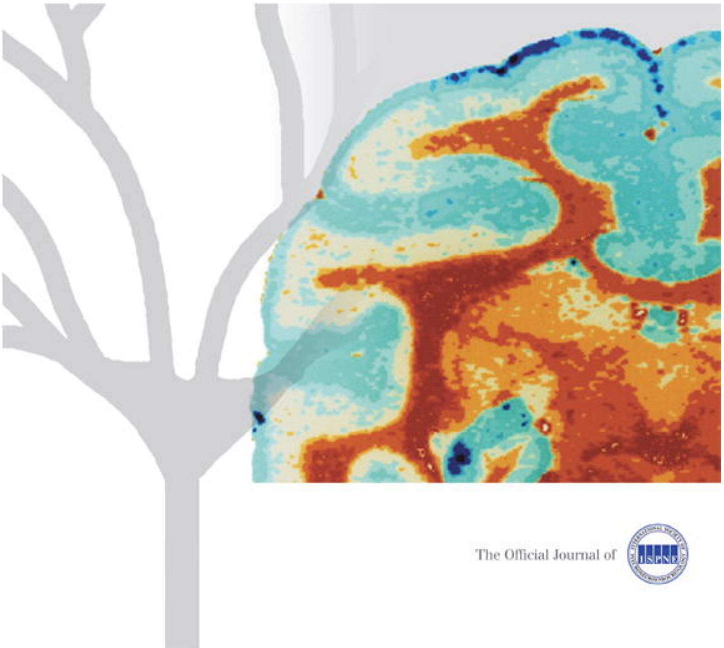
Volume 32 Numbers 8–10 Sep./Oct./Nov. 2007 ISSN 0306-4530

ELSEVIER

IMPRESSIVE IMPACT FACTOR 4.850

Psychoneuroendocrinology



The Official Journal of ISPNE

Psychoneuroendocrinology (2007) **32**, 1000–1012

Available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/psyneuen

The moderating impact of emotional intelligence on free cortisol responses to stress

Moïra Mikolajczak[a,b,*], Emmanuel Roy[a], Olivier Luminet[a,b], Catherine Fillée[c], Philippe de Timary[d]

[a]*Department of Psychology, Research Unit for Emotion, Cognition and Health, Université catholique de Louvain, Place Cardinal Mercier 10, 1348 Louvain-la-Neuve, Belgium*
[b]*Belgian National Fund for Scientific Research, Belgium*
[c]*Department of Medical Biochemistry, Cliniques Universitaires Saint Luc, Av. Hippocrates, 10, 1200 Brussels, Belgium*
[d]*Unité Intégrée d'Hépatologie, Department of Adult Psychiatry, Cliniques Universitaires Saint Luc, Av. Hippocrates, 10, 1200 Brussels, Belgium*

Received 13 December 2006; received in revised form 20 July 2007; accepted 21 July 2007

KEYWORDS
Cortisol;
Neuroendocrine;
Emotional intelligence;
Stress;
Personality;
Hypothalamic–pituitary–adrenal axis

Summary
The construct of trait emotional intelligence (trait EI) refers to the individual differences in the perception, processing, regulation and utilization of emotional information. Several studies have found that trait EI was a significant moderator of subjective responses (e.g., mood deterioration, emotional intensity, action tendencies, bodily sensations) to both natural and laboratory stressors. The present study aims at extending these findings by examining whether trait EI also moderates the biological (i.e., cortisol) response to stress. To this end, 56 participants were assigned to either a neutral or a stressful condition (public speech task) and psychological and cortisol reactivity were examined. Results revealed that higher trait EI scores were associated with significantly lower reactivity to stress at both psychological (i.e., mood deterioration) and biological (i.e., salivary cortisol) levels. Additional analyses revealed that trait EI had incremental validity to predict stress reactivity over and above social desirability, alexithymia and the five-factor model of personality.

*Corresponding author. Department of Psychology, Research Unit for Emotion, Cognition and Health, Université catholique de Louvain, Place Cardinal Mercier 10, 1348 Louvain-la-Neuve, Belgium. Tel.: +32 10 47 44 03.
E-mail address: moira.mikolajczak@psp.ucl.ac.be (M. Mikolajczak).

0306-4530/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.psyneuen.2007.07.009

1. The predictive and incremental validity of trait emotional intelligence regarding the subjective and cortisol responses4 to a laboratory stressor

1.1. The construct of emotional intelligence

Though emotions are common to all human beings, individuals markedly differ in the extent to which they attend to, process, and utilize affect-laden information of an *intra* personal (e.g., managing one's own emotions) or *inter* personal (e.g., managing others' emotions) nature (Petrides and Furnham, 2003). The construct of "trait emotional intelligence" (trait EI) provides a scientific framework to this idea.

Basically, the trait EI construct aims at gathering key *affect*-related personality facets under the same umbrella (see Appendix A). This construct thus encompasses two kinds of variance: one portion of variance already covered by established personality taxonomies such as the Giant Three or the Big Five, and one portion of variance that lies outside these dimensions (Petrides et al., 2007c). Gathering all affect-related personality traits under the same umbrella seems to be fruitful from both explicative and predictive standpoints. Firstly, this construct is useful because it organizes under a single framework the main individual differences in affectivity, which have been up to now scattered across the basic *Big Five* dimensions (i.e., neuroticism, extraversion, openness, agreeableness and conscientiousness) (Petrides et al., 2007a). Second, trait EI has demonstrated incremental validity to predict a number of behaviours, emotional responses and achievements over and above established constructs such as the *Big Five* (e.g., van der Zee et al., 2003; Petrides et al., 2006; Mikolajczak et al., 2007a, b).

1.2. Trait EI and health: empirical evidence and mediational pathways

A vast amount of research has documented an association between trait EI and health-related variables. At a psychological level, trait EI has been negatively associated with depression (e.g., Schutte et al., 1998; Ciarrochi et al., 2002; Saklofske et al., 2003), anxiety (e.g., Ciarrochi et al., 2001; Mikolajczak et al., 2007a), phobic and obsessive symptoms (Mikolajczak et al., 2006) and burnout (e.g., Mikolajczak et al., 2007b). At a physical level, trait EI has been systematically linked to fewer self-reported symptoms and somatic complaints (e.g., Dawda and Hart, 2000; Mikolajczak et al., 2006). Although it is tempting to conclude that trait EI prevents physical illness, these studies demonstrate only a reliable *association*. There are several different pathways that could potentially account for this relationship (Lumley et al., 1996). Firstly, it is possible that the association between trait EI and health is merely an artifact of the methods and measures used ("response bias pathway"). In particular, the reliance on self-reports for the assessment of trait EI, mental health and physical health alike (symptoms reporting) raises the possibility that a pervasive response disposition leads to the observed association. Secondly, trait EI may affect health indirectly ("behavioral pathway"). Specifically, because of their failure to regulate emotions via adaptive coping strategies, low trait EI individuals may attempt to diffuse unpleasant bodily tension through behaviours with health-related consequences (e.g., smoking, drug or alcohol abuse). These behaviors may in turn result in poor psychological and physical health. Thirdly, the emotional regulation failure mentioned above may also result in prolonged physiological arousal ("physiological pathway"). This prolonged arousal could contribute to the development of both psychological and somatic illnesses.

