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Emotion regulation mediates the relationship between personality and sleep quality

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Objective: Despite a long history of interest in personality as well as in the mechanisms that regulate sleep, the relationship between personality and sleep is not yet well understood. The purpose of this study was to explore how personality affects sleep.

Design: The present cross-sectional study, based on a sample of 1291 participants with a mean age of 31.16 years (SD = 12.77), investigates the impact of personality styles, assessed by the Personality Adjectives Checklist (PACL), on subjective sleep quality, as well as the possible mediation of this relationship by dispositional emotion regulation (ER) styles.

Results: The dispositional use of suppression was a quite consistent predictor of poor subjective sleep quality for individuals scoring high on Confident, Cooperative or Introversion personality traits, but low on Respectful personality traits. Although a positive relationship between reappraisal and subjective sleep quality was found, there was only little evidence for a relationship between the assessed personality styles and the use of cognitive reappraisal.

Conclusion: The present results indicate that in the evaluation of subjective sleep, the impact of personality and ER processes, such as emotion suppression, should be taken into account.

Keywords: personality; emotion regulation; sleep quality

Introduction

The association between stress and sleep disturbance is rather well accepted (Morin, Rodrigue, & Ivers, 2003; Rubman et al., 1990). Daily emotionally stressful events can affect sleep physiology, sleep quality and well-being (for a review see Vandekerckhove & Cluydts, 2010). Stress exposure (e.g. watching an arousing movie) has been related to more REM-sleep and REM-sleep duration (Goodenough, Witkin, Koukla, & Cohen, 1975) and a pre-sleep emotional failure experience resulted in a significant increase in sleep fragmentation (Vandekerckhove et al., 2011). Other types of emotional stress such as the anticipation of giving a speech (Germain, Buysse, Ombao, Kupfer, & Hall, 2003) or interpersonal conflict (Brissette & Cohen, 2002) can also disrupt sleep. On the whole, affective, cognitive and behavioural factors play a key role in the precipitating and perpetuating effects of stress on sleep and sleep disturbances, such as insomnia.
Personality and sleep

Although emotional stress is an important predictor of sleep, it has been demonstrated that also person-related variables have an influence on several sleep parameters such as sleep quality (Bouyer, Deminière, Mayo, & Le Moal, 1997; Gross, 1998; Vandekerckhove et al., 2011; Weise, Ong, Tesler, Kim, & Roth, 2013). For instance, it has been shown that personality highly impacts the way one copes with stress, influencing not only daily life stress but also subsequent sleep quality.

In research on sleep and Big Five personality factors, a negative relationship between Neuroticism or emotional lability and subjective sleep quality has been previously established (Costa & McCrae, 1992; Gray & Watson, 2002; Soehner, Kennedy, & Monk, 2007). Gray and Watson (2002) collected self-report data about the relation of personality traits, sleep and academic performance. Extraversion predicted better sleep quality. Conversely, in a study by Soehner et al. (2007) no relationship was found between Extraversion and sleep.

Personality and emotion regulation

Besides the inconsistent relationship between personality and sleep, the underlying mechanisms in how personality affects sleep remain unclear as well (Guastella & Moulds, 2007; Harvey, 2005; Thomsen, Mehl, Christensen, & Zachariae, 2003; Vandekerckhove & Cluydts, 2010). A way to address this question is to examine how different personality styles tend to use different dispositional emotion regulation (ER) styles, such as reappraisal vs. suppression, in coping with daily emotional stressful events and in the perception of their sleep quality. ER refers to the capacity to influence or regulate automatically or intentionally daily stressful emotional responses, the experience and expression of emotions, as well as the times in which emotions occur (Gross, 1998). Difficulties in regulating emotions result in higher or lower emotional reactivity and are linked to many psychiatric disorders (Derryberry & Reed, 2003). In the case of insomnia, emotional reactivity is usually heightened to such an extent that it renders the individual unable to sleep (Baglioni, Spiegelhalder, Lombardo, & Riemann, 2010). Furthermore, it has been linked to stable personality dimensions such as Neuroticism and Extraversion (Derryberry & Reed, 2003). Unsurprisingly, it has been suggested that personality trait differences yield distinct ER styles: Gresham and Gullone (2012) found that higher levels of Extraversion and Openness predicted more use of cognitive reappraisal, while Neuroticism predicted the use of suppression. Lower levels of Extraversion predicted the use of suppression. However, neither John and Gross (2007) nor Donohoe (2006) found any relationship between Extraversion and the use of cognitive reappraisal. Neither did Donohoe (2006) find any relationship between Extraversion/Introversion and suppression. Thus, individuals with different personality traits differ, at least to some extent, in their dispositional ER strategies but it is not yet clear which personality traits are linked to specific ER styles.

