (4.9)	31.7 (5.6)	.51
Mood (MDBF), baseline	48.5 (6.3)	46.9 (7.7)	.40

[a] Data are expressed as mean (S.D.).
[b] Probability value from Student's t-test.
[c] Calculated as weight in kilograms (before beginning of pregnancy) divided by the square of height in meters.

Table 2
Pearson's correlations of psychosocial resources and TSST-measurements

	Self-efficacy	Daily uplifts	VASAUC	MDBFAUC	STAIAUC	Cortisol AUC	Alpha-amylase AUC
Self-efficacy	1	.415**	−.349***	.394***	−.436***	−.202*	−.293**
Daily uplifts		1	−.033	.010	−.076	−.136	−.317*
VASAUC			1	−.607****	.573****	.150	−.091
MDBFAUC				1	−.794****	−.137	.071
STAIAUC					1	.139	−.147
Cortisol AUC						1	.171
Alpha-amylase AUC							1

$N = 60$; *$P < .30$; **$P < .05$; ***$P < .01$; ****$P < .001$.

with the factor group and the measurements of VAS, nor for MDBF and STAI.

4.4. Physiological stress response

Results obtained by two-way ANOVA with repeated measures indicated that the stress protocol induced significant increases in cortisol levels (main effect of time: $F(1.57, 90.82) = 21.93$; $P < .0001$). For the total amount of cortisol increase (−20 min to +60 min), a one-way ANOVA with the calculated area under the response curve (AUC_i) showed no significant differences between the two groups ($F(1, 58) = .63$; $P = .43$) (Fig. 1A).

A two-way ANOVA with repeated measures revealed a significant alpha-amylase response to stress (main effect of time: $F(3.84, 222.72) = 12.43$, $P < .0001$). For the total amount of alpha-amylase increase (AUC_i), no significant differences between the two pregnant groups were obtained ($F(1, 58) = .24$, $P = .63$) (Fig. 1B).

4.5. Effects of psychosocial resource variables on physiological stress response

We calculated moderator analyses by means of linear regression analyses with the AUC of alpha-amylase as dependent variable. As independent variables we simultaneously entered the group variable (second vs. third trimester), the continuous psychosocial resource variable, as well as the interaction thereof.

Alpha-amylase and self-efficacy. Higher self-efficacy but not trimester ($P = .39$) predicted lower stress reactivity of alpha-amylase ($\beta = -.29$, $P = .03$, $\Delta R^2 = .09$). The interaction of trimester by self-efficacy did not significantly predict AUC of alpha-amylase ($P = .92$). Age and BMI were controlled (P's $> .77$) (Fig. 2A).

Alpha-amylase and daily uplifts. Again, higher levels of daily uplifts but not trimester ($P = .55$) were associated with lower alpha-amylase stress reactivity ($\beta = -.34$, $P < .02$, $\Delta R^2 = .11$). The interaction of trimester-by-daily-uplifts was not a significant

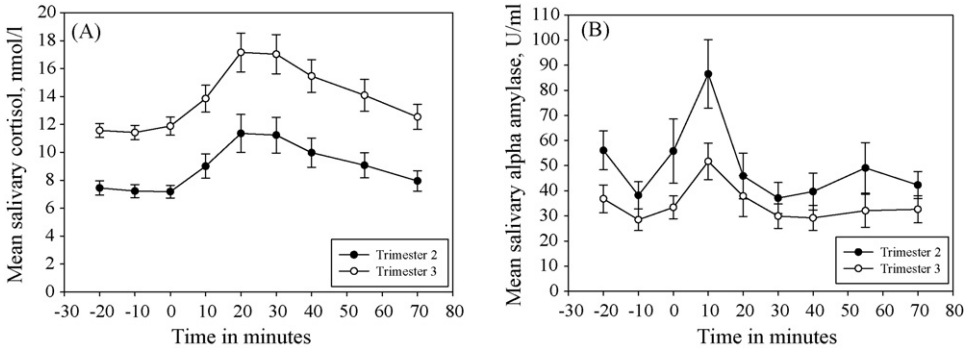

Fig. 1. Physiological stress response of cortisol, main effect of time: $F(1.57, 90.82) = 21.93$; $P < .0001$ (Panel A) and alpha-amylase, main effect of time $F(3.84, 222.72) = 12.43$; $P < .0001$ (Panel B). Stress was induced between minutes 0 and 10.