The response bias pathway has never been investigated. It is unknown whether or not low levels of trait EI lead to a focus on and/or an amplification of the somatic sensations that accompany emotional arousal, thus leading people to report, though not experience, more frequent and/or more intense somatic symptoms. The behavioral pathway has been relatively better documented, with studies showing that trait EI was associated with less tobacco use (Limonero et al., 2006), less substance abuse (Brackett and Mayer, 2003; Riley and Schutte, 2003; Limonero et al., 2006), and less alcohol-related problems (Riley and Schutte, 2003). It is thus likely that the association between trait EI and health is not *only* an artifact of the measures used. The physiological pathway has received little attention so far. Only one study has investigated the association between trait EI and the biological response to stress, providing preliminary evidence that trait EI might moderate the effect of stress (Salovey et al., 2002). However, these results should be considered with caution because the study was based on an obsolete model and measure of trait EI (namely, the Trait Meta-Mood Scale; ibid.), which encompasses only three dimensions: attention to feelings, clarity of feelings and emotional repair. Moreover, the results were relatively ambiguous (only "clarity" predicted lower cortisol reactivity in Study 1 and only "attention" predicted lower cortisol reactivity in Study 2). In addition, the incremental validity of trait EI over and above concurrent predictors was not examined. The present study aims at overcoming these limitations.

1.3. The present study

The first goal of this study was to examine the extent to which trait EI buffers the relationship between a laboratory stressor (i.e., the Trier Social Stress Task) and the subsequent subjective (i.e., mood deterioration) and objective responses (i.e., salivary cortisol). Compared with other emotional states such as sadness, shame or guilt—-whose neuroendocrine correlates are often either unknown or unspecific—stress induces the activation of two axes: the sympathetic-adrenomedullary (SAM) system and the hypothalamic–pituitary–adrenocortical (HPA) axis. The activation of these axes respectively result in the releasing of catecholamines (epinephrine, norepinephrine) and corticosteroids (e.g., cortisol), which bring about a number of biological modifications aimed at providing the organism with the energy necessary to face the stressor. Cortisol secretion is considered as a reliable, sensitive and objective indicator of hypothalamic–pituitary–adrenal axis activation, which makes it one of the most widely used index of stress in psychoendocrine research (Ursin, 1998; Dickerson and Kemeny, 2004). The assessment of salivary cortisol is also more popular than plasma cortisol on account of its non-invasiveness, laboratory independence and almost unlimited saliva sampling compared to plasma and urine. Moreover, multiple saliva sampling enables the study of the *dynamics* of the cortisol response to acute stressors, which accumulative measures such as urinary cortisol do not permit (Garcia de la Banda et al., 2004).

The second goal of this study was to examine the added value of the trait EI construct to predict cortisol secretion vis-à-vis concurrent predictors such as alexithymia and the five-factor model of personality (FFM). This was especially important because trait EI shares a high percentage of its variance with these constructs (e.g., Parker et al., 2001; Saklofske et al., 2003; Mikolajczak et al., 2007a). Alexithymia is a multidimensional construct encompassing four dimensions thought to reflect deficits in the cognitive processing of emotions: (a) a difficulty in identifying and distinguishing between feelings and the bodily sensations of emotional arousal; (b) a difficulty in describing feelings to others; (c) a restricted imagination, as evidenced by a paucity of fantasies and (d) a cognitive style that is literal, utilitarian and externally oriented (Taylor and Bagby, 2000). The FFM is currently the most prominent model for describing personality. This model posits that personality (viz., individual differences in the configurations of thoughts, emotions and behaviours; McCrae and Costa, 1990, p. 23) can be summarized in five major dimensions (often referred to as the "*Big Five*"): neuroticism (N), extraversion (E), openness to experience (O), agreeability (A) and conscientiousness (C). Along with thoughts and behaviours, emotions are important parts of the definitions of these traits. *N* and *E* pre-dispose to negative and positive emotions, respectively, *O* captures interest for emotions, *A* reflects the hostile triad of emotions (anger, contempt and disgust) and *C* refers to the ability to control impulses (Luminet et al., 1999). Given the partial overlap between alexithymia, the FFM and trait EI, it was important to investigate the ability of trait EI to predict mood change and cortisol secretion over and above these variables.

2. Method

2.1. Sample

Fifty-nine students recruited through advertisement participated in the study in exchange for course credit or remuneration. Students who presented somatic or psychiatric illnesses, or those who currently used any form of medication were not included. Females and those who reported smoking behaviour were also excluded, due to the documented effect of gender (Kudielka and Kirschbaum, 2005) and smoking (Kirschbaum et al., 1992) on cortisol responses. Subjects were randomly assigned to control ($N = 28$) or stress ($N = 31$) conditions. After screening for the exclusion criteria mentioned above, participants were provided with a brief description of the study (they were told that it was about individual differences in job interviews). Participants were also instructed (1) not to drink too much the day before the individual session and to respect their usual sleeping hours; (2) not to ingest alcohol, caffeine, or soda drinks the day of the individual session and (3) not to ingest any food or drink 1 h before the start of the individual session.

Three individuals from the stress group were removed from subsequent analyses. Two presented extreme cortisol values (deviating more than 3 SD from the group mean) and one showed a highly chaotic cortisol profile: whereas all other participants showed a progressive increase in cortisol secretion from baseline to peak and then a decrease from peak to the last sampling, this participant showed erratic values, with sudden and drastic increases/decreases from one sampling to another (the values were 7.8, 61.3, 31.8, 100.7, 36.5, 105.2, 54.7, 42.2 in that order). In addition, this mean cortisol value deviated more than 6 SD from the group mean. Final analyses were thus performed on 56 subjects (mean age: 20.18 years; SD: 2.02 years) evenly distributed among the stress and control groups.

2.2. Measures

Trait EI [$\alpha = .96$] was measured through the Trait EI Questionnaire (TEIQue; Petrides and Furnham, 2003; for the psychometric properties of the French adaptation used in this study, see Mikolajczak et al., 2007a). The TEIQue consists of 153 items responded to on a 7-point scale. It assesses 15 subscales and provides a global trait EI score as well as scores on four specific factors (*well-being* [$\alpha = .93$], *self-control* [$\alpha = .86$], *emotional sensitivity* [$\alpha = .91$], and *sociability* [$\alpha = .91$]). A detailed description of the factors and subscales is provided in Appendix A.

Positive and negative affectivity were assessed through an extended version of the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988). In its original version, it consists of 20 adjectives rated along 5-point scales, 10 of which measure positive affectivity (PA) and 10 measure negative affectivity (NA). In order to increase the sensitivity of the instrument to the manipulation, the following adjectives were added on account of their particular relevance to our investigation: "disheartened," "incapable," "grumpy," "disgusted," and "tense." The Cronbach alphas for PA and NA (including the new adjectives) were, respectively, .85 and .88 at baseline and .90 and .89 after the mood induction.

Cortisol secretion. Saliva samples were collected using the Sarstedt® Salivette collection devices (Nümbrecht, Germany), stored at room temperature until completion of the session and at $-20\,^{\circ}\mathrm{C}$ until assay. The cortisol assays were carried out at the Department of Clinical Biochemistry, Cliniques Universitaires Saint Luc (Brussels, Belgium). Saliva was extracted from the cotton swab by centrifugation (1000*g*, 2 min) and the cortisol was measured using a competitive polyclonal immunoassay, comprised of an electromagnetic separation step followed by electrochemiluminescence quantitation with the Elecsys 1010/2010 analyser (Roche Diagnostics, Mannheim, Germany). The intra- and interassay coefficients were, respectively, 4.0% and 7.2%. Results are expressed in nanomoles per litre (nmol/l).

Social desirability [$\alpha = .64$] was measured with the Marlowe–Crowne Social Desirability Scale (Crowne and

Marlowe, 1960), which consists of 30 items rated on a dichotomous (true/false) scale. Sample items are "I am always courteous, even to people who are disagreeable," "When I don't know something, I don't mind at all admitting it."

