How does sleep affect the perception of facial emotion?

Dear Editor,

In the past 10 years, there has been increasing interest in the role of sleep in socioemotional performance, and this has been reflected in experimental tasks using facial emotion perception paradigms [1]. However, a diversity of tasks have been employed, and these would seem to be linked to apparent discrepant results as to whether and how sleep affects the perception of facial emotion. I will discuss in turn differences in samples, experimental stimuli and tasks, and dependent variables, with regard to these tasks.

Firstly, there are clear differences in the samples used. These include healthy participants subject to sleep deprivation (e.g. Refs. 2–5) and sleep restriction (e.g. Refs. 6–8) paradigms, as well as medication which affects sleep (e.g. Refs. 9 and 10]), sleep parameters, and insomnia symptoms [11, 12], and the clinical sleep conditions of insomnia disorder [13, 14], sleep apnea [14], and narcolepsy with cataplexy [15]. Gender-specific effects have been investigated (e.g. Refs. 2, 5–8, and 16). Samples also differ with regard to size and age, which included adolescents (e.g. Ref. 17), young adults (e.g. Refs. 2 and 11), and middle-aged adults (e.g. Ref. 13). However, adolescence is considered to be the period at which mental health conditions first emerge [18, 19] and sleep disruption is common in college students [20]. Future studies should consider the interactions of vulnerability/resilience in regard to tasks (e.g. Refs. 21 and 22). Furthermore, the absence of a clinical sleep disorder does not necessarily mean that participants are “good” sleepers (cf. the work of Beattie et al. [23]).

Secondly, there are differences in the experimental stimuli and tasks. Specifically, the numbers of emotions considered varied, as did their intensity levels and presentation duration, and order of presentation. Although a smaller number of emotion categories may make it harder to detect effects, emotion faces have been found to correspond to both basic emotion and dimensional perspectives [24], see also Ref. 25, and additional emotions would be likely to be associated with these general categories. Importantly, it is well known that there can be emotion-specific effects on recognition [26]. Full intensity levels may also make it harder to detect effects; however, precise ways in which the muscle units (action units) of the human face combine to form subtle expressions may not be the mid-point of the “full” expression (cf. Refs. 27–29). Furthermore, the procedure to “morph” faces affects spatial frequency information, and it may therefore be important to consider the effects of sleep on visual perception in general. A longer presentation duration may make it easier for a facial emotion to be recognized [30], although it should be noted that extended presentation durations risk ecological validity (cf. Ref. 31). Similarly, presenting emotion faces in a blocked design also affects ecological validity, and means that categorization is harder to assess. However, such a task would be required in order to assess recognition sensitivity and bias in accordance with signal detection theory. The number of identities on which emotions were depicted also varied, alongside the number of repetitions. It should also be noted that there is recent evidence of effects of sleep on unfamiliar face matching [32], and unfamiliar faces are typically employed. A majority of studies have used static faces (but see the work of Holding et al. [11]).

Thirdly, various dependent variables have been used. Behavioral responses include categorization judgements, alongside reaction times and intensity judgements, although emotion matching has also been used [6], as has the identification of specific emotions [17], and rated intensity of specific emotions [2]. The precise combination of stimuli with task demands and response variables also seem likely to matter. Reaction times have been reported less frequently, as have error patterns (but see Refs. 4 and 11). Although the relationship of emotion perception to mood is complex, a review with regard to depression suggests that effects are mainly linked to bias, with heterogeneity in the tasks also noted [33]. Although correlates of emotion perception results have been reported, e.g. Refs. 2 and 13, it would be useful if such correlates were routinely reported. Emotion face tasks have also been employed in conjunction with measures of polysomnography (PSG) sleep [34–36] although in memory tasks/tasks with the same stimuli (see also, e.g. Refs. 37–40). This is clearly an area for future study. Event-related potentials (ERPs) have also been used with regard to emotion face tasks [4], as has functional magnetic resonance imaging (fMRI; e.g. Refs. 8, 41, and 42) and eye-tracking [12], and the use of these measures will have additional benefits for assessing how emotion faces are processed.

In general, the purpose and theoretical context of using emotional faces needs to be considered and made explicit. The perception of facial emotion occurs within a wider context of social interactions, and with regard to expression generation, there is also evidence of altered expressivity with sleep disruption [43–45]. Thus, the effects of sleep on social interactions affect both the creation and decoding of a signal. In addition, the relationship between emotion generation and emotion regulation may not be discrete [46], although emotional displays will be subject to display rules which are affected by context [27]. Task demands also affect the results [47]. Furthermore, sleep disruption affects aspects of facial appearance [48] which can be detected [49] and which may be differentially processed in insomnia [50, 51]. Conclusions as to neural processing will have to reconcile models of face perception (e.g. Ref. 52) with the socioemotional (cf. Ref. 53) and sleep (e.g. Ref. 54) and circadian literature.

In summary, the findings of the effects of sleep on emotion face perception are affected by the task used, and there are a large number of possible task variants which affect the precise results found. However, converging evidence suggests that sleep does indeed affect emotion perception, in several populations. Further research on how emotion faces are processed beyond behavioral measures, and how this is influenced by sleep architecture, will also be important. Assessments of possible task performance correlates with reference to the extant sleep literature, which will also help us to clarify these results. Hopefully future research will make clear the precise ways in which these different facial emotion tasks and results relate to perception, cognition, mood and emotional regulation, and social functioning—and how sleep affects them.

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