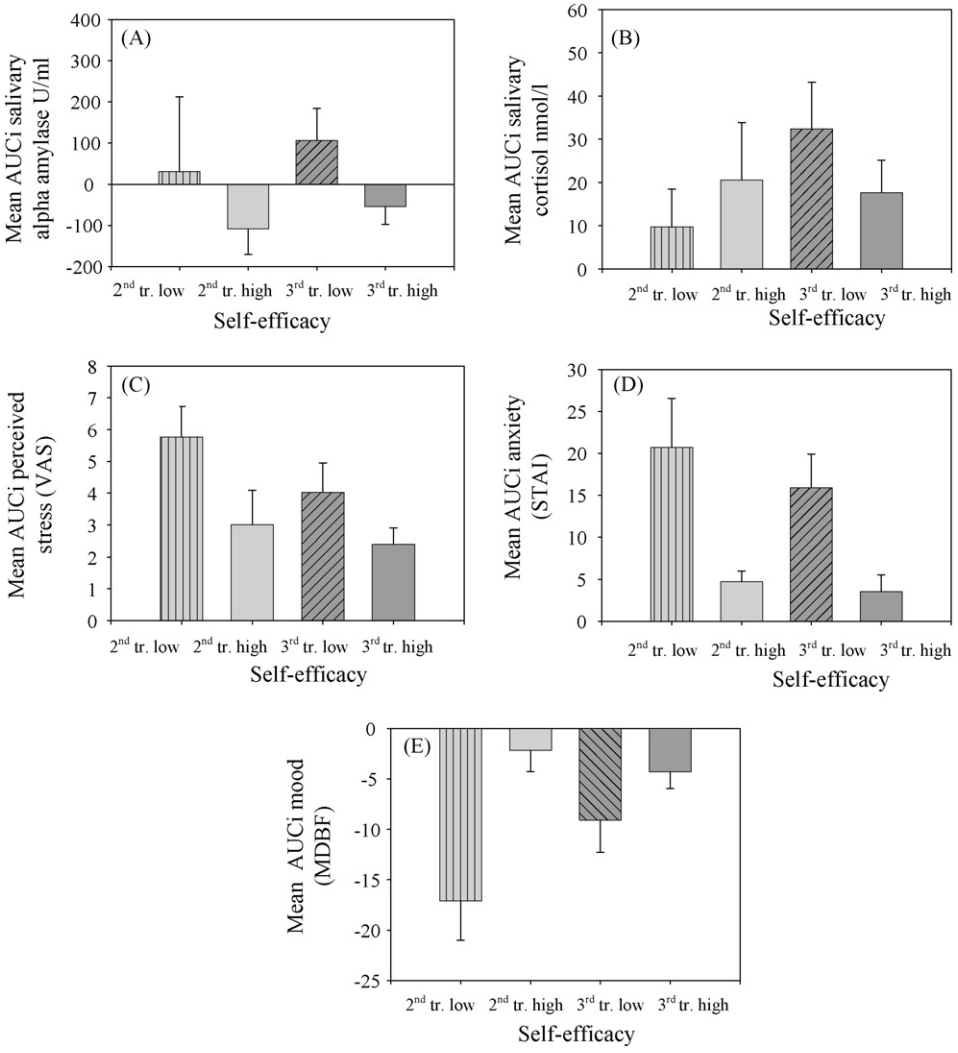

Fig. 2. *Self-efficacy*. Stress responses in physiological (alpha-amylase, Panel A; cortisol, Panel B) and psychological stress parameters (perceived stress, Panel C; anxiety, Panel D; mood, Panel E) in pregnant women in second and third trimester (tr.) with highest and lowest tertile levels of the psychosocial resource variable self-efficacy. Values are means ± S.E.M. Regression analyses revealed that higher self-efficacy was associated with lower stress reactivity of AUC_i of alpha-amylase ($\beta = -.29$, $P = .03$, $\Delta R^2 = .09$, Panel A) and cortisol ($\beta = -.21$, $P = .10$, $\Delta R^2 = .05$, Panel B) independent of trimester and the interaction between trimester and self-efficacy. Post-hoc tests revealed that higher self-efficacy was associated with lower stress reactivity in terms of perceived stress perceived stress ($\beta = -.35$, $P = .007$, $\Delta R^2 = .13$, Panel C), and anxiety ($\beta = -.44$, $P = .001$, $\Delta R^2 = .19$, Panel D) and better mood ($\beta = .40$, $P = .002$, $\Delta R^2 = .16$, Panel E), independent of trimester and the interaction between trimester and self-efficacy.

