Exposure is one of the most effective and validated forms of treatment for anxiety disorders (Norton 2007) and specific phobia (hirai 2007). However, because exposure relies on confronting aversive stimuli and can be an intense experience for clients, many of those suffering from anxiety disorders terminate treatment early (loerinc 2015) or do not even begin treatment (wang 2002, 2005), leaving a large proportion of this population without help.

Multivoxel neuro-reinforcement has been developed as an alternative intervention that circumvents the aversive nature of traditional exposure therapy while retaining its fundamental goals of fear reduction. The method rewards unconscious neural activation of a category representation (e.g. spider) through real-time fMRI (wantanabe 2017, Koizumi 2016, Shibata 2019) such that participants are kept unaware of the feared stimuli throughout treatment and thus avoid the discomfort normally associated with exposure therapy. Previous experiments with multivoxel neuro-reinforcement with animal phobia have demonstrated its ability to decrease amygdala reactivity to feared animals (taschereau dumochel 2018).

However, the mechanics of neuro-reinforcement are still understudied (tascherau dumochel 2020, Shibata 2019). Knowledge about the intermediate neural changes caused by neuro-reinforcement is an unmet need and is necessary in order to more clearly elucidate the causal mechanisms linking neuro-reinforcement and previously demonstrated outcomes. Some nascent research has focused on examining functional connectivity during resting state as a means to uncover intermediary changes from neuro-reinforcement (scheinost 2013, Megumi 2015), but no studies, to the authors’ knowledge, have investigated these changes following a multivoxel neuro-reinforcement intervention nor in a population with clinically diagnosed animal phobia.

We conducted an unrestricted connectivity analysis of resting state data collected as part of a greater study (cushing 2023) in order to examine changes in functional connectivity during resting state pre- to post-treatment. Using group-ICA, this approach allowed us to explore changes in the brain in a purely data-drive, model-free way.

Our multivoxel neuro-reinforcement intervention primarily reinforced representations of the feared animals in the Ventral Temporal Cortex. From this, we first expected to see changes in functional connectivity in related areas of the brain broadly responsible for visual processing and object recognition. Secondly, from the decreased amygdala response we observed in the main paper (cushing 2023), we expected changes in resting state functional connectivity to be associated with decreases in amygdala response.