Alexithymia [$\alpha = .80$] was measured with the Toronto Alexithymia Scale (Bagby et al., 1994; French adaptation: Loas et al., 1996). This questionnaire consists of 20 items responded to on a 5-point scale, targeting three specific dimensions: difficulty in identifying feelings ("When I am upset, I do not know if I am sad, frightened or angry"), difficulty in describing feelings ("I find it hard to describe how I feel about people") and externally oriented thinking ("I prefer talking to people about daily activities rather than their feelings").

The FFM was measured with the D5D (Rolland and Mogenet, 2001), a widely used French personality inventory based on the FFM (Costa and McCrae, 1992). It assesses the Big Five dimensions of emotional stability [$\alpha = .86$], introversion [$\alpha = .82$], openness [$\alpha = .72$], conscientiousness [$\alpha = .80$], and agreeableness [$\alpha = .83$] through 55 adjectives (e.g., "nervous," "reserved," "cultivated," "compassionate," "tidy," etc.) rated on a 6-point scale (-3 = "does not describe me at all," +3 = "describes me perfectly").

2.3. Procedure

2.3.1. Experimental session

The experiment was conducted in accordance with the Declaration of Helsinki and was approved by the IRB. The effect of circadian hormone rhythms was minimized by conducting all sessions between 1400 and 1800 h. After providing written informed consent and a basal sample of saliva, participants underwent a short relaxation procedure and then were left alone for 10 min in a comfortable room with several magazines at their disposal. Then, baseline positive and negative affectivity were assessed through the PANAS. After a second basal sample of saliva was taken, subjects were introduced to the Trier Social Stress Test (TSST; see Kirschbaum et al., 1993 for the detailed procedure). This stressor—which has repeatedly been found to induce pronounced endocrine and cardiovascular responses in 70–80% of the subjects tested—consists of both a public speech (5 min, after 10 min preparation period) and a cognitive task[1] (5 min) in front of an audience of two people and a video camera. Afterwards, participants returned to the first room, provided a sample of saliva and were retested on the PANAS. They spent the rest of the experiment alone in the room (reading magazines etc.), interrupted only for saliva collection (see Appendix B for exact timing). They were debriefed just before the last sampling.

The neutral condition was similar to the stressful one in all respects, except for two modifications: (1) participants were tested collectively instead of individually and (2) the TSST (i.e., instructions, preparation, interview and cognitive test) was replaced by the presentation of a (pre-tested) neutral clip of a documentary on Mayan people (Azzarella and Boyajian, 1997, French version).

2.3.2. Questionnaire session

The questionnaire session took place about 3 weeks after the experimental one. This collective session lasted for about 1 h, during which participants completed measures of the five factors of personality, emotional intelligence, alexithymia and social desirability.

2.4. Statistical analyses

Regarding the subjective response, mood change scores were computed by subtracting "before manipulation" scores from "after manipulation" scores (PA2−PA1, NA2−NA1). Main effects and interactions of condition and trait EI were then examined through three-step multiple regression analyses. In Step 1, we introduced the condition (a dummy variable contrasting *neutral* [1] to *stressful* conditions [−1]). In Step 2, we entered trait EI scores (a continuous variable). The interaction between Condition and Trait EI was entered in Step 3. Following Aiken and West's (1991) suggestion, trait EI scores were centred around their mean.

As far as the cortisol response is concerned, areas under the response curve were calculated with respect to ground (AUCg) and with respect to the increase (AUCi) using the trapezoidal method recommended by Pruessner et al. (2003). The computation of the AUC is a frequently used method in endocrine and neuroscience research as it enables one to simplify the statistical analyses and increase the power of the testing without sacrificing the information contained in multiple measurements (id.). Main and interaction effects were then examined through multiple regression analyses (see above). In order to simplify the visual presentation of the results, the foregoing analyses were supplemented by the computation of ANOVAs for repeated measures with time as a within-subject factor, and condition and level of trait EI (two categories: below and above the mean, respectively named high and low trait EI) as between-subjects factors. The graphs resulting from this procedure are particularly readable because trait EI is treated as a categorical rather than a continuous variable.

3. Results

3.1. Mood manipulation check

At the subjective level, regression analyses yielded a main effect of condition, indicating greater mood deterioration in the stress condition than in the neutral one. The deterioration was highly manifest in NA ($R^2_{Adj} = 0.30$; $F_{(1,\ 54)} = 20.186$, $p \leqslant .001$, $mean_{neutral} = -.17$, $SD = 0.37$; $mean_{stress} = 0.37$, $SD = 0.51$) but only marginal in PA scores ($R^2_{Adj} = 0.41$; $F_{(1,\ 54)} = 3.371$, $p \leqslant .10$, $mean_{neutral} = -0.30$, $SD = 0.51$, $mean_{stress} = -0.05$, $SD = 0.50$).

At the cortisol level, regressions revealed a significant effect of condition on the AUCg ($R^2_{Adj} = 0.30$; $F_{(1,\ 54)} = 24.510$, $p \leqslant .001$; $mean_{neutral} = 546.17$ nmol/l, $SD = 215.07$; $mean_{stress} = 986.65$ nmol/l, $SD = 418.80$) which

[1]The cognitive task was presented to the participant as a psychotechnical test, typical of hiring situations. Actually, it consisted only in the most difficult items of the Raven Advanced Progressive Matrices (1976), which were impossible to solve under the time pressure we set (30 s per matrix).

Table 1 Regression analyses predicting subjective and cortisol responses by condition, trait EI and their interaction.

	Change in negative affectivity		Baseline cortisol		Area under the curve (AUCg)		Increase from baseline (AUCi)	
	Beta	*t*	Beta	*t*	Beta	*t*	Beta	*t*
	$F_{(3,\ 52)} = 12.459$***, $R^2_{adj} = .39$		$F_{(3,\ 52)} = 2.98$*, $R^2_{adj} = .10$		$F_{(3,\ 52)} = 16.100$***, $R^2_{adj} = .45$		$F_{(3,\ 52)} = 3.555$*, $R^2_{adj} = .12$	
Constant	0.12*		8.40***		796.93***		−167.32*	
Condition	−.583	−5.32***	−.109	−0.28	−.586	−5.66***	−.402	−3.068**
Trait EI	−.302	−2.76**	−.136	−1.02	−.195	−1.886†	.011	0.087
Condition × trait EI	.220	2.06*	.335*	2.60	.348	3.467***	−.108	−0.853

Note. Neutral condition was coded as 1 and stressful condition was coded as −1.
***$p \leqslant .001$; **$p \leqslant .01$; *$p \leqslant .05$; †$p \leqslant .10$.

corresponded to a significant time × condition interaction effect in the ANOVAs for repeated measures (cubic $F = 38.888$, $p \leqslant .001$). There was a significant cortisol increase in the stressful condition and a significant cortisol decrease in the neutral condition. The decrease observed in the neutral condition most probably indicates that participants arrived a bit tense at the experiment but that they relaxed as time went by. It is noteworthy that the effect size of the manipulation in the stressful condition (difference between baseline and peak) was .55 (Cohen's *d*), which is within the typical range for laboratory-induced cortisol responses (see Dickerson and Kemeny, 2004 for a meta-analysis).

3.2. Relationship between mood deterioration and cortisol secretion

There was no correlation between baseline cortisol and NA ($r = -.09$, ns) or PA ($r = 0.05$, ns) at the beginning of the experiment. However, there were significant correlations between mood deterioration and two of the three indicators of cortisol responses: AUCg ($r = 0.46$, $p < 0.05$) and cortisol at the peak (i.e., salivette 4: $r = 0.51$, $r < 0.01$) in the stressful condition. The correlation with AUCi was marginal ($r = 0.31$, $p = 0.10$). It is noteworthy that trait EI did not moderate the association between psychological and biological parameters.

