Randomized Controlled Trial > Psychiatry Clin Neurosci. 2024 Nov;78(11):678-686.
doi: 10.1111/pcn.13726. Epub 2024 Sep 2.

A double-blind trial of decoded neurofeedback intervention for specific phobias

Cody A Cushing [1], Hakwan Lau [2], Mitsuo Kawato [3 4], Michelle G Craske [1], Vincent Taschereau-Dumouchel [5 6]

Affiliations + expand

PMID: 39221769 PMCID: PMC11531993 DOI: 10.1111/pcn.13726

Abstract

Aim: A new closed-loop functional magnetic resonance imaging method called multivoxel neuroreinforcement has the potential to alleviate the subjective aversiveness of exposure-based interventions by directly inducing phobic representations in the brain, outside of conscious awareness. The current study seeks to test this method as an intervention for specific phobia.

Methods: In a randomized, double-blind, controlled single-university trial, individuals diagnosed with at least two (one target, one control) animal subtype-specific phobias were randomly assigned (1:1:1) to receive one, three, or five sessions of multivoxel neuroreinforcement in which they were rewarded for implicit activation of a target animal representation. Amygdala response to phobic stimuli was assessed by study staff blind to target and control animal assignments. Pretreatment to posttreatment differences were analyzed with a two-way repeated-measures anova.

Results: A total of 23 participants (69.6% female) were randomized to receive one (n = 8), three (n = 7), or five (n = 7) sessions of multivoxel neuroreinforcement. Eighteen (n = 6 each group) participants were analyzed for our primary outcome. After neuroreinforcement, we observed an interaction indicating a significant decrease in amygdala response for the target phobia but not the control phobia. No adverse events or dropouts were reported as a result of the intervention.

Conclusion: Results suggest that multivoxel neuroreinforcement can specifically reduce threat signatures in specific phobia. Consequently, this intervention may complement conventional psychotherapy approaches with a nondistressing experience for patients seeking treatment. This trial sets the stage for a larger randomized clinical trial to replicate these results and examine the effects on real-life exposure.

Clinical trial registration: The now-closed trial was prospectively registered at ClinicalTrials.gov with ID NCT03655262.

Keywords: decoding; fMRI; neurofeedback; phobia; reinforcement.

Figures

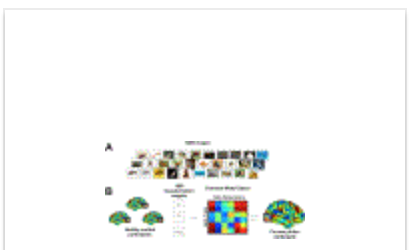

Figure 1. Functional alignment of brain data...

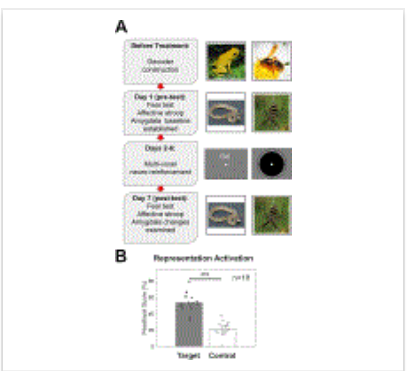

Figure 2. Study design and activation of...

Figure 3. CONSORT diagram of recruitment flow.

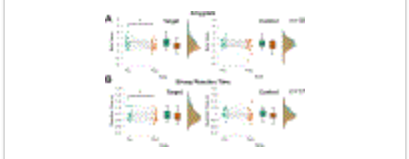

Figure 4. Changes in fear test amygdala...

Update of

A double-blind trial of decoded neurofeedback intervention for specific phobias.
Cushing CA, Lau H, Kawato M, Craske MG, Taschereau-Dumouchel V.
medRxiv [Preprint]. 2024 Aug 1:2023.04.25.23289107. doi: 10.1101/2023.04.25.23289107.
Update in: Psychiatry Clin Neurosci. 2024 Nov;78(11):678-686. doi: 10.1111/pcn.13726.
PMID: 39132473 **Free PMC article.** Preprint.

Similar articles

A double-blind trial of decoded neurofeedback intervention for specific phobias.
Cushing CA, Lau H, Kawato M, Craske MG, Taschereau-Dumouchel V.
medRxiv [Preprint]. 2024 Aug 1:2023.04.25.23289107. doi: 10.1101/2023.04.25.23289107.
Update in: Psychiatry Clin Neurosci. 2024 Nov;78(11):678-686. doi: 10.1111/pcn.13726.
PMID: 39132473 **Free PMC article.** Preprint.

Study protocol for a multi-session randomized sham-controlled trial of PCC- and amygdala-targeted neurofeedback for the treatment of PTSD.
Lieberman JM, Lanius RA, Théberge J, Frey BN, Frewen PA, Scharnowski F, Steyrl D, Ros T, Densmore M, Tassinari E, Matic V, Hosseini-Kamkar N, Narikuzhy S, Hosseiny F, Jetly R, Nicholson AA.
BMC Psychiatry. 2025 Jul 15;25(1):698. doi: 10.1186/s12888-025-07050-5.
PMID: 40665286 **Free PMC article.**

Vesicoureteral Reflux.
Leslie SW, Aeddula NR.
2024 Apr 30. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan–.
PMID: 33085409 **Free Books & Documents.**

A randomised controlled trial of amygdala fMRI-neurofeedback versus sham-feedback in borderline-personality disorder - systematic literature review and introduction to the BrainSTEADy trial.