Emotion regulation and sleep

Recent research confirmed the adaptability of reappraisal as a cognitive approach by changing the way one thinks about a potentially emotion-eliciting event (Gross, 1998; John & Gross, 2004; Ochsner et al., 2009), as opposed to suppression. Expressive
suppression is a form of response modulation that involves inhibiting ongoing emotion-expressive behaviour (Gross, 1998), e.g. one can keep a poker face while holding a great hand during a card game (Gross & John, 2003). In the present study, we focused on what is considered as one of the most adaptive vs. maladaptive strategies for regulating emotion: reappraisal in comparison with suppression. Most evidence has been shown in support of the beneficial usage of cognitive reappraisal, and denotes the application of suppression in regard to stressful, negative situations (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Eippert et al., 2007; Gross, 2002; John & Gross, 2004).

Despite a long history of interest in links between ER and psychopathology or physical disease (Hayes, Strosahl, & Wilson, 1999), the link between specific ER modes and sleep is largely unexplored and involves rather conflicting findings so far. Effective ER should facilitate well-being and is often impaired in individuals with internalising problems such as insomnia and other sleep disturbances. Research findings confirm that emotion dysregulation leads to enhanced emotional reactivity by cognitive and autonomic hyperarousal facilitating the development of insomnia (Baglioni et al., 2010). For instance, it has been found that the personality style of individuals with primary insomnia complaints was characterised more by internalising problems (e.g. depression, worry) than by externalising problems (e.g. acting out, being aggressive) (Kales, Caldwell, Preston, Healey, & Kales, 1976). Based on these findings, the theory of internalisation of conflicts was proposed (Kales et al., 1976). According to this theory, a person’s tendency to internalise problems leads to higher levels of emotional arousal. Heightened emotional arousal in turn creates physiological hyperarousal. The person then experiences sleep disruption or a longer sleep onset latency. Espie (2002), in turn, states that affect dysregulation mediates influences of cognitive and autonomic hyperarousal on sleep (Baglioni et al., 2010, p. 228). After a bad night of sleep, an individual may experience daytime insomnia symptoms, such as fatigue, daytime sleepiness, irritability and a lack of energy to fulfil daytime activities (American Academy of Sleep Medicine [AASM], 2014).

Along the same line, cognitive control by suppression, worry, rumination and imagery control has been confirmed to be associated with sleep disturbance in studies investigating dispositional as well as instructed ER (Schmidt, Harvey, & Van der Linden, 2011). A study from our own research group (Vandekerckhove et al., 2012) compared the effects of the use of an experiential ER in comparison to a cognitive analytical approach. A cognitive analytical approach is defined by the cognitive analysis of the causes, meanings and implications of the situation for one’s own self while focusing on thoughts instead of their feelings. The adoption of an experiential approach, defined by the acknowledging and expression of affective experience, resulted in better sleep quality expressed in terms of higher sleep efficiency and less sleep fragmentation (Vandekerckhove et al., 2012). However, other cognitive strategies such as reappraisal have to be distinguished from the cognitive analytical strategy, as subjects have to reappraise the meaning of the stressful event in order to feel better. In line with the adaptive effect of cognitive reappraisal on the modulation of emotional responses (Gross, 1998; McRae et al., 2012) and on the neural level (Kim & Hamann, 2007; Schaefer et al., 2002; Ochsner et al., 2004), we assumed that this positive effect would also extend into sleep.

In conclusion, personality styles and ER strategies appear to have both positive and negative effects on sleep (cf. supra, Gray & Watson, 2002; Soehner et al., 2007;
Vandekerckhove et al., 2012). Despite these independent lines of research on personality traits and ER styles, and between ER and sleep quality, no clear evidence exists about the intermixed effects of personality styles and ER on sleep.