3.3. Moderating effect of trait EI on mood deterioration

As reported in Table 1, regressions revealed a main effect of global trait EI on the difference in NA, indicating a negative relationship between trait EI and mood deterioration. As expected, there was also a condition × trait EI interaction, indicating that the negative relationship between trait EI and mood deterioration was stronger in the stress than in the neutral condition (see Figure 1 and Table 2). Namely, high trait EI individuals were less affected by the stress induction (i.e., they gained less NA and lost less PA) than their low EI counterparts.

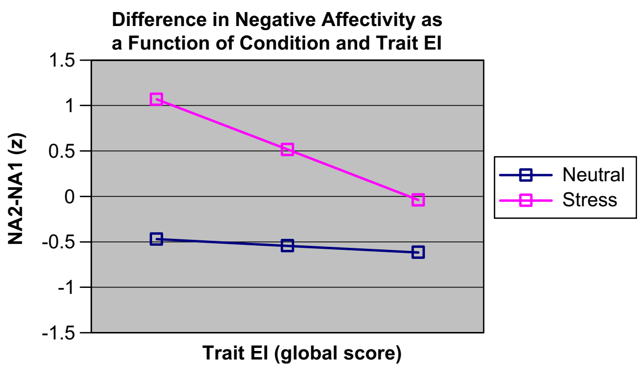


Figure 1 Difference in negative affectivity as a function of condition and trait EI. *Note*: In order to facilitate the interpretation of the graphs, post-manipulation mood is expressed in standardized units [Z(PA2) or Z(NA2)] corresponding, respectively (and separately for each condition), to the mean trait EI score minus 1 standard deviation, the mean trait EI score, and the mean trait EI score plus 1 standard deviation. zNA2 values above zero indicate mood deterioration whereas zNA2 values below zero indicate mood improvement.

3.4. Moderating effect of trait EI on cortisol secretion

First and foremost, regressions (see Table 1) revealed a significant condition × trait EI interaction on the AUCg, indicating that higher trait EI scores displayed a smaller overall cortisol secretion than lower scores in the stressful condition (the relationship between trait EI and AUCg was $r = .28$, $p =$ ns in the neutral condition, and was $r = -.54$, $p \leqslant .005$ in the stressful condition; see also Table 2). Such results were also evident in the repeated measures ANOVAs, which yielded a significant time × condition × trait EI interaction (multivariate $F = 2.19$, $p \leqslant .05$). As depicted in Figure 2 (ANOVA graphs), high trait EI individuals secreted less cortisol in the stress condition than their low trait EI peers. It is noteworthy that condition and trait EI (and their interaction) accounted together for 45% of the variance in cortisol data (see $R^2_{adjusted}$ in Table 1).

Table 2 Correlations between trait EI and both baseline/peak cortisol measures and mood deterioration (separately for the two conditions).

Condition	Cortisol at baseline	Cortisol at the peak	Increase in NA	Decrease in PA
Stress ($N = 28$)				
Global trait EI	−.44*	−.41*	−.55**	−.35†
Well-being	−.51**	−.29	−.43*	−.41*
Self-control	−.42*	−.27	−.35†	−.15
Emotional sensitivity	−.36*	−.40*	−.45*	−.25
Sociability	−.16	−.38*	−.48**	−.28
Neutral ($N = 28$)				
Global trait EI	.23	.19	−.10	−.00
Well-being	.04	.05	−.09	−.03
Self-control	.25	.29	−.04	−.08
Emotional sensitivity	.20	.15	−.09	.10
Sociability	.23	.16	.05	.03

***$p \leqslant .001$; **$p \leqslant .01$; *$p \leqslant .05$; †$p \leqslant .10$.

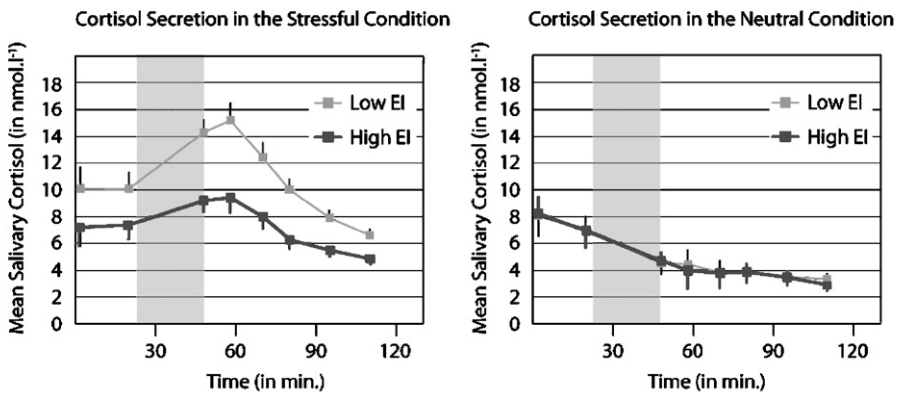


Figure 2 Cortisol secretion as a function of condition and Trait EI. *Note*: In the stressful condition, the effect size (Cohen's*d*) of trait EI on the Area Under the Curve (AUCg) is −1.11 and −0.92 on the cortisol secretion at the peak (salivette 4).

Complementary analyses performed to detect the source of the foregoing difference in overall cortisol response suggested that it was mainly attributable to the anticipation phase. There was indeed no significant effect of trait EI on the AUCi. However, there was a significant interaction effect of condition × trait EI on baseline[2] salivary cortisol ($R^2_{adj} = 0.10$; F_{change} $(1, 52) = 6.735$, $p \leqslant .05$), indicating that low trait EI participants anticipated the experiment more anxiously than high trait EI participants in the stressful condition (see Figure 2 and Table 2). The fact that this effect occurred only in the stressful condition is not surprising as people knew in advance (viz., since enrolment) whether the first session in which they would participate would be an individual session (i.e., the stressful condition) or a collective one (i.e., the neutral condition). It is easy to imagine that the prospect of being alone with the experimenter may be perceived as more stressful than the prospect of being with about 30 other people.

It is of note that all trait EI subfactors displayed similar response patterns as that of Figure 2: a lower cortisol secretion at baseline causing less overall cortisol secretion in the stressful condition (see Tables 2 and 3), thereby suggesting that all factors contribute to the global effect.

[2]A single baseline value was created by averaging the two baseline salivary cortisol measures.

3.5. Incremental validity of trait EI over and above social desirability, alexithymia and the FFM

3.5.1. Statistical analyses

Incremental analyses were completed in two steps. First, we performed separate multiple regressions (entering condition, predictor, and condition × predictor) to identify independently the significant predictors of subjective and cortisol responses. We then tested the incremental validity of trait EI over and above these determined significant predictors using a partially stepwise regression procedure (Hunsley and Meyer, 2003).

3.5.2. Incremental validity of trait EI to predict mood deterioration

Among social desirability, alexithymia and the FFM, the following variables were found to be significant predictors of mood deterioration: emotional stability, openness, agreeability and social desirability had a main effect (i.e., the

Table 3 Regression analyses predicting baseline and integrated cortisol responses by condition, trait EI factors and their interaction.