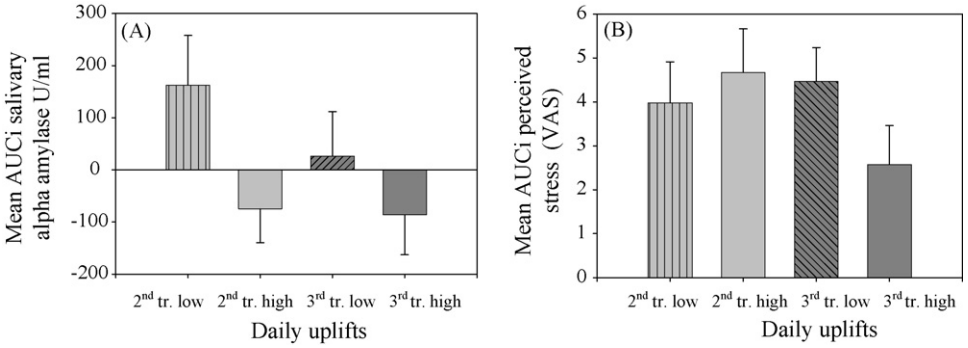

Fig. 3. *Daily uplifts*. Stress responses in alpha-amylase (Panel A) and perceived stress (Panel B) in pregnant women in second and third trimester (tr.) with highest and lowest tertile levels of the psychosocial resource variable daily uplifts. Values are means ± S.E.M. Regression analyses revealed that higher levels of daily uplifts were associated with lower alpha-amylase stress reactivity ($\beta = -.34$, $P < .02$, $\Delta R^2 = .11$, Panel A), independent of trimester and the interaction between trimester and daily uplifts. Post-hoc testing of the significant interaction of trimester-by-daily-uplifts predicting lower perceived stress of borderline significance ($\beta = -.2.45$, $P = .081$, $\Delta R^2 = .06$) revealed the following: Daily uplifts did not change perceived stress in second trimester ($P = .54$) whereas in third trimester high daily uplifts were associated with lower perceived stress, although not significantly ($P = .13$) (Panel B).

predictor of alpha-amylase AUC ($P = .34$). Again, age and BMI (P's $> .64$) did not significantly influence results (Fig. 3A).

Cortisol and self-efficacy. After controlling for age ($P = .74$) and BMI ($\beta = .36$, $P = .007$), higher self-efficacy but not trimester ($P = .36$) predicted lower cortisol stress reactivity of borderline significance ($\beta = -.21$, $P = .10$, $\Delta R^2 = .05$). The interaction of trimester-by-self-efficacy ($P = .22$) did not significantly predict cortisol AUC (Fig. 2B).

4.6. Effects of psychosocial resource variables on psychological stress response

Self-efficacy. MANOVA analysis revealed a significant main effect for self-efficacy ($F_{(3,53)} = 4.68$, $P = .006$, $\text{eta}_p^2 = .21$), but not for trimester ($P = .47$). The interaction of group-by-self-efficacy was not significant ($P = .93$). Subsequent post-hoc tests revealed that higher self-efficacy but not trimester (P's $> .12$) was associated with lower stress reactivity in terms of perceived stress ($\beta = -.35$, $P = .007$, $\Delta R^2 = .13$), and anxiety ($\beta = -.44$, $P = .001$, $\Delta R^2 = .19$) and better mood ($\beta = .40$, $P = .002$, $\Delta R^2 = .16$). Interaction effects were not significant (P's $> .67$) (Fig. 2C–E).