**Objective**

In the present study, we investigated the assumptions that (1) individuals with personality styles characterised by a predisposition to use reappraisal would experience a better sleep quality, and (2) that the tendency to use suppression would correlate negatively with subjective sleep quality, especially if this tendency is linked to personality styles characterised by negative emotions or insecurity. Thus, we propose that sleep is affected by personality through the effects of ER. As such, we will investigate the role of suppression and reappraisal as mediators in the relationship between personality styles and subjective sleep quality. Theoretically, we refer to personality styles based on the personality model of Millon (Millon, 1969, 1983), as they are assessed by the Personality Adjectives Checklist (PACL; Rossi, Sloore, & Strack, 2006; Strack, 1987). In Table 1, these personality styles are described according to the Personal Adjective Checklist and according to current evidence. Their hypothesised dispositional ER styles are also presented. The Personal Adjective Checklist assesses personality styles in a dimensional way.

As can be inferred from the descriptions of the personality styles and evidence linking individual insecurity and emotional problems (Denollet, 2005; Hsieh & Stright,

<table>
<thead>
<tr>
<th>Personality style (PACL)</th>
<th>Core Personality traits</th>
<th>Emotion Regulation style</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forceful</td>
<td>Strong-willed, ambitious, competitive and self-determined, assertive, dominant and in some cases also hostile, sensitive to criticism and rejection (Strack, 1987). Appearance: confident, but often covering feelings of personal inadequacy</td>
<td>↑ Suppression</td>
</tr>
<tr>
<td>Confident</td>
<td>Like to take control but in an empathic manner, a lack of confidence and a large need for social approval and admiration by keeping up secure appearances (Strack, 1987)</td>
<td>↑ Suppression</td>
</tr>
<tr>
<td>Cooperative</td>
<td>Cooperative, high need for social approval, appeasing, unassertive (Strack, 1987)</td>
<td>/</td>
</tr>
<tr>
<td>Respectful</td>
<td>Responsible, persistent in goal-directed efforts industrious, often considered by others as perfectionistic, inflexible and formal (Strack, 1987)</td>
<td>↓ Suppression</td>
</tr>
<tr>
<td>Sensitive</td>
<td>Unconventional, uncertain, moody, spontaneous, creative (Strack, 1987)</td>
<td>/</td>
</tr>
<tr>
<td>Introverted</td>
<td>Sensitive, aloof, show a tendency towards social withdrawal (Strack, 1987)</td>
<td>↑ Suppression</td>
</tr>
<tr>
<td>Inhibited</td>
<td>Tendency to isolate themselves based on their sensitivity to their own and others’ feelings, especially on fear of negative (interpersonal) consequences (Strack, 1987)</td>
<td>↑ Suppression (Sher, 2005).</td>
</tr>
<tr>
<td>Sociable</td>
<td>Sociable, extraverted, spontaneous, (Strack, 1987)</td>
<td>/</td>
</tr>
</tbody>
</table>

Notes: ‘↑ suppression’, ‘↓ suppression’ denote a dispositional tendency to use an emotion regulation style or coping style respectively more vs. less.
we hypothesise that the higher individuals score on personality characteristics that relate to individual insecurity and enhanced social sensitivity, the more they are prone to emotion dysregulation, leading to decreased subjective sleep quality. We propose that suppression explains this presumed relationship between personality characteristics and subjective sleep quality. As described in Table 1, the use of suppression is likely to be found in individuals with Forceful, Confident, Introversive and Inhibited personality characteristics. Since individuals with Forceful as well as Confident personality characteristics strive to show a secure appearance (Strack, 1987), we postulated that this might motivate them to suppress their emotions in many situations. Individuals who show more Inhibited personality characteristics, as well as Introversive personalities, probably feel self-conscious and uncertain in social situations and thus probably suppress their emotions frequently (Gresham & Gullone, 2012; Strack, 1987). Our focus was directed to these four personality styles since this pattern of negative affectivity/insecurity and suppression is supposed to yield important implications for an individual’s subjective sleep quality.