	Baseline cortisol		Area under the curve (AUCg)	
	Beta	t	Beta	t
Well-being	$F_{(1,\ 52)} = 3.657^{*}$, $R^2_{adj} = .13$		$F_{(3,\ 52)} = 13.483^{***}$, $R^2_{adj} = .41$	
Constant (intercept)	8.51^{***}		802.98^{***}	
Condition	−.185	−1.39	−.631	-5.72^{***}
Well-being	−.301	-2.25^{*}	−.246	-2.22^{*}
Condition × well-being	.314	2.48^{*}	.286	2.75^{**}
Self-control	$F_{(1,\ 52)} = 2.838^{*}$, $R^2_{adj} = .10$		$F_{(3,\ 52)} = 11.661^{***}$, $R^2_{adj} = .37$	
Constant (intercept)	8.02^{***}		766.11^{***}	
Condition	−.092	−0.72	−.555	-5.18^{***}
Self-control	−.083	−0.62	−.084	−0.76
Condition × self-control	.333	1.84^{*}	.268	2.42^{*}
Emotional sensitivity	$F_{(1,\ 52)}\ 2.047^{*}$, $R^2_{adj} = .11$		$F_{(3,\ 52)} = 14.437^{***}$, $R^2_{adj} = .42$	
Constant (intercept)	8.23^{***}		782.81^{***}	
Condition	−.089	−0.66	−.563	-5.37^{***}
Emotional sensitivity	−.124	−0.93	−.205	$-1.96^{\dagger}$
Condition × emotional sensitivity	.293	2.22^{*}	.330	3.20^{**}
Sociability	$F_{(1,\ 52)} = 0.045$, $R^2_{adj} = .05$		$F_{(3,\ 52)} = 11.950^{***}$, $R^2_{adj} = .37$	
Constant (intercept)	8.25^{***}		789.98^{***}	
Condition	−.083	−0.59	−.579	-5.26^{***}
Sociability	.028	0.20	−.13	−1.13
Condition × sociability	.192	1.39	.265	2.45^{*}

Note: (1) The decomposition of the significant interaction effects figure in Table 2 (i.e., the separate slopes of the effect of trait EI in each condition correspond to the "r_s" presented in Table 2). (2) Neutral condition was coded as 1 and stressful condition was coded as −1.
***$p \leqslant .001$; **$p \leqslant .01$; *$p \leqslant .05$; $^{\dagger}p \leqslant .10$.

higher the scores, the lesser the mood deterioration) and alexithymia had a marginal interaction effect (the higher the scores, the higher the mood deterioration, but in the stressful condition only). The multiple regression analysis performed to test the incremental validity of trait EI over and above these predictors was computed as follows: condition was entered as the first block, emotional stability, openness, agreeability and social desirability as well as the interaction term of "condition × alexithymia" were entered in a stepwise fashion as the second block. Finally, trait EI and the interaction term of "condition × trait EI" were entered in a stepwise fashion as the third block. Results are reported in Table 4. Trait EI significantly predicted mood deterioration (the higher the trait EI scores, the lesser the mood deterioration in the stress condition) over and above other predictors entered in the model (the stepwise procedure retained only openness as a significant predictor in the second block and only the interaction term "trait EI × condition" in the third block).

3.5.3. Incremental validity of trait EI to predict salivary cortisol

Among alexithymia and the FFM, all predictors except introversion and conscientiousness were found to interact with condition to predict cortisol secretion. Emotional stability, agreeability and openness were protective factors (i.e., the higher the scores, the lower the cortisol secretion) whereas alexithymia was a vulnerability factor (i.e., the higher the scores, the higher the cortisol secretion). It is noteworthy that the effect of the latter factor was only marginally significant. The following multiple regression was thus performed to test the incremental validity of trait EI over these predictors: condition was entered as the first block, the interaction terms of "condition × emotional stability," "condition × agreeability," "condition × openness," and "condition × alexithymia" were entered in a stepwise fashion as the second block. Finally, the interaction term of "condition × trait EI" was entered as the third block. Results are reported in Table 4. Trait EI significantly predicted cortisol secretion (AUCg) over and above the other predictors entered in the model (the stepwise procedure retained only emotional stability as a significant predictor in the second block). Note that separate regression analyses examining the incremental validity of trait EI on each of these predictors taken individually[3] revealed that EI also had incremental validity over each of these predictors separately. The opposite was not true (i.e.,

[3] Condition was entered as block 1, main and interaction effect of predictor as block 2 and main and interaction effects of trait EI as block 3.

Table 4 Hierarchical regression analyses testing the incremental validity of trait EI over and above social desirability, alexithymia and the five-factor model of personality, with regard to the prediction of subjective and cortisol responses.

Criterion variable	Forced hierarchical order	Predictor variable	*R*	$R^2_{adj.}$	*F* change	Semipartial *r*[¶]
NA change[‡]	1	Condition	.522	.259	20.186***	−.592***
	2	Openness	.656	.408	14.653***	−.374***
	3	Trait EI × condition	.688	.442	4.242*	.207*
Cortisol AUCg[§]	1	Condition	.559	.299	24.510***	−.540***
	2	Emotional stability × condition	.641	.389	8.902**	.113
	3	Trait EI × condition	.677	.428	4.585*	.218*

Note. Neutral condition was coded as 1 and stressful condition was coded as −1.
***$p \leqslant 0.001$; **$p \leqslant 0.01$; *$p \leqslant 0.05$; †$p < 0.10$.
[‡]Procedure: condition was entered as the first block, the *Z* scores of neuroticism, openness, agreeability and social desirability as well as the interaction term of "condition × alexithymia" were entered in a stepwise fashion as the second block; finally the *Z* scores of trait EI and the interaction term of "condition × trait EI" were entered in a stepwise fashion as the third block.
[§]Procedure: condition was entered as the first block, the interaction terms of "condition × emotional stability," "condition × agreeability," "condition × openness," and "condition × alexithymia" were entered in a stepwise fashion as the second block. Finally, the interaction term of "condition × trait EI" was entered as the third block.
[¶]These are the semipartial *r*s when all variables are considered together (step 3).

predictors did not have incremental validity over and above trait EI) except for agreeability, which explained a unique (but marginal) part of variance over and above trait EI.

4. Discussion

Several prior studies revealed that trait EI was a significant moderator of *subjective* responses to both natural and laboratory stressors. For instance, in applied settings, students with higher trait EI scores displayed a lesser increase in psychological symptoms and somatic complaints during exams than their lower trait EI counterparts (Mikolajczak et al., 2006). In the same vein, nurses with higher trait EI scores reported lower levels of burnout and somatic complaints than nurses with lower scores (Mikolajczak et al., 2007b). These findings were replicated in three experimental studies, in which trait EI was found to be associated with less mood deterioration and less emotional reactivity (emotional intensity, action tendencies and bodily sensations) following a laboratory stressor (Mikolajczak, 2006; Mikolajczak et al., 2007a).

This study extends and strengthens previous findings by showing that trait EI moderates not only the subjective response to stress but also the objective (i.e., cortisol secretion) response. Moreover, our data showed that all trait EI subfactors had a significant moderating impact on cortisol responses, thereby supporting the view that trait EI is a homogeneous construct, even in its biological effects. Given that the moderating effect of trait EI on the *subjective* component of the stress response replicates results from our previous field and experimental studies, this effect will not be discussed any further. We refer interested readers to our previous contributions on this topic (references listed above). The rest of this discussion will thus focus on the effect of trait EI on the cortisol response.

The present results indicate that high and low EI people differ in their overall reactivity to potentially stressful situations. This difference is manifest at baseline, at the peak and in overall cortisol secretion, all three of which being significantly lower in high EI individuals compared to their low EI peers. Analyses performed in order to document the source of this difference revealed that high and low EI people do not differ in their increase in cortisol from baseline to peak, meaning that the HPA axis of the former is as reactive as the one of the latter when actually confronted to the stressor. The lower cortisol secretion exhibited by high EI individuals all over the experiment is rather attributable to baseline differences. That is, there was a significant anticipation-related effect that maintained throughout the entire session. As a matter of fact, baseline differences could potentially account for the absence of significant differences between groups in the increase from baseline to peak. It is well known, indeed, that cortisol release retroacts on the anterior pituitary corticotrophs to reduce the secretion of adrenocorticotropic hormone (ACTH), resulting in a decrease in the synthesis and release of cortisol from the adrenal cortex. For instance, a study in rats showed that the administration of 100μg/kg corticosterone immediately prior to restraint stress (Viau et al., 1993) significantly decreased subsequent plasma ACTH responses to restraint. Thus it is plausible that there was an increased feedback action in low EI individuals due to baseline (anticipation-related) elevated cortisol levels.