Paret C, Jindrová M, Kleindienst N, Eck J, Breman H, Lührs M, Barth B, Ethofer T, Fallgatter AJ, Goebel R, Hoell A, Lockhofen D, Reinhold AS, Maier S, Matthies S, Mulert C, Schönholz C, van Elst LT, Schmahl C.

BMC Psychiatry. 2025 Jul 8;25(1):687. doi: 10.1186/s12888-025-07000-1.

PMID: 40629288 **Free PMC article.**

Therapist-supported Internet cognitive behavioural therapy for anxiety disorders in adults.

Olthuis JV, Watt MC, Bailey K, Hayden JA, Stewart SH.

Cochrane Database Syst Rev. 2015 Mar 5;(3):CD011565. doi: 10.1002/14651858.CD011565.

Update in: Cochrane Database Syst Rev. 2016 Mar 12;3:CD011565. doi: 10.1002/14651858.CD011565.pub2.

PMID: 25742186

See all similar articles

Cited by

Broadening the scope: Multiple functional connectivity networks underlying threat conditioning and extinction.

Cushing CA, Peng Y, Anderson Z, Young KS, Bookheimer SY, Zinbarg RE, Nusslock R, Craske MG.

Imaging Neurosci (Camb). 2024 Jul 3;2:imag-2-00213. doi: 10.1162/imag_a_00213. eCollection 2024.

PMID: 40800357 **Free PMC article.**

Enhancement of the left frontoparietal network through real-time functional magnetic resonance imaging functional connectivity-informed neurofeedback and its impact on working memory in schizophrenia: A pilot study.

Kobayashi Y, Asai T, Yoshihara Y, Yamashita M, Nakamura H, Shimizu M, Kawashima T, Miyata J, Kawato M, Murai T, Imamizu H, Takahashi H.

Psychiatry Clin Neurosci. 2025 Sep;79(9):531-544. doi: 10.1111/pcn.13849. Epub 2025 Jun 22.

PMID: 40545821 **Free PMC article.** Clinical Trial.

Modulating subjective pain perception with decoded Montreal Neurological Institute-space neurofeedback: a proof-of-concept study.

Berman T, Cushing C, Manuel S, Vachon-Presseau E, Cortese A, Kawato M, Woo CW, Wager TD, Lau H, Roy M, Taschereau-Dumouchel V.

Philos Trans R Soc Lond B Biol Sci. 2024 Dec 2;379(1915):20230082. doi: 10.1098/rstb.2023.0082. Epub 2024 Oct 21.

PMID: 39428876 **Free PMC article.**

References

1. Craske MG, Kircanski K, Zelikowsky M, Mystkowski J, Chowdhury N, Baker A. Optimizing inhibitory learning during exposure therapy. Behav Res Ther. 2008. Jan;46(1):5–27. - PubMed
2. Loerinc AG, Meuret AE, Twohig MP, Rosenfield D, Bluett EJ, Craske MG. Response rates for CBT for anxiety disorders: Need for standardized criteria. Clin Psychol Rev. 2015. Dec;42:72–82. - PubMed
3. Zayfert C, DeViva JC, Becker CB, Pike JL, Gillock KL, Hayes SA. Exposure utilization and completion of cognitive behavioral therapy for PTSD in a “real world” clinical practice. Journal of Traumatic Stress. 2005;18(6):637–45. - PubMed
4. Eftekhari A, Ruzek JI, Crowley JJ, Rosen CS, Greenbaum MA, Karlin BE. Effectiveness of National Implementation of Prolonged Exposure Therapy in Veterans Affairs Care. JAMA Psychiatry. 2013. Sep 1;70(9):949–55. - PubMed
5. Powers MB, Emmelkamp PMG. Virtual reality exposure therapy for anxiety disorders: A meta-analysis. Journal of Anxiety Disorders. 2008. Apr 1;22(3):561–9. - PubMed

Show all 50 references

Publication types

> Randomized Controlled Trial

MeSH terms

> Adult
> Amygdala* / diagnostic imaging
> Amygdala* / physiology
> Amygdala* / physiopathology
> Double-Blind Method
> Female
> Humans
> Magnetic Resonance Imaging*
> Male
> Neurofeedback* / methods
> Outcome Assessment, Health Care
> Phobic Disorders* / physiopathology
> Phobic Disorders* / therapy
> Young Adult

Supplementary concepts

> Phobia, Specific

Associated data

> ClinicalTrials.gov/NCT03655262

Grants and funding

JP18dm0307008/Japan Agency for Medical Research and Development
R61MH113772/MH/NIMH NIH HHS/United States
Fondation de l'Institut Universitaire en Santé Mentale de Montréal
R61 MH113772/MH/NIMH NIH HHS/United States
JPJ004596/Innovative Science and Technology Initiative for Security

Show all 7 grants

LinkOut - more resources

Full Text Sources

Ovid Technologies, Inc.
PubMed Central
Wiley

Medical

ClinicalTrials.gov
MedlinePlus Health Information

Connect with NLM

National Library of Medicine
8600 Rockville Pike
Bethesda, MD 20894