Furthermore, Neuroticism has been related to poor sleep quality (cf. supra) as well as difficulties in regulating emotions (Kokkonen & Pulkkinen, 2001) and unsuccessful coping attempts (Dyne, 2010). As the constructs of the Sensitive personality style and Neuroticism share several personality traits (Strack & Lorr, 1990), individuals who obtain high scores on characteristics of a Sensitive personality style are expected to be less effective at regulating their emotions. Despite the observation that individuals who score high on Sensitive characteristics are probably more sensitive to stress (Sher, 2005; Smith & Zautra, 2002), which might enhance the need to regulate, there is no compelling evidence yet that they would regulate their emotions consistently in a specific way. We did not have indications to predict a particular relationship between individuals with Cooperative, Respectful or Sociable personality styles and subjective sleep quality.

Design
Subjects
Participants were recruited via mailing lists of the electronic communication platform of the Vrije Universiteit Brussel and via flyers. Individuals who took neuropharmacological treatments (other than sleep medication), as well as individuals younger than 18 years old or older than 65 years old were excluded from the sample. As such, from a total sample of 1,384 Dutch speaking individuals, 1,291 individuals were selected to constitute the final sample. Our final sample contains 330 men (25.70%) and 953 women (74.30%), with a mean age of 31.16 year (SD = 12.77). In Table 2, health-related information about our sample is presented.

Main outcome measures
The online survey consisted of two parts. Part one of the survey consisted of demographic and health-related questions (see Table 2), part two of previously validated psychological questionnaires, as described below.

In the present study, we used the following previously published questionnaires.

The Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) was designed to assess individual differences in the dispositional use of two ER strategies: cognitive
reappraisal and expressive suppression. Factor analyses gave evidence for two factors (i.e. cognitive reappraisal and expressive suppression; Gross & John, 2003). The ERQ consists of 10 items that are rated on a seven-point scale. Examples of items are ‘I control my emotions by not expressing them’ (expressive suppression) and ‘I control my emotions by changing the way I think about the situation I’m in’ (cognitive reappraisal). Results indicated adequate internal consistencies for cognitive reappraisal and expressive suppression, respectively (α = .85; α = .81).

The Personality Adjectives Checklist (PACL; Rossi et al., 2006; Strack, 1987) consists of 153 items and was conceived as a tool to measure and study Millon’s eight personality styles in normal form: Introversive, Inhibited, Cooperative, Sociable, Confident, Forceful, Respectful and Sensitive personality styles. Because the PACL measures theoretically derived, normal versions of personality disorders found in DSM-IV and DSM-V, even extreme scale elevations should not necessarily be interpreted as indicators of a personality disorder. In the PACL, individuals have to tick every item that applies to them and individuals will thus differ in the total amount of items ticked (Strack, 1987). Possible threats for test validity were controlled for by taking the number of items checked into account. Mean internal consistency (α) for all eight scales was .61.

The Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) is a 19-item self-report questionnaire consisting of seven scales. The scales assess sleep onset latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medication, daytime dysfunctioning and sleep quality. The subscale daytime dysfunctioning assesses the extent to which an individual experiences trouble staying awake in several situations (i.e. sleepiness) and keeping up enthusiasm to fulfil daytime activities. The scales were summed up to yield a global PSQI score. A cut-off score of 5 is used, with higher scores indicating worse sleep quality. Internal consistency (α) for its seven components was on average .82. In this study, we focused on the global PSQI score. The subscales were analysed as well and the results can be found in the supplemental materials section (Table 5).

**Table 2. Health-related information.**

<table>
<thead>
<tr>
<th>Health-related factors</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physician visits/year</td>
<td>3.04</td>
<td>4.67</td>
</tr>
<tr>
<td>Sleep (hours/night)</td>
<td>7.53</td>
<td>1.14</td>
</tr>
<tr>
<td>Sleep quality (PSQI; Buysse et al., 1989)</td>
<td>5.07</td>
<td>2.88</td>
</tr>
<tr>
<td>Smoking (cigarettes/day)</td>
<td>1.39</td>
<td>4.52</td>
</tr>
<tr>
<td>Caffeine intake (cups/day)</td>
<td>2.08</td>
<td>2.41</td>
</tr>
<tr>
<td>Alcohol intake (units/week)</td>
<td>3.48</td>
<td>4.96</td>
</tr>
<tr>
<td>BMI</td>
<td>23.14</td>
<td>4.00</td>
</tr>
</tbody>
</table>