The fact that low trait EI individuals anticipated the stressful session[4] more anxiously than high trait EI individuals (i.e., displayed a higher cortisol baseline in the stressful condition, see Figure 2) is in accordance with findings from one of our previous experimental studies

[4]They did not know that the session would be stressful but they knew it would be individual rather than collective.

(Mikolajczak, 2006). In the latter, the stressor consisted of an arithmetic task to be performed in either a stressful (time and accuracy monitored) or a neutral condition. Participants completed a challenge/threat appraisal questionnaire after receiving the instructions but before performing the task. Results revealed that high EI participants evaluated the forthcoming task as a challenge whereas their low trait EI counterparts evaluated it as a threat. This effect was manifest in the stressful condition only. It is thus likely that a similar anticipation effect accounted for the difference between high and low trait EI cortisol baseline observed in the stressful condition in the present study. The consequences of this anticipation effect regarding health should not be underestimated. Indeed, under "real life" conditions, anticipation usually lasts longer than stress. Moreover, elevations in cortisol secretion has been shown to increase corticotropin-releasing hormone (CRH) mRNA expression in the amygdala, resulting in exaggerated response to fear (Schulkin et al., 1998, cited by Takahashi et al., 2005). Thus, it is plausible that cortisol secretion in response to previous stressful experiences result in exaggerated threatening anticipation of upcoming stressors.

As we have pointed out earlier, the anticipation-related effect maintained throughout the entire session, such that high EI individuals secreted overall significantly lesser cortisol than their low EI peers, even if the increase from baseline to peak itself was not smaller. In terms of effect sizes (Cohen's *d*), the magnitude of the impact of trait EI on the integrated cortisol response (AUCg) in the stressful condition is −1.11 (−0.92 on peak cortisol secretion). These effect sizes correspond to large effects according to Cohen's (1988) norms for the social sciences. The practical implications of these numbers are even more interesting than their statistical significance: an effect size of 1 indicates that the difference between the mean cortisol secretion of high and low trait EI groups is 1 standard deviation. If we consider the number of stressors one will face during his/her lifetime along with the ubiquitous functions of cortisol in the body, the accumulation of these differences in cortisol secretion may ultimately lead to different somatic health states. Cortisol is indeed in the regulation of bone resorption, immune and inflammatory functions, glycaemia, fat storage and cognitive functions (to cite only its main roles). Whereas small increases of cortisol are necessary to induce stress-related changes in the body and are thus adaptive, exaggerated activation of the HPA axis in reaction to acute stressors may interfere with effective information processing and the selection of appropriate responses (de Kloet et al., 1999; for a review, see Bremner, 1999). Moreover, prolonged cortisol response to chronic stressors has been shown to have negative effects (e.g., impaired cognitive performances, blood sugar imbalances, decrease in muscles tissues, decreased bone density, lowered cellular immunity and inflammatory responses), which may ultimately damage the organism and lead to organic diseases (e.g., Chrousos, 2000; Thurin and Baumann, 2003).

The relationship between trait EI and cortisol response to stress provides some insights about the potential mediating mechanisms linking trait EI to health. Although the present study solely investigated the effect of trait EI on the cortisol response to an *acute* stressor, it is plausible that this effect would also apply in the case of *chronic* stressors (e.g., bereavement). Indeed, several studies have found support for such an effect at the subjective level. For instance, trait EI moderates psychological and (self-reported) somatic resistance to chronic stressors such as exam sessions (Mikolajczak et al., 2006) or stressful occupations (Mikolajczak et al., 2007b). If future studies replicate this effect at a biological level, the ensuing prolonged cortisol secretion which would be evidenced by low trait EI individuals may possibly explain why the latter individuals were systematically found to report more somatic complaints than their high trait EI peers in our previous studies. Thus, low trait EI individuals may perhaps not only *report* more somatic complaints but also *experience* objectively more physical symptoms. Investigating this issue through prospective studies using objective medical indices might represent a fruitful avenue of research.

Before concluding, it is worth noting that trait EI had incremental validity to predict salivary cortisol response to stress, over and above constructs such as alexithymia and the five factors of personality. This finding adds to the growing body of evidence showing that trait EI brings a unique contribution in the prediction of a number of adaptation-related phenomena (in addition to the studies conducted in our own research group, see for instance Austin, 2004; Van Rooy and Viswesvaran, 2004; Petrides et al., 2007b).

The contribution of this study is twofold. Its first contribution concerns stress. Whereas several studies documented the role of *situational* variables accounting for the variability in cortisol responses *between* studies (see for example the meta-analysis of Dickerson and Kemeny, 2004), the present one documents the role of *personality* variables explaining the variability of cortisol *within* studies (for examples, see Pruessner et al., 1997 for locus of control and self-concept; Pruessner et al., 1999 for self-esteem; Jezova et al., 2004 for trait anxiety; Gaab et al., 2005 for appraisals and Takahashi et al., 2005 for interpersonal trust). The second contribution concerns the EI field. Firstly, it extends previous findings on the moderating role of trait EI in the stress response and substantiates former evidence suggesting that EI is a useful construct to measure individual differences in emotional regulation. Secondly, it sheds some light about the potential mechanisms linking emotional competencies and dispositions to health.

However, several limitations have to be acknowledged. The first one resides in the sample composition: all participants were young, healthy and non-smoking males, which raise direct concerns about the generalizability of the results to other populations (viz., females, smokers, children or older adults). The second limitation concerns the control variables. Because the present sample was composed of a priori normal individuals, we chose to control for personality traits instead of clinical conditions such as anxiety or depression. However, given their association with trait EI and their influence on HPA axis, it is important that future studies control for these variables. The third limitation lies in the fact that only one type of stressor was examined. Future investigations are needed to determine whether the increased stress resistance exhibited by high trait EI individuals holds in other contexts (e.g., chronic stressors, or uncontrollable stressors such as incurable disease). The fourth limitation pertains to the control group. In many TSST studies there is no control group. The rationale for having one was that we wanted to compare the curve under stress with the normal evolution of cortisol secretion across time. However, for reasons of simplicity (i.e., to save time), the control condition was conducted in groups rather than individually. Therefore, two differences existed between the control and the stress condition : the absence of a stressor and the presence of a group. Although future studies might want to use a purer design such that the control condition differs from the stress condition regarding only one parameter, the present setting allowed an interesting post-hoc observation. Indeed, high and low EI people differed in their anticipation of the task, but only in the stress condition. This finding suggests that the presence of a group may be particularly reassuring for low EI individuals. This is in keeping with the idea that social support may modulate cortisol response (Kirschbaum et al., 1995) but suggests that this effect may especially apply to people with poor emotion regulation skills. Future studies would certainly benefit from testing this hypothesis. The last main limitation pertains to the direction of causality. Namely, it is probable that the causality is not unidirectional (i.e., trait EI causing cortisol response) but rather bidirectional. It is indeed likely that different trait EI levels induce different neuroendocrine responses, which in turn retroacts on the level of trait EI. However, it is not easy to determine which from the personality or sensitivity of HPA axis came first. Several authors have indeed hypothesized that patterns of behaviours have their roots in the sensitivity of biological structures to environmental challenges (e.g., Eysenck and Eysenck, 1985).

