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# **Altered perception of facially expressed tiredness in insomnia**

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**Abstract:**

The present study compared normal and poor-sleepers in their ratings for the expression intensity of tiredness and alertness whilst observing tired and neutral faces. Fifty-six normal-sleepers and 58 individuals with insomnia symptoms observed 98 facial photographs (49 neutral; 49 tired). Using a visual analogue scale, participants were required to rate the extent to which each face appeared as tired and alert. Tired faces were created by manipulating neutral photographs to include previously identified facial tiredness cues. All participants rated sleep-related faces as more tired and less alert relative to neutral photographs. A significant group x face x rating interaction demonstrated that, compared to normal-sleepers, the insomnia symptoms group showed lower ratings for the expression of tiredness, but not alertness, whilst observing the tired faces. The findings suggest that the presence of insomnia symptoms is associated with reduced ratings of expression intensity for sleep-related facial photographs displaying tiredness. These outcomes add to the body of literature on how facial cues of tiredness are perceived by those with insomnia symptoms. Further work is required to elucidate the mechanisms underlying the relationship between insomnia symptoms and reduced perceptions of facially expressed tiredness.

**Keywords:**

Insomnia, Tiredness, Faces, Face perception, Sleep

## **Introduction:**

Symptoms of insomnia including difficulty and/or maintaining sleep, early morning awakenings with an inability to return to sleep, and impaired daytime functioning are highly prevalent affecting 30% of the general population (American Academy of Sleep Medicine, 2005; Espie, Kyle, Hames, Cyhlarova, & Benzeval, 2012; Morin, LeBlanc, Daley, Gregoire, & Merette, 2006). Whereas at disorder level, insomnia affects approximately 10% of the population (Morin et al., 2006). Individuals with insomnia often report problems with emotion regulation and impaired social interactions (Baglioni, Spiegelhalder, Lombardo, & Riemann, 2010; Espie et al., 2012), and recent research concurs that insomnia is associated with a blunted response to emotional facial stimuli depicting fear, sadness and happiness (Cronlein, Langguth, & Busch, 2016; Kyle, Beattie, Spiegelhalder, Rogers, & Espie, 2014). The ability to accurately gauge facial expressions is vital for social interaction and influencing social judgments (e.g. perceived health and attractiveness). As such, these outcomes highlight potential negative psychosocial implications which may result from persistent poor sleep. Despite this, limited research to date has examined how individuals with insomnia perceive faces.

Tiredness is one of the most commonly reported symptoms amongst individuals with insomnia (Balter & Uhlenhuth, 1991). Considering the salience of this specific symptom, a series of studies examined how individuals with insomnia perceive facial cues of tiredness from the perspective of self and social perception (Akram, Ellis, Myachykov, & Barclay, 2016a, 2016b, 2017). Using a visual task where participants indicated when a continuously morphing image of their face, varying in degrees of tiredness and alertness, represented their current level of tiredness, the authors demonstrated that individuals with insomnia displayed an interpretive bias: they misperceived their own face as appearing more tired than they physically were (Akram et al., 2016a). This bias, however, did not extend to the perception of other people's faces, which were, contrastingly, more accurately perceived (Akram et al., 2016b). Moreover, when asked to explore and examine their own and other people's faces, a follow-up study determined that people with insomnia were quicker to direct initial attention to and maintain overall attention towards the eye region (Akram et al., 2017), an area of the face which is known to be associated with tiredness (Knoll, Attkiss, & Persing, 2008; Nguyen, Isaacowitz, & Rubin, 2009; Sundelin et al., 2013). Thus, whilst individuals with insomnia display an equivalent level of attention towards both their own and other people's facial features relating to tiredness, only their own facial attributes of tiredness are interpreted in a manner consistent with the physical presence of a sleep disturbance.

To further examine how people with insomnia perceive the facial expression of tiredness whilst observing other people, this exploratory study aimed to determine whether increased insomnia symptoms were related to reduced ratings of expression intensity for novel faces depicting a tired facial expression. Specifically, we compared normal sleepers and those displaying insomnia symptoms in their ratings for the expression intensity of tiredness and alertness whilst observing tired and neutral faces. Individuals with insomnia have been shown to experience a blunted response to emotional facial stimuli (Cronlein et al., 2016; Kyle et al., 2014) and interpret faces of others as appearing less tired compared to self (Akram et al.,

2016b). As such, we hypothesized that individuals displaying insomnia symptoms would show lower ratings of expression intensity for tired faces relative to normal sleepers.