**Analysis**

Before conducting mediation analyses, variables were checked for multicollinearity, were Z-transformed and the specific type of the mediator model was determined. After evaluating the effects of potential confounding variables, we inspected correlations between (1) personality style and sleep, (2) personality style and ER and (3) ER and sleep. Finally, we conducted mediation analyses to obtain the indirect effects of personality style on subjective sleep (i.e. mediation effects).
Multicollinearity
Multicollinearity analysis resulted all in VIF < 1.70, which means that no multicollinearity problems existed in the analysed model (Kutner, Nachtsheim, & Neter, 2004).

Mediation model and method
Further, we found a significant correlation between reappraisal and suppression \( (r = .15, \ p < .001) \). Based on the idea of coactive ER and preceding results from coping research (Brans, Koval, Verduyn, Lim, & Kuppens, 2013; Folkman & Moskowitz, 2004), we can conclude that people use multiple ER strategies concurrently. As a consequence, it is useful to consider a model with multiple mediators. The relationship between personality, ER and sleep was then studied using ‘INDIRECT’, an SPSS-macro that uses ordinary least squares regression analyses (Preacher & Hayes, 2008). The module uses indirect models, in which multiple mediation models are estimated. Indirect effects of an independent variable on the dependent variable are estimated using bootstrapping (Preacher & Hayes, 2008). SPSS version 19 (IBM SPSS Version 19.0, 2010) was used.

Results
Control variables
Preliminary analyses were performed to evaluate the effects of potential confounding variables (see Table 2 for \( M \) and \( SDs \)). Significant or at least marginally significant relationships were found for number of physician visits per year \( (p < .05) \), age \( (p < .10) \) and gender \( (p < .10) \). The effects of caffeine intake, amount of cigarettes per day, BMI and alcohol intake did not reach statistical significance, and were excluded from the model. We therefore controlled for gender \( (0 = \text{male}, \ 1 = \text{female}) \), age and general practitioner visits during the last year (as a proxy for physical health status).

Correlations between personality, emotion regulation and sleep
The associations between personality style, ER and sleep quality were estimated, controlling for gender, age and general practitioner visits during the last year. Globally, scores on the Respectful personality scale and the Sensitive personality scale were negatively related to the global PSQI-score \( (r = -.09, \ p < .01 \text{ in both cases}) \), thus indicating better subjective sleep quality given the fact that higher PSQI-scores indicate worse sleep quality (Table 3). Taking a closer look at personality and ER, positive relationships were found between the Forceful personality style, the Confident personality style, the Cooperative personality style and the Introversive personality style and suppression \( (r = .07, \ p < .05; \ r = .10, \ p < .01; \ r = .09, \ p < .01; \ r = .09, \ p < .01, \text{ respectively}) \). Scoring high on Respectful personality traits correlated negatively with the dispositional use of suppression \( (r = -.08, \ p < .05) \). A positive correlation was found between the Sensitive personality style and the dispositional use of cognitive reappraisal \( (r = .10, \ p < .01) \). Inspection of possible relationships between ER and sleep revealed a negative relationship between suppression and subjective sleep quality \( (r = .13, \ p < .01) \), and a positive relationship between reappraisal and subjective sleep quality \( (r = -.07, \ p < .01) \). A correlation matrix with regard to personality, emotion regulation and the PSQI-subscales can be found in the supplemental materials section (Table 5).
Table 3. Correlations between personality style, emotion regulation and subjective sleep quality ($N = 1001$).

