

Effects of CO on the brain

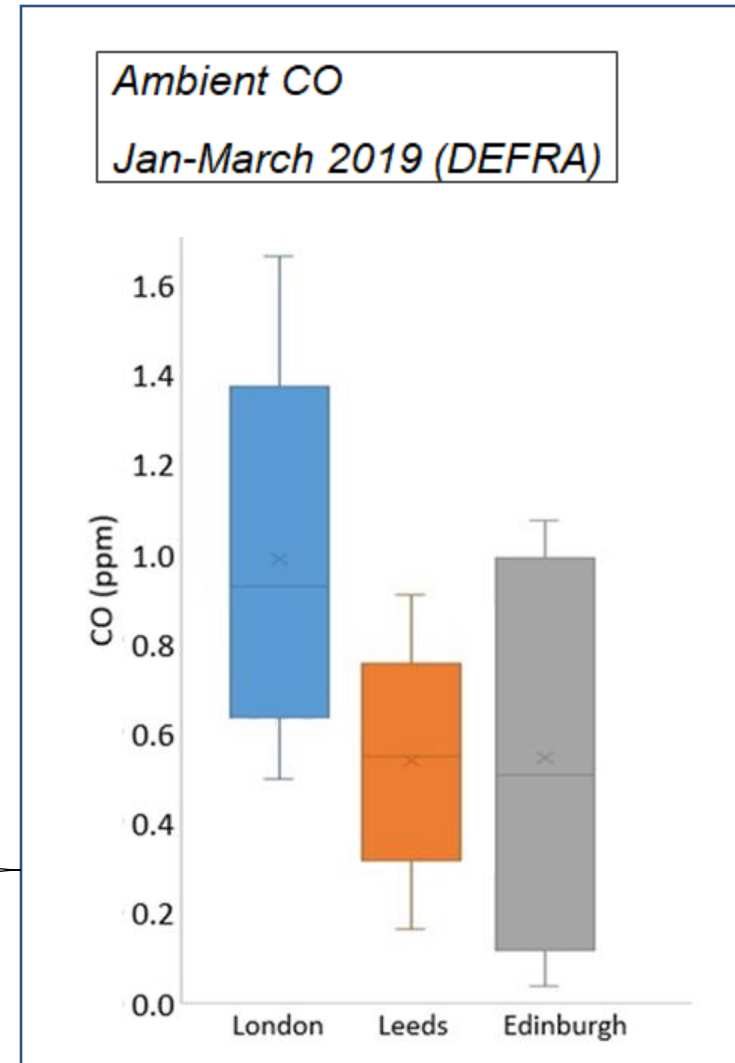
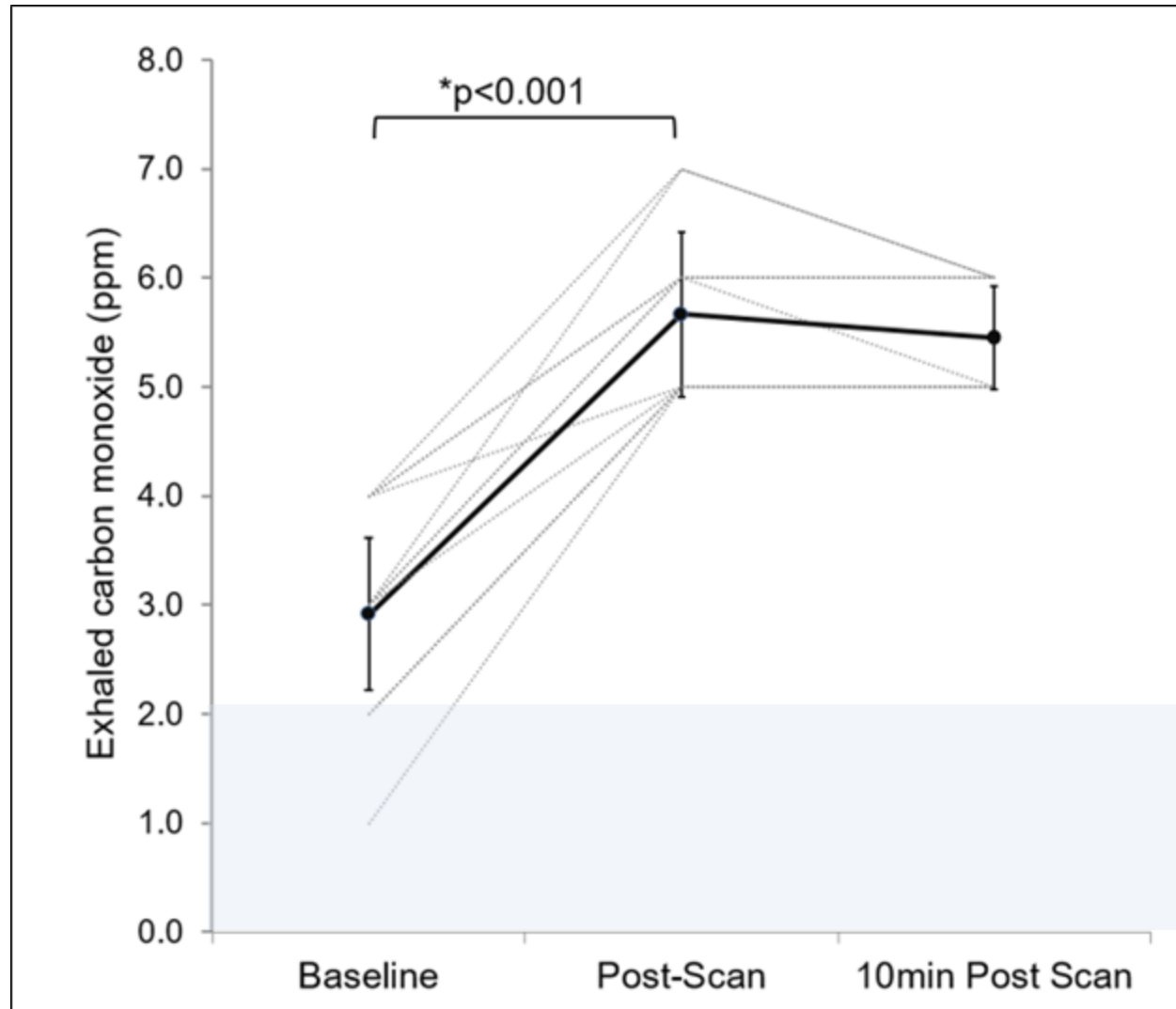
Dr Mari Herigstad