Role of funding source

Funding for this study was provided by a post-doctoral fellowship grant from the Belgian Fund for Scientific Research (FNRS) accorded to the first author, and Grants FSR 2003, 2004, 2005 from the *Université catholique de Louvain* accorded to the last author.

The FNRS and the FRS had no further role in study design; in the collection, analysis and interpretation of data; in the writing of the report and in the decision to submit the paper for publication.

Conflict of interest

All five authors declare that they have no conflict of interest.

Acknowledgements

We are grateful to the persons who participated in this research, especially those assigned to the stressful condition.

Appendix A. Factor structure of the TEIQue

	High scorers perceive themselves as...	Sample items
Well-being		
Self-esteem	...successful and self-confident	I'm not able to do things as well as most people
Trait happiness	...cheerful and satisfied with their lives	I generally don't find life enjoyable (R)
Trait optimism	...confident and likely to "look on the bright side" of life	I tend to see the glass as half-empty rather than half-full (R)
Self-control		
Emotion regulation	...capable of controlling their emotions	I'm usually able to calm down quickly after I've got mad at someone
Stress management	...capable of withstanding pressure and regulating stress	Others tell me that I get stressed very easily (R)
Impulsiveness (low)	...reflective and less likely to give in to their urges	I tend to rush into things without much planning (R)
Emotional sensitivity		
Emotion perception (self and others)	...clear about their own and other people's feelings	I often find it difficult to recognize what emotion I'm feeling (R)
Emotion expression	...capable of communicating their feelings to others	Others tell me that I rarely speak about how I feel (R)
Relationship skills	...capable of having fulfilling personal relationships	Those close to me often complain that I don't treat them right (R)
Empathy	...capable of taking someone else's perspective	I often find it difficult to see things from another person's viewpoint (R)
Sociability		
Social competence	...accomplished networkers with excellent social skills	I'm generally good at social chit-chat
Emotion management (others)	...capable of influencing other people's feelings	I'm usually able to influence the way people feel
Assertiveness	...forthright, frank and willing	I am a follower, not a leader (R)

	to stand up for their rights	
Adaptability[a]	...flexible and willing to adapt to new conditions.	I don't mind frequently changing my daily routine
Self-motivation[a]	...driven and unlikely to give up in the face of adversity.	Generally, I need a lot of incentives in order to do my best (R)

[a]These subscales contribute directly to the global trait EI score.

Appendix B

Unfolding of the experimental session in stressful and neutral conditions (example for a participant arriving at the laboratory at 1400 h (= 2 pm).

From	Until	Stressful condition	Neutral condition
1400 h	1402 h	Welcome, ethical considerations, written informed consent	Idem
1402 h	1404 h	Salivette 1	Idem
1404 h	1406 h	One-minute relaxation procedure	Idem
1406 h	1416 h	Free relaxation time (e.g., reading a magazine, etc.)	Idem
1416 h	1421 h	Positive and negative mood assessment (PANAS)	Idem
1421 h	1423 h	Salivette 2	Idem
1423 h	1426 h	Instruction for the Trier Social Stress Test (job interview)	Showing of a film clip: "Lost Kingdom of the Maya" (National Geographic documentary). Pre-tested as being neutral.
1426 h	1436 h	Preparation of the job interview	
1436 h	1441 h	Job interview (TSST)	
1441 h	1444 h	Instruction+preliminary practice to the cognitive task	
1444 h	1448 h	Cognitive task	
1448 h	1450 h	Salivette 3	Idem
1450 h	1453 h	Positive and negative mood assessment (PANAS)	Idem
1453 h	1458 h	Emotional intensity, bodily sensations and action tendencies questionnaire[a]	Idem
1458 h	1500 h	Salivette 4	Idem
1500 h	1510 h	Free relaxation time (e.g., reading a magazine, etc.)	Idem
1510 h	1512 h	Salivette 5	Idem
1512 h	1521 h	Free relaxation time (e.g., reading a magazine, etc.)	Idem
1521 h	1523 h	Salivette 6	Idem
1523 h	1536 h	Free relaxation time (e.g., reading a magazine, etc.)	Idem
1536 h	1538 h	Salivette 7	Idem
1538 h	1553 h	Debriefing	Idem
1553 h	1555 h	Salivette 8	Idem

[a]Results reported in Mikolajczak et al. (2007a).

References

Aiken, L.S., West, S.G., 1991. Multiple Regression: Testing and Interpreting Interactions. Sage, London.

Austin, E.J., 2004. An investigation of the relationship between trait emotional intelligence and emotional task performance. Pers. Individ. Dif. 36, 1855–1864.

Azzarella, D., Boyajian, A. (Producers), 1997. Lost Kingdoms of the Maya [DVD]. National Geographic, United States.

Bagby, R.M., Parker, J.D.A., Taylor, G.J., 1994. The 20-item toronto-alexithymia-scale .1. Item selection and cross-validation of the factor structure. J. Psychosom. Res. 38, 23–32.

Brackett, M.A., Mayer, J.D., 2003. Convergent, discriminant, and incremental validity of competing measures of emotional intelligence. Pers. Soc. Psychol. Bull. 29, 1147–1158.

Bremner, J.D., 1999. Does stress damage the brain? Biol. Psychiatry 45, 797–805.

Chrousos, G.P., 2000. The role of stress and the hypothalamic–pituitary–adrenal axis in the pathogenesis of the metabolic syndrome: neuro-endocrine and target tissue-related causes. Int. J. Obes. 24, S50–S55.

Ciarrochi, J., Chan, A.Y.C., Bajgar, J., 2001. Measuring emotional intelligence in adolescents. Pers. Individ. Dif. 31, 1105–1119.

Ciarrochi, J., Deane, F.P., Anderson, S., 2002. Emotional intelligence moderates the relationship between stress and mental health. Pers. Individ. Dif. 32, 197–209.

Cohen, J., 1988. Statistical Power Analysis for the Behavioral Sciences. Lawrence Erlbaum Associates, Hillsdale, NJ.

Costa, P.T., McCrae, R.R., 1992. Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI) Professional Manual. Psychological Assessment Resources, Odessa, FL.

Crowne, D.P., Marlowe, D., 1960. A new scale of social desirability independent of psychopathology. J. Consult. Psychol. 24, 349–354.

Dawda, D., Hart, S.D., 2000. Assessing emotional intelligence: reliability and validity of the Bar-On Emotional Quotient Inventory (EQ-i) in university students. Pers. Individ. Dif. 28, 797–812.

de Kloet, R., Oitzl, M.S., Joëls, M., 1999. Stress and cognition: are corticosteroids good guys or bad guys? Trends Neurosci. 22, 422–426.

Dickerson, S.S., Kemeny, M.E., 2004. Acute stressors and cortisol responses: a theoretical integration and synthesis of laboratory research. Psychol. Bull. 130, 355–391.

Eysenck, H.J., Eysenck, M.W., 1985. Personality and Individual Differences: A Natural Science Approach. Plenum Press, New York.

Gaab, J., Rohleder, N., Nater, U.M., Ehlert, U., 2005. Psychological determinants of the cortisol stress response: the role of anticipatory cognitive appraisal. Psychoneuroendocrinology 30, 599–610.

Garcia de la Banda, G., Martinez-Abascal, M.A., Pastor, M., Riesco, M., Pérez, G., Doctor, R., 2004. Extraversion and neuroticism as predictors of salivary cortisol levels in public speaking. Anál. Modif. Conducta 30, 935–948.

Hunsley, J., Meyer, G.J., 2003. The incremental validity of psychological testing and assessment: conceptual, methodological, and statistical issues. Psychol. Assess. 15, 445–455.