Daily Uplifts. MANOVA analysis revealed a significant interaction effect of daily uplifts with trimester ($F_{(3,48)} = 2.81$, $P = .049$, $\text{eta}_p^2 = .15$). Neither the main effect of daily uplifts ($P = .79$) nor the group effect were significant ($P = .35$). The interaction of trimester-by-daily-uplifts predicted lower perceived stress of borderline significance ($\beta = -.2.45$, $P = .081$, $\Delta R^2 = .06$, Panel) suggesting a moderation effect for daily uplifts on perceived stress in the trimester groups. To further analyze this significant interaction, we divided each trimester into tertiles of the daily uplift variable and compared the highest and the lowest tertile per trimester group. This procedure rendered two groups of second trimester with lowest (second trimester daily uplifts low) and highest tertile levels of daily uplifts (second trimester daily uplifts high) and two groups of third trimester again with lowest (third trimester daily uplifts low) and highest tertile levels of daily uplifts (third trimester daily uplifts high). Post-hoc tests (with AUC of VAS as the dependent variable and the four trimester-by-daily uplift combinations as the independent variables) revealed that daily uplifts did not change perceived stress in second trimester ($P = .54$) whereas in third trimester high daily uplifts were associated with lower perceived stress, although not significantly ($P = .13$) (Fig. 3B). None of the other main and interaction effects approached significance ($P > .22$).

5. Discussion

In this study, we investigated the potential buffering effects of psychosocial resources of pregnant women on physiological and psychological stress responses. Up to now, studies in this field have mainly focused on the association of stress with negative health state and adverse health outcome. To our knowledge, this is the first study to examine stress-buffering effects on physiological and psychological responses in healthy pregnant women. Our results show that self-efficacy and daily uplifts appear to attenuate physiological and psychological stress responses.

The major aim of the present study was to identify the potential moderating effects of psychosocial resources on *physiological* stress response in pregnant women. The study was able to determine a buffering effect of self-efficacy on alpha-amylase and cortisol stress responses. Self-efficacy predicted the total of cortisol and alpha-amylase stress response in pregnant women and accounted for 5% of the variance of cortisol and 9% of the variance of alpha-amylase. These results are in line with findings of studies with non-pregnant subjects, reporting inverse correlations of self-efficacy and cortisol, e.g. after treadmill walking (Butki et al., 2001) or mental tasks (Kelly et al., 1996). In addition, higher values of daily uplifts predicted lower levels of alpha-amylase stress response in pregnant women (explaining 11% of the variance). To sum up, these results indicate that psychosocial resources seem to act as a buffer on HPA and ANS stress responses, thereby protecting pregnant women under stress conditions and helping them to avoid maladaptive physiological responses.

Another aim of this study was to examine the predictive value of psychosocial resources on *psychological* stress responses. Our study revealed that higher levels of self-efficacy significantly predicted lower perceived stress, lower anxiety and higher mood levels in pregnant women, predicting 13% of the variance of perceived stress, 19% of the variance of anxiety and 16% of the variance of mood. Our results extend other findings from the small amount of existing research in pregnant women indicating that psychosocial resources appear to have a buffering effect on psychological stress responses (Allolio et al., 1990; Brugha et al., 1998; Orr, 2004; Robertson et al., 2004; Soet et al., 2003).

Although our data showed that higher self-efficacy was associated with lower psychological and physiological stress reactivity, we found neither significant group nor interaction effects. This is not in line with a recent longitudinal study, in which changes in the way of coping with stress during the course of pregnancy have been identified (Huizink, 2000). However, our analysis revealed a significant interaction of trimester-by-daily-uplifts predicting lower perceived stress of borderline significance: Higher daily uplifts were associated with lower perceived stress in third trimester pregnancy, but not in second trimester pregnancy. Further research is needed to confirm whether indeed differences in moderating effects occur at different stages of pregnancy.

In summary, there seems to be a compelling need for studies focusing on ways of coping with stress during pregnancy by means of examining potential buffering influences on the stress response. In this first study to investigate moderating effects of psychosocial resources in a standardized study design, we found that self-efficacy and daily uplifts appear to attenuate psychological and physiological stress response. These findings might provide future research in this field with additional impulses, integrating both previously examined and other potential moderating psychosocial resources into existing multidimensional models for explaining stress in pregnancy. As a consequence, our findings might provide essential basic information for the development of targeted early prevention programs for high-risk populations of pregnant women.

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