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forceful</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confident</td>
<td>.39**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperative</td>
<td>.11**</td>
<td>.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respectful</td>
<td>.08*</td>
<td>.04</td>
<td>.31**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitive</td>
<td>.19**</td>
<td>-.03</td>
<td>.03</td>
<td>.17**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introversive</td>
<td>.04**</td>
<td>.05</td>
<td>-.01</td>
<td>-.02**</td>
<td>.07*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inhibited</td>
<td>-.04</td>
<td>-.01</td>
<td>.15**</td>
<td>.03</td>
<td>.36**</td>
<td>.20**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sociable</td>
<td>.11**</td>
<td>.21**</td>
<td>.13**</td>
<td>.16**</td>
<td>.07*</td>
<td>-.06**</td>
<td>.07*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reappraisal</td>
<td>.00</td>
<td>-.02</td>
<td>-.06</td>
<td>.01</td>
<td>.1**</td>
<td>.01**</td>
<td>.02</td>
<td>.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suppression</td>
<td>.07*</td>
<td>.1**</td>
<td>.09**</td>
<td>-.08*</td>
<td>-.03</td>
<td>.09**</td>
<td>.02</td>
<td>-.02</td>
<td>.15**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep Quality</td>
<td>.05</td>
<td>.04</td>
<td>.02</td>
<td>-.09**</td>
<td>-.09**</td>
<td>.01**</td>
<td>-.04</td>
<td>-.05</td>
<td>-.07*</td>
<td>.13**</td>
<td></td>
</tr>
</tbody>
</table>

Note: Correlations are partial correlations, controlling for gender, age and general practitioner visits during the last year. Significance level:
*Correlation is significant at .05 level (two-tailed).
**Correlation is significant at .01 level (two-tailed).
Mediation analyses

Mediation occurs when a predictor (personality) affects a dependent variable (e.g. sleep quality) indirectly through at least one intervening variable (the mediator; Preacher & Hayes, 2008). The indirect effects of personality on subjective sleep quality were bootstrapped using 5000 samples. Ninety-five per cent bias-corrected confidence intervals for all indirect effects and contrasts were generated.

Specific indirect effects of suppression and reappraisal: global sleep quality

The specific indirect effects of the Confident, the Cooperative, the Respectful and the Introverted personality style on the subjective sleep quality score were $a_2b_2 = .02$, $a_2b_2 = .01$, $a_2b_2 = -.02$ and $a_2b_2 = .02$, respectively (mediation through suppression). Reappraisal did not function as a mediator in neither of the personality – sleep quality relationships. These results can be found in Table 4. Results of the subscales of the PSQI are not shown here but are available in the online supplemental materials (see Table 6a, 6b for subscale results).

Table 4. Indirect effects of reappraisal and suppression in the prediction of subjective sleep quality ($N = 1001$).

<table>
<thead>
<tr>
<th>Personality Style</th>
<th>Mediator</th>
<th>Point Estimate ($a*b$)</th>
<th>Bootstrapping BC 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forceful</td>
<td>Reappraisal</td>
<td>.00</td>
<td>[-.01, .01]</td>
</tr>
<tr>
<td></td>
<td>Suppression</td>
<td>.02</td>
<td>[.00, .04]</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>.02</td>
<td>[.00, .04]</td>
</tr>
<tr>
<td>Confident</td>
<td>Reappraisal</td>
<td>.00</td>
<td>[-.01, .01]</td>
</tr>
<tr>
<td></td>
<td>Suppression</td>
<td>.02</td>
<td>[.01, .04]</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>.02</td>
<td>[.01, .04]</td>
</tr>
<tr>
<td>Cooperative</td>
<td>Reappraisal</td>
<td>.01</td>
<td>[.00, .02]</td>
</tr>
<tr>
<td></td>
<td>Suppression</td>
<td>.01</td>
<td>[.01, .03]</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>.02</td>
<td>[.01, .03]</td>
</tr>
<tr>
<td>Respectful</td>
<td>Reappraisal</td>
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<td>[-.02, .01]</td>
</tr>
<tr>
<td></td>
<td>Suppression</td>
<td>-.02</td>
<td>[-.04, -.01]</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>-.02</td>
<td>[-.05, -.01]</td>
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<tr>
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<td>Reappraisal</td>
<td>-.01</td>
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</tr>
<tr>
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</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>-.01</td>
<td>[-.02, .00]</td>
</tr>
<tr>
<td>Introverted</td>
<td>Reappraisal</td>
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<td>[.00, .02]</td>
</tr>
<tr>
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<td>Suppression</td>
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<td>[.01, .05]</td>
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<tr>
<td></td>
<td>TOTAL</td>
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<td>[.01, .06]</td>
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<tr>
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<td>Reappraisal</td>
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<td></td>
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<tr>
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<tr>
<td></td>
<td>TOTAL</td>
<td>-.01</td>
<td>[-.04, .01]</td>
</tr>
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Note: 95% Bias-corrected intervals. Confidence intervals that do not contain zero are depicted in bold.
Conclusions

