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Letter to the Editor

Simply avoiding reactivating fear memory after exposure therapy may help to consolidate fear extinction memory

Enhancing the efficiency of psychotherapy has become a central issue in its recent development as cost-effective approaches and many studies have shown that it is indeed possible to increase the efficacy of psychological treatment. In the recent study of Kleim *et al.* (2014), going to sleep immediately after exposure increased the efficacy of the treatment of spider phobia, compared to staying awake after a session. The authors explain this effect by the benefits of sleep on memory consolidation found in earlier studies. Therefore, if exposure is followed by sleep, the spider non-fearful memories will be better reactivated when competing with spider fearful memories.

Kleim *et al.* (2014) used a 90 min-long documentary about European cities for the awake condition. We can assume that this documentary contains some cues associated with spiders, as spiders can be found in most modern homes. Thus, this experiment may have compared a post-exposure period devoid of spider cues, that is a 90-min sleep period where less than 20% of recorded sleep gave the opportunity to dream and have nightmares about spiders, to a post-exposure period that may have contained spider fear-associated cues. These cues could reactivate spider fear memories and thus impair memory consolidation of non-fearful spider memories.

It is considered that fearful memories consolidate progressively into persistent traces through synthesis of new proteins (McGaugh, 2000). When retrieval of a consolidated fear memory occurs, this memory returns transiently to a labile state, thus requiring a new protein synthesis to persist further (Nader *et al.* 2000). This unstable period, called a consolidation window, lasts a few hours. Exposure therapy is based on the experimental fear extinction model that helps to develop new, non-fearful memories that follow the same consolidation process. During this labile state, the memory is amenable to enhancement or disruption (Nader *et al.* 2000). Monfils *et al.* (2009) elegantly demonstrated that when fear extinction training occurs within the consolidation window of a learned fear (i.e. within 6 h after triggering fear), fear memory is disrupted and later permanently attenuated. We can deduce, therefore, that it is important for phobic

subjects to avoid reactivating fear memories during the consolidation period of non-fear memories.

The study of Kleim *et al.* (2014) emphasizes that, to ensure that the next 6 h needed for memory consolidation will not be disturbed by exposure to phobic cues (and reactivate the fear), behaviour therapists must enquire about post-exposure session activities of treated patients.

We need further studies assessing the specific positive effects of sleep, in the post-exposure period, compared to the vigilant state in a phobic cue-free environment, to determine whether it might be considered a necessary condition for better consolidation of non-fear memories.

Declaration of Interest

None.

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Letter to the Editor

Simply avoiding reactivating fear memory after exposure therapy may help to consolidate fear extinction memory – a reply

We thank Dr Dardennes and colleagues (Dardennes *et al.* 2014) for their thoughtful and informed comments

and their interest in our study in which we have reported that sleep after exposure therapy improves therapeutic success in individuals with spider phobia (Kleim *et al.* 2014). In our paper, we suggest that the beneficial effect of sleep on exposure therapy might be explained by an active role of sleep for the consolidation of extinction memories (Rasch & Born, 2013). According to Dardennes and colleagues, the beneficial effect of sleep on exposure therapy outcome could alternatively be explained by the role of sleep in avoiding reactivation of fear memories which might occur during post-therapy wakefulness.

More specifically, Dardennes and colleagues suggest that in our study, spider-related cues might have induced reactivation and reconsolidation of fear memories during film-viewing of our wake control group. We consider this possibility unlikely, because we carefully selected and pre-screened the movie to ensure absence of obvious spider cues. Furthermore, a post-film questionnaire revealed no evidence for any disturbing or distracting elements in the movie. Importantly, none of our participants reported anything related to spiders or spider-related cues. Thus, the movie clearly contained no obvious or consciously perceived spider cues.

However, we cannot exclude that some non-obvious cues might have subconsciously reactivated fear memories during wakefulness, which could happen in any environment independent from the movie we used in our study. Even in the case of reducing external input to a minimum (e.g. staying awake in a dark room), internally triggered reactivation of fear memories might occur. Thus, wakefulness *per se* might be a state with a higher chance of externally or internally triggered reactivation and reconsolidation of fear memories, possibly hindering successful consolidation of extinction memories. It is important to note that sleep is the only naturally occurring (non-pharmacologically induced) state in which external and internal interference is strongly reduced, which might indeed contribute to the beneficial effect of sleep for memory consolidation (see Mednick *et al.* 2011).

Identifying an active contribution of sleep after exposure therapy might require more sophisticated experimental designs. For examples, night-half designs comparing memory consolidation during early, SWS rich sleep *v.* late REM sleep have successfully revealed differential contributions on neutral *v.* emotional memories (e.g. Plihal & Born, 1997; Wagner *et al.* 2001, Groch *et al.* 2013). Furthermore, experimentally inducing slow oscillations (Marshall *et al.* 2006) or cueing memories during SWS (Rasch *et al.* 2007) improves consolidation processes during sleep, which could be successfully adapted to further improve the beneficial effect of sleep on therapy outcome. In our

study, the finding that greater percentages of stage 2 sleep were associated with greater reductions in fear and negative cognitions also speaks in favour of active consolidation processes acting during sleep. Further studies are certainly needed in order to explore and disentangle active mechanisms that contribute to the beneficial effects of sleep on emotional learning during therapy.

Declaration of Interest

None.

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