## **Methods:**

### Participants

114 people completed an online survey after responding to an advertisement for a face rating study via email and social media. Participants were stratified into normal sleepers (n=56; 26.95±9.32yrs, 68% female) determined as scoring below 8 on the Insomnia Severity Index (ISI: Bastien, Vallieres, & Morin, 2001) (3.73±2.12), and insomnia symptoms (n=58; 26.19±9.16yrs, 86% female) determined as scoring 8 or more on the ISI (13.14±3.94). A score of 8 or more on the ISI is suggestive of subthreshold insomnia. The insomnia symptoms group scored significantly higher on the ISI (13.14±3.94) relative to normal sleepers (3.73±2.12;  $t(112)=-15.81$ ,  $P=.001$ ), however did not differ in age (Insomnia: 26.19±9.16 years, Normal sleepers: 26.95±9.32 years;  $t(112)=0.44$ ,  $P=.66$ ).

### Materials

#### *Insomnia Severity Index*

Insomnia symptoms were assessed using The Insomnia Severity Index. The ISI consists of 7 items examining the severity of insomnia symptoms over the past two weeks including difficulty initiating and maintaining sleep, and awakening too early. Items are scored on a 5-point likert scale, with total scores ranging from 0–28. Higher scores suggest greater insomnia severity. Assessment of internal consistency yielded a Cronbach's alpha of .87.

#### *Facial Stimuli*

Forty-nine facial photographs displaying a neutral expression were taken from the Karolinska Directed Emotional Faces database (Lundqvist, Flykt, & Ohman, 1998). For the present study, we cropped the hair and neckline from each neutral image, leaving a series of oval shaped neutral facial images (see Figure 1).

To create the corresponding tired face pairs, each neutral face was subject to standardized manipulations of: increased pretarsal skin show; upper eyelid depression; dark circles under eyes; and drooped corners of the mouth. These specific manipulations have previously been associated with an increased perception of tiredness (Akram et al., 2016a; Sundelin et al., 2013). Each manipulation was carried out using imaging software, analogous to the methods used by Akram and colleagues (2016a). Specifically, the upper eyelid was edited by calculating in mm from top to bottom the degree to which each eye was open from its center. Manipulations were subsequently produced based upon a percentage decrease (37.5%) of this height. Likewise, pretarsal show size was also calculated in mm, and manipulations were produced based upon a percentage increase (75%) of this height. The height of dark circles under the eyes were also calculated in mm, and manipulations were produced based upon a percentage increase (50%) of this height. Finally, the corner of each mouth was drooped down by 1mm.

This resulted in a final facial stimuli set comprised of 98 images: 49 face pairs consisting of the same face displaying a manipulated tired and original neutral expression. Paired samples t-tests confirmed that for each individual face pair, the tired face was rated as appearing significantly more tired and less alert relative to the corresponding neutral face (all P's <.05). See Figure 1 for an example face pair.

### **INSERT FIGURE 1 HERE**

#### **Procedure**

All participants provided informed consent prior to participation. Ethical approval was granted by the Faculty of Health and Life Sciences Ethics Committee at Northumbria University, UK. Participants completed an online questionnaire, in which they were presented with the series of 98 images in randomized order. For each image, participants were asked to quantify on a 100mm visual analogue scale the extent to which each face appeared as tired or alert. Higher scores represented a greater presence of the specified expression. Following facial expression ratings, participants completed the ISI. Once complete, participants were debriefed about the nature of the study.

#### **Statistical Analyses**

Mean ratings of expression intensity were calculated for both neutral and sleep-related faces. A 2 (group: insomnia symptoms vs. normal sleepers) x 2 (face: neutral vs. tired) x 2 (rating: tired vs. alert) mixed measures ANOVA analyses were employed, with expression intensity rating as the dependent variable. This was conducted to assess the main effects of group, face and rating. The group x face x rating, group x face, group x rating, face x rating interactions were also assessed. Significance was considered at the  $P < .05$  level.

#### **Results:**

Mean scores of expression intensity rating for each group are displayed in Table 1. The results revealed a significant main effect of face on expression intensity ratings,  $F(1,112)=70.91, P=.001$ . Moreover, a significant face x rating interaction confirmed that, as expected, regardless of group, all participants rated sleep-related faces as more tired and less alert relative to neutral photographs,  $F(1,112)=447.75, P=.001$ .

