Structural and behavioural differences between high and low trait-anxious individuals

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Introduction

Learning, conditioning and a genetic predisposition influence the processing of negative emotional stimuli (e.g. Phelps, 2004). Here, we are focusing on the learning-process, memory-consolidation and the associated neural fibre-connections in individuals with elevated trait-anxiety. These people are especially prone to develop anxiety-disorders and differ from people with reduced or average trait-anxiety with regard to the processing, evaluation and memory of threat-related stimulus-material (McCabe, 1999; Russo et al, 2006; Mitte, 2008).

To date, studies on memory-bias in subclinical anxiety patients do not add up to a consistent picture. While some authors strongly support the existence of a memory bias, others blame findings on unpropitious experimental designs or insufficient criterions (Russo et al 1999). It is the intent of this study to finally clarify if subclinical high and low individuals significantly differ from each other or not. To achieve this, shortcomings of earlier studies are addressed, circumvented and behavioural testing is combined with a state-of-the art imaging technique.

Method

The State Trait Anxiety Inventory (Spielberger et al., 1983) served to form two groups, one high and one low in trait-anxiety (fig. 1a). An associative statistical word-learning (training) was applied to investigate the development of memory bias for negatively arousing stimuli. Within this framework, 60 neutral word stimuli (e.g. *binu*) were linked with negative arousing colour pictures (e.g. explosion) (fig. 1b). To check for memory-biases, we implicitly and explicitly tested the learned word-material. These tests were carried out directly after training and two weeks later (fig. 1c). The latter was implemented to investigate the impact of consolidation on the development of memory biases A subgroup of n= 34 subjects was additionally scanned via Diffusion Tensor Imaging (DTI). The program *Tract-based spacial statistics* from FSL was used to investigate white matter differences between groups via Fractional Anisotropy (FA) Values.

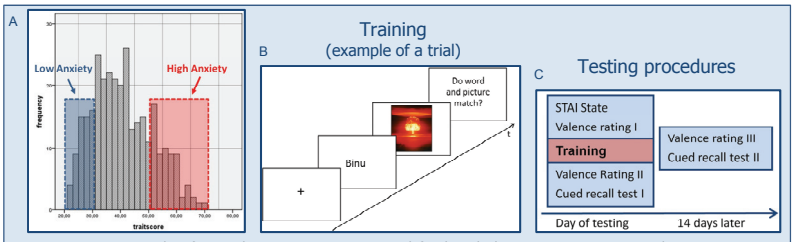

Figure 1: STAI-trait results of 311 subjects. Scores ≥ 50 were defined as *high anxiety*. Scores ≤ 30 as *low anxiety*. N= 54 subjects took part in the main experiment (A). Visualisation of a word-learning-trial from training. After listening to a pseudo word and viewing a picture-object, participants had to decide via button-press if word and object did match or did not match (B). Schematic diagram, visualising the behavioural testing-procedures (C).

Behavioral Results

Results of the recall test yielded a significant main effect for *word type*, $F(1, 52) = 8.787$; $p = 0.005$, and interaction effect for *anxiety* x *word-type*, $F(1, 52) = 4.687$; $p = 0.035$. As hypothesized, higher recall-rates were exclusively found in high anxious individuals (fig. 2a). Results of the valence-rating showed main effects for *group*, $F(1, 529) = 34.534$; $p < 0.001$, and *anxiety* $F(1, 52) = 7.153$; $p = 0.010$, an interaction effect *session* x *word type* $F(2, 104) = 28.697$; $p < 0.001$ but no interaction between *anxiety* x *word-type* (fig. 2b) .

Figure 3: Development of accuracy in % during training (n=54).

Structural Results

Analysis of the DTI-data revealed significant structural differences between high and low-anxious subjects. These were particularly visible in dorsolateral Prefrontal Cortex (dlPFC) and thalamic regions. Here, the low-anxiety group exhibited higher FA-Values, hence stronger integrity of white matter (fig. 4).

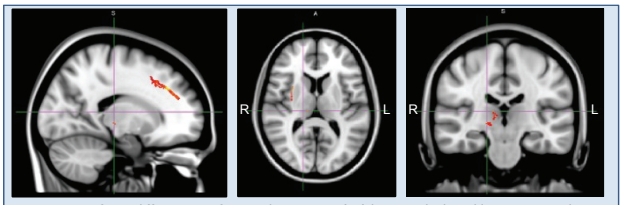

Figure 4: Significant differences in fractional anisotropy (FA) between high and low-anxious subjects (shown in red/yellow). FA-differences are located in right hemispheric dlPFC and thalamic regions.

These memory-bias effects were not yet visible during the learning process itself. Here, results yielded increasing learning curves for all subjects (fig. 3) but did not show differences between anxiety-groups. Thus, no evidence for the development of a bias during the acquisition of the new word-material was found.
A remarkable finding emerged two weeks after the training when high anxiety subjects rated the neutrally linked words in a strongly negative manner, suggesting a generalization-bias (fig. 2b).

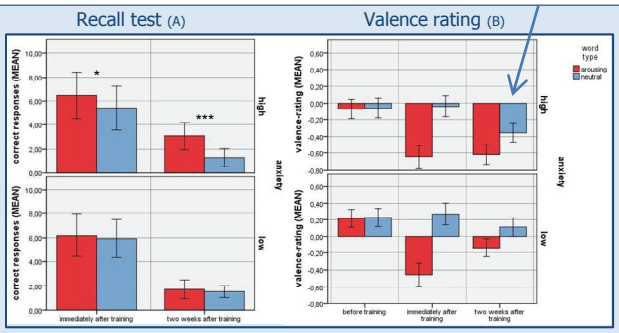

Figure 2: Percentage of correct responses in the cued recall test (A) and valence ratings of words (B). High anxiety subjects remembered negatively linked words better than neutrally linked words.
A trend of this discrimination effect was visible immediately after training. Two weeks after training, the effect had strengthened. No comparable effect was found in the low-anxiety subjects (A).
Before training, subjects did not differentiate between word types and rated words of both categories comparable to each other. Immediately after training, high and low anxiety subjects rated negatively linked words in a more negative way. This discrimination-effect was still visible two weeks after training. At this time, the high anxiety group displayed a generalization effect by additionally rating neutrally linked words in a negative manner. This was not seen in the low anxiety group (B).

Conclusion

Overall, the results clearly emphasize neuroanatomical and behavioral differences between subclinical high and low trait-anxious individuals. Behavioural differences regarding learning (memory bias) are stronger for explicit than implicit memory. The absence of group-differences during the training suggests that development of the memory-bias takes place at later learning-stages such as consolidation or retrieval.

Consolidated implicit responses of the high anxiety group indicate a generalization-bias, which might be due to anxiety-specific consolidation-mechanisms and which is associated with lower white matter integrity in right-hemispheric dlPFC and thalamic regions. The results of this study could have implications for therapeutic treatment and have to be discussed in relation to current theories on anxiety disorders.

References

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