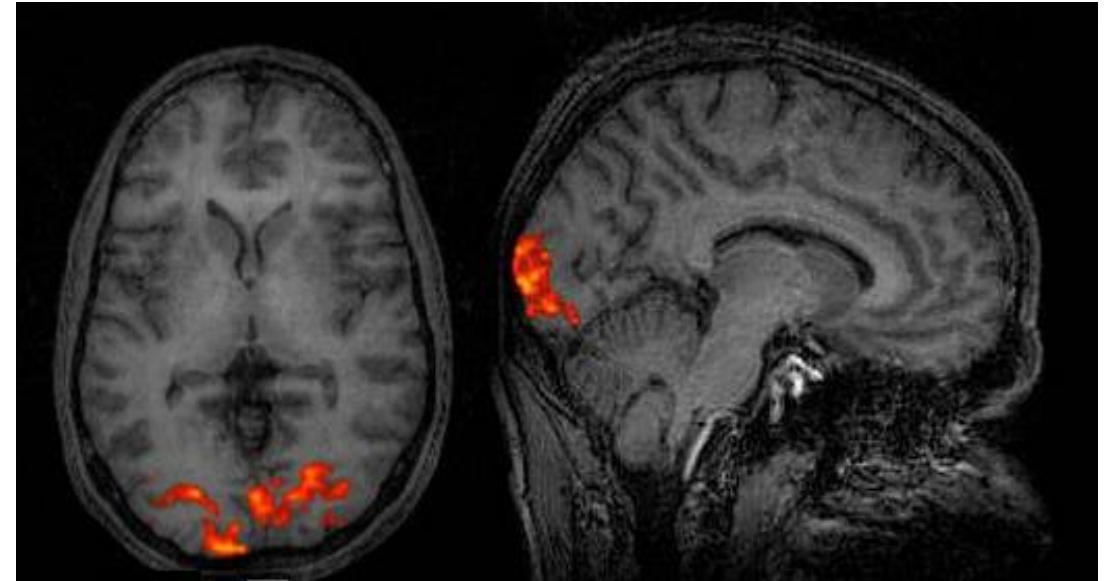
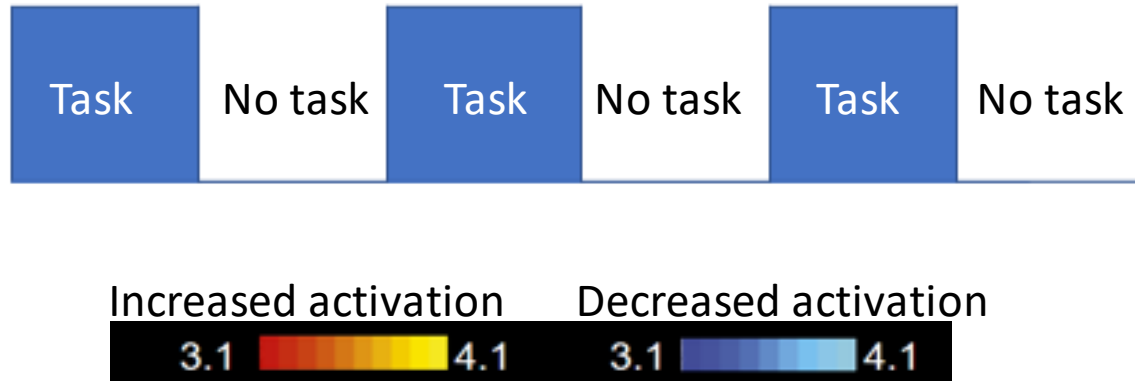
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Air-pollution level CO: How low?