### **INSERT TABLE 1 HERE**

A significant group x face x rating interaction demonstrated that, compared to normal-sleepers ( $63.80 \pm 13.04$ ), the insomnia symptoms group ( $56.61 \pm 14.39$ ) showed lower ratings for the expression of tiredness, but not alertness (NS:  $34.69 \pm 14.91$ ; PS:  $37.09 \pm 12.23$ ), whilst observing the sleep-related faces,  $F(1,112)=8.03, P=.005$ . These results suggest that whilst observing tired faces, individuals displaying insomnia symptoms show attenuated processing of the corresponding expression of tiredness. No main effects of group ( $F(1,112)=2.81, P=.09$ ), rating ( $F(1,112)=1.52, P=.22$ ), or group x face ( $F(1,224)=0.12, P=.73$ ) or group x rating ( $F(1,224)=1.23, P=.27$ ) interactions were determined.

## **Discussion:**

The present study aimed to determine whether increased insomnia symptoms were related to reduced ratings of expression intensity for faces depicting a tired facial expression. As expected, our results demonstrated that whilst observing novel tired faces, individuals with insomnia symptoms show a blunted perception of tiredness relative to normal sleepers.

People with insomnia selectively attend to facial cues known to be associated with tiredness whilst observing their own and other people's faces (Akram et al., 2017), and this attention could extend to facial manipulations that function to characterize tiredness. Heightened attention for tiredness cues in insomnia may subsequently influence the interpretation of these cues. With that in mind, this population interprets only their own facial attributes of tiredness in a manner consistent with the presence of a physical sleep deficit (Akram et al., 2016b). As individuals with insomnia possibly attend to other people's facial attributes of tiredness to evaluate these features and draw negative comparisons to their own (Akram et al., 2017), the current outcomes may be indicative of an interpretive bias in that other people are considered to appear less tired. Traditionally, a sleep-related interpretive bias would present itself in a manner consistent with insomnia symptoms. In this case, tired faces would be judged by increased ratings of expression intensity. However, it may be hypothesized that an evaluation process occurs whereby people with insomnia first determine the salience of the stimulus, which then influences the orientation of the subsequent interpretation. The face is used in social perception to portray one's internal state to others (Allison, Puce, & McCarthy, 2000). Thus, if other people are perceived to appear, and indeed feel, 'less tired', this may contribute to worry, arousal and distress as described in cognitive models of insomnia (e.g. Harvey, 2002), particularly if a comparison to the self is made (e.g. 'I look exhausted compared with everybody else').

Insomnia has previously been associated with reduced rating of emotion intensity for faces displaying happiness, fear and sadness (Cronlein et al., 2016; Kyle et al., 2014), and research demonstrates that experimentally induced sleep deprivation impairs recognition of several facially expressed emotions including anger, happiness and sadness (Killgore, Balkin, Yarnell, & Capaldi, 2017; Van Der Helm, Gujar, & Walker, 2010). Moreover, a recent study determined that both insomnia and sleep apnea patients show blunted intensity ratings for, and impaired ability to categorize, faces depicting happiness and sadness when compared to normal sleeping controls (Cronlein et al., 2016). Considering sleep apnea is characterized by objectively disturbed sleep occurring in the absence of cognitive factors (i.e. sleep-related interpretive bias), the current findings may be explained by a visual perception alteration that eventually occurs amongst individuals with insomnia such that the ability to accurately gauge facial expression intensity becomes impaired.

Several limitations of the current study should be noted. The currently used facial stimuli depicting tiredness were not naturally occurring, instead being based on standardised manipulations of the face. Whilst these manipulations were based upon previously established tiredness cues (Akram et al., 2016a; Knoll et al., 2008; Sundelin et al., 2013), facial photographs of individuals displaying experimentally induced tiredness through sleep

deprivation or sustained wakefulness may be more suitable. The current sample consisted primarily of female participants, and as such the present findings may not be fully generalizable to males. However, it is relevant to note that women are more likely than men to be diagnosed with insomnia (Zhang & Wing, 2006). Moreover, whilst the present study used a comprehensive assessment to address insomnia symptoms amongst the general population from the perspective of diagnostic criteria, the current outcomes cannot be extrapolated to individuals meeting diagnostic criteria for insomnia. To that end, a replication of the current study amongst a sample meeting diagnostic criteria for insomnia would be beneficial.

The current outcomes add the growing body of literature surrounding how people with insomnia perceive facial cues of tiredness. Further work is now required to elucidate the mechanisms underlying the relationship between insomnia symptoms and the blunted perception of facially expressed tiredness. Specifically, to tease apart whether the current outcomes are characteristic of a visual perception alteration or a sleep-related interpretive bias.

#### **Declaration of Conflicting Interests**

The authors declare no conflict of interest.

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