The influence of personality and ER styles, more specifically reappraisal and suppression, on sleep has, to our knowledge, never been reported before. The present study has shown that specific types of ER and personality styles affect subjective sleep quality. Our results confirm the maladaptive role of suppression as ER strategy on sleep, resulting in poorer subjective sleep quality. The role of reappraisal is less clear. Although general relationships between reappraisal and subjective sleep quality are positive, reappraisal could not explain the relationship between personality styles and subjective sleep quality, an issue we will further discuss.

Forceful, confident, introversive and inhibited personality styles, emotion regulation and sleep

Our hypotheses about the link between certain personality styles (i.e. Forceful, Confident, Introversive and Inhibited), ER and subjective sleep quality were only partially confirmed. Since individuals with Forceful as well as Confident personality characteristics strive to show a secure appearance (Strack, 1987), we postulated that this might motivate them to suppress their emotions in many situations, leading to a poorer sleep quality. Unexpectedly, no relationship between the Forceful personality style and sleep quality (based on our correlation analysis) was found, although a Forceful personality style was associated with the dispositional use of suppression. There is no reason to suspect that expressive suppression effectively decreases (negative) emotional experiences in these individuals. However, other dispositional characteristics such as emotional sensitivity or other coping and ER strategies may interfere with the effect of suppression on emotional experience and subsequently, on sleep quality. However, this issue should be investigated in further research. For individuals who scored higher on Confident personality characteristics, ER did influence sleep quality. They tend to use more suppression as ER style, which in turn leads to a poorer subjective sleep quality.

As stated above, we postulated that individuals with high Introversive personality characteristics, but also Inhibited personalities, are more self-conscious and uncertain in social situations and thus probably suppress their emotions frequently, influencing sleep quality. In line with our expectations and with findings of John and Gross (2007) and Gresham and Gullone (2012), scoring high on Introversive personality traits leads to a tendency to use suppression, which in turn influences sleep quality.

In contrast to our hypothesis, no significant relationship between the Inhibited personality style and suppression nor subjective sleep quality was found. This result is remarkable since individuals scoring high on Inhibited personality traits tend to isolate themselves from others because of interpersonal anxiety and are thus expected to show inhibited self-expression in social interactions (Denollet et al., 2006; Strack, 1987). Possibly, inhibited personality traits on their own do not cause sleep problems in isolation but e.g. in association with Introversive or Sensitive personality traits. Both Introversive, Sensitive and Inhibited personality traits are central in the concept of personality Type D, characterised by a negative affectivity-social inhibition synergy (Howard & Hughes, 2012) and known to cause negative health effects such as heightened cardiac output at rest.
Cooperative, respectful, sensitive and sociable personality styles, emotion regulation and sleep

Suppression mediated the relationship between the Cooperative personality style and sleep quality, leading to a poorer sleep quality. As stated in Table 1, individuals with higher scores on Cooperative traits strive to live in accordance with the desires of others (Strack, 1987, p. 9), denying their own needs. Our findings point to the fact that this pattern displays itself in their tendency to use emotional suppression resulting in a worse sleep quality (Schmidt et al., 2011). Apparently, the more individuals possess Cooperative personality traits, the more they use top-down control such as suppression of their emotional stress which in turn interferes with their sleep quality. By contrast, the higher an individual scored on the Respectful personality scale, the less he or she uses suppression, protecting sleep quality. Apparently, conscientiousness, which characterises the Respectful personality style (Strack & Lorr, 1990), has been found to correlate negatively with suppression (Gresham & Gullone, 2012; Gross & John, 2003; Hasking et al., 2010). An explanation for this negative correlation may be that individuals with respectful/conscientious personality traits are often persistent in goal-directed efforts (see Table 1), actively challenging stressful situations in a problem-focused way (e.g. by means of task-oriented coping), rather than suppressing them (Thoresen, 2001). However, this question has to be addressed in further research. As there was no direct evidence nor a convincing theoretical ground to expect that individuals scoring higher on Sensitive personality traits would regulate their emotions consistently in a specific way, we did not make predictions about a relationship between this personality style, ER and sleep. However, individuals scoring higher on Sensitive personality traits reported a better subjective sleep quality which could not be explained by their tendency to use reappraisal. In line with our prediction, no relationships between a Sociable personality style, ER and subjective sleep were detected. There was no reason to suspect a particular relationship between sociability and the assessed ER styles.