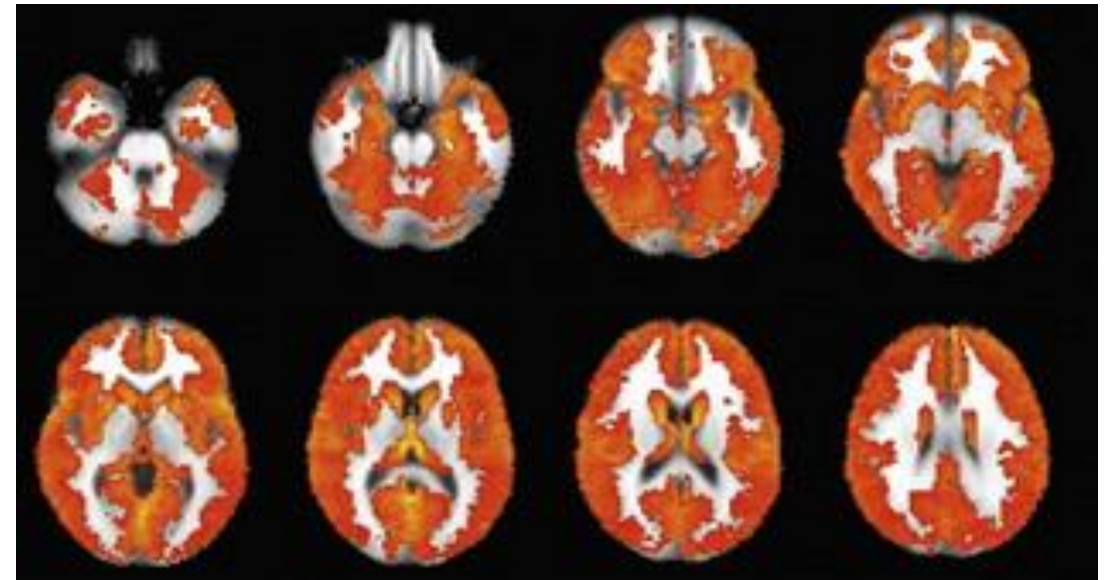
Neurological impact: comparing breathing CO with breathing air



From: www.ptb.de/cms/en/ptb/fachabteilungen/abt8/fb-81/ag-812/fmri-812.html

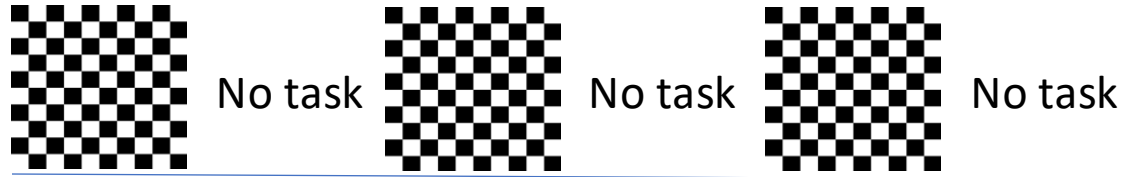
Four areas of interrogation:

1. Visual processing
2. Breathing (breath holds)
3. Cerebrovascular function
4. Behaviour/cognition

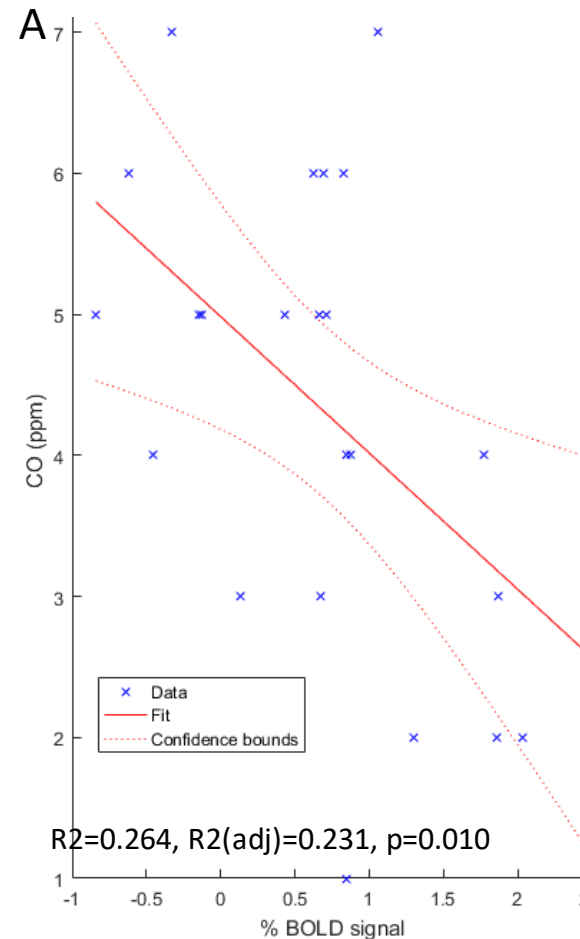