Jezova, D., Makatsori, A., Duncko, R., Moncek, F., Jakubek, M., 2004. High trait anxiety is associated with low neuroendocrine activity during psychosocial stress. Prog. Neuropsychopharmacol. Biol. Psychiatry 28, 1331–1336.

Kirschbaum, C., Wust, S., Hellhammer, D., 1992. Consistent sex-differences in cortisol responses to psychological stress. Psychosom. Med. 54, 648–657.

Kirschbaum, C., Pirke, K.M., Hellhammer, D.H., 1993. The trier social stress test: a tool for investigating psychobiological stress responses in laboratory settings. Neuropsychobiology 28, 76–81.

Kirschbaum, C., Klauer, T., Filipp, S.H., Hellhammer, D.H., 1995. Sex-specific effects of social support on cortisol and subjective responses to acute psychological stress. Psychosom. Med. 57, 23–31.

Kudielka, B.M., Kirschbaum, C., 2005. Sex differences in HPA axis responses to stress: a review. Biol. Psychol. 69, 113–132.

Limonero, J.T., Tómas-Sábado, J., Fernández-Castro, J., 2006. Perceived emotional intelligence and its relation to tobacco and cannabis use among university students. Psicothema 18, 95–100.

Loas, G., Otmani, O., Verrier, A., Fremaux, D., Marchand, M.P., 1996. Factor analysis of the French version of the 20-item Toronto alexithymia scale (TAS-20). Psychopathology 29, 139–144.

Luminet, O., Bagby, M., Wagner, H., Taylor, G.J., Parker, J.D.A., 1999. Relation between alexithymia and the five-factor model of personality: a facet-level analysis. J. Pers. Assess. 73, 345–358.

Lumley, M.A., Stettner, L., Wehmer, F., 1996. How are alexithymia and physical illness linked? A review and critique of pathways. J. Psychosom. Res. 41, 505–518.

McCrae, R.R., Costa, P.T., 1990. Personality in Adulthood. The Guilford Press, New York.

Mikolajczak, M., 2006. The moderating effect of emotional intelligence on psychological and neuroendocrine resistance to stress. Doctoral Dissertation, Université catholique de Louvain, Louvain-la-Neuve, Belgium.

Mikolajczak, M., Luminet, O., Menil, C., 2006. Predicting resistance to stress: incremental validity of trait emotional intelligence over alexithymia and optimism. Psicothema 18, S79–S88.

Mikolajczak, M., Luminet, O., Leroy, C., Roy, E., 2007a. Psychometric properties of the trait emotional intelligence questionnaire: factor structure, reliability, construct, and incremental validity in a French-speaking population. J. Pers. Assess. 88, 338–353.

Mikolajczak, M., Menil, C., Luminet, O., 2007b. Explaining the protective effect of trait emotional intelligence regarding occupational stress: exploration of challenge/threat appraisals and emotional labour processes. J. Res. Pers. 41, 1107–1117.

Parker, J.D.A., Taylor, G.J., Bagby, R.M., 2001. The relationship between emotional intelligence and alexithymia. Pers. Individ. Dif. 30, 107–115.

Petrides, K.V., Furnham, A., 2003. Trait emotional intelligence: behavioural validation in two studies of emotion recognition and reactivity to mood induction. Eur. J. Pers. 17, 39–57.

Petrides, K.V., Niven, L., Mouskounti, T., 2006. The trait emotional intelligence of ballet dancers and musicians. Psicothema 18, S101–S107.

Petrides, K.V., Furnham, A., Mavroveli, S., 2007a. Trait emotional intelligence: moving forward in the field of EI. In: Matthews, G., Zeidner, M., Roberts, R.D. (Eds.), Emotional Intelligence: Knowns and Unknowns. Oxford University Press, Oxford.

Petrides, K.V., Pérez-González, J.C., Furnham, A., 2007b. On the criterion and incremental validity of trait emotional intelligence. Cogn. Emot. 21, 26–55.

Petrides, K.V., Pita, R., Kokkinaki, F., 2007c. The location of trait emotional intelligence in personality factor space. Br. J. Psychol. 98, 273–289.

Pruessner, J.C., Gaab, J., Hellhammer, D.H., Lintz, D., Schommer, N., Kirschbaum, C., 1997. Increasing correlations between personality traits and cortisol stress responses obtained by data aggregation. Psychoneuroendocrinology 22, 615–625.

Pruessner, J.C., Hellhammer, D.H., Kirschbaum, C., 1999. Low self-esteem, induced failure and the adrenocortical stress response. Pers. Individ. Dif. 27, 477–489.

Pruessner, J.C., Kirschbaum, C., Meinlschmid, G., Hellhammer, D.H., 2003. Two formulas for the computation of the area under the curve represent measures of total hormone concentration versus time-dependent change. Psychoneuroendocrinology 28, 916–931.

Riley, H., Schutte, N.S., 2003. Low emotional intelligence as a predictor of substance-use problems. J. Drug Educ. 33, 391–398.

Rolland, J.-P., Mogenet, J.-L., 2001. Manuel Du Système D5D, second ed. ECPA, Paris.

Saklofske, D.H., Austin, E.J., Minski, P.S., 2003. Factor structure and validity of a trait emotional intelligence measure. Pers. Individ. Dif. 34, 707–721.

Salovey, P., Stroud, L.R., Woolery, A., Epel, E.S., 2002. Perceived emotional intelligence, stress reactivity, and symptom reports: further explorations using the trait meta-mood scale. Psychol. Health 17, 611–627.

Schulkin, J., Gold, P.W., McEwen, B.S., 1998. Induction of corticotropin releasing hormone gene expression by glucocorticoïds: implication for understanding the states of fear and anxiety and allostatic load. Psychoneuroendocrinology 23, 219–243.

Schutte, N.S., Malouff, J.M., Hall, L.E., Haggerty, D.J., Cooper, J.T., Golden, C.J., et al., 1998. Development and validation of a measure of emotional intelligence. Pers. Individ. Dif. 25, 167–177.

Takahashi, T., Ikeda, K., Kitamura, N., Tsukasaki, T., Nakama, D., Kameda, T., 2005. Interpersonal trust and social stress-induced cortisol elevation. NeuroReport 16, 197–199.

Taylor, G.J., Bagby, R.M., 2000. An overview of the alexithymia construct. In: Bar-On, R., Parker, J.D.A. (Eds.), The Handbook of Emotional Intelligence: Theory, Development, Assessment, and Application at Home, School, and in the Workplace. Jossey-Bass, San Francisco, pp. 40–67.

Thurin, J.-M., Baumann, N., 2003. Stress, Pathologies et Immunite [Stress, Pathotholy and Immunity]. Flammarion, Paris.

Ursin, H., 1998. The psychology in psychoneuroendocrinology. Psychoneuroendocrinology 23, 555–570.
van der Zee, K., Thijs, M., Schakel, L., 2003. The relationship of emotional intelligence with academic intelligence and the big five. Eur. J. Pers. 16, 103–125.
Van Rooy, D.L., Viswesvaran, C., 2004. Emotional intelligence: a meta-analytic investigation of predictive validity and nomological net. J. Vocat. Behav. 65, 71–95.
Viau, V., Sharma, S., Plotsky, P.M., Meaney, M.J., 1993. Increased plasma ACTH responses to stress in nonhandled compared with handled rats require basal levels of corticosterone and are associated with increased levels of ACTH secretagogues in the median eminence. J. Neurosci. 13, 1097–1105.
Watson, D., Clark, L.A., Tellegen, A., 1988. Development and validation of brief measures of positive and negative affect-the panas scales. J. Pers. Soc. Psychol. 54, 1063–1070.