We can conclude that the dispositional use of suppression, in personalities scoring high on Confident, Cooperative or Introverte personality traits, but low on Respectful personality traits, was a quite consistent predictor of poor subjective sleep quality. In contrast, the dispositional use of reappraisal was only observed in the Sensitive personality but could not explain the relationship between this personality style and subjective sleep quality. Since we have no indications to doubt about the representability of our sample, another explanation is offered with regard to the lack of correlations between reappraisal and the assessed personality styles. First, the personality styles consist of a whole range of traits, some of which may relate to reappraisal, while others may not. For example, as stated in our introduction, higher levels of Extraversion and Openness predicted more use of cognitive reappraisal. Second, each individual has a unique score on each of the personality scales and individuals will thus be characterised by a combination of traits or styles. One might, for example, score high on the Sociable personality scale as well as on the Sensitive personality scale and so on. The current results confirm the role of ER, as an important modulator of sleep quality: individuals tending to use maladaptive ER modes report a poorer sleep quality.

Still, since strategies of ER could only partially explain the relationship between personality style and sleep, this points to the relevance of taking into account other personality variables such as arousability and the dispositional tendency to experience
various negative and positive emotions, but also sleeping habits or circadian preferences. Suppression, for instance, usually leads to higher arousal and more negative affect (e.g. Campbell-Sills & Barlow, 2007; Gross, 1998) but since objective arousal was not measured here we can only speculate that pre-sleep arousal played a role in the link between suppression and subjective sleep quality. For future research, it seems important to investigate specific direct contributions of negative affect and initial reactivity from arousal and negative affect due to the use of suppression.

Despite its strength, the design of this cross-sectional study implies some limitations. First, our study was based on self-report data. Experimental research with inclusion of polysomnography (PSG) along with a longitudinal design could be more appropriate way to study not only the impact of actual arousability and the tendency of the above-mentioned personality styles to experience positive and negative affects, but also how it is regulated. However, PSG studies of the current sample-size magnitude are rarely found in the literature due to limited practical feasibility. Moreover, it has previously been mentioned that classical PSG variables may not be able to express potential underlying disturbances involved in the non-recovering sensations of reported poor sleep quality (Mairesse & Neu, 2016; Neu et al., 2007).

Also, in order to understand these complex relations between ER, personality and sleep evidentially, there is a need to (1) extend the scope of the study by including other coping or ER styles such as an emotional approach, distraction, rumination, task-oriented coping and so forth (Koole, 2009; Vandekerckhove et al., 2012), (2) approach the study object using experience-sampling methods to accurately assess subjective daily experiences of sleep quality, stress responses and ER. Experience sampling methods can be more appropriate to detect time- and context-sensitive changes in the use of several ER modes.

To conclude, despite these limitations, this study demonstrates the importance of taking personality styles into account while evaluating the impact and adaptiveness of several ER modes on sleep. With regard to current inconclusive findings about suppression in the literature, it especially confirms the maladaptive role of suppression playing a mediating role in quality of sleep. These findings on personality, ER and sleep are in their own right highly important in the clinical prevention and treatment of the onset of sleep disturbances and even insomnia. For instance, our results highlight the importance of taking emotional experience and expression into account in the prevention and treatment of sleep problems. Nowadays, cognitive behavioural therapy (which focuses in the first instance at changing maladaptive thoughts about sleep) is mostly applied. Although the positive effects of this treatment are recognised (e.g. Morin et al., 2006), the current findings indicate that it could be interesting to complement treatments focused on cognitive change with strategies focusing on emotion and emotion expression or to invest in treatments for sleep which are rather based on encouraging the acceptance of unaltered, present affective experience, as is the case, for instance, in Acceptance and Commitment Therapy and Dialectical Behavior Therapy (Hayes et al., 1999).

**Disclosure statement**

No potential conflict of interest was reported by the authors.
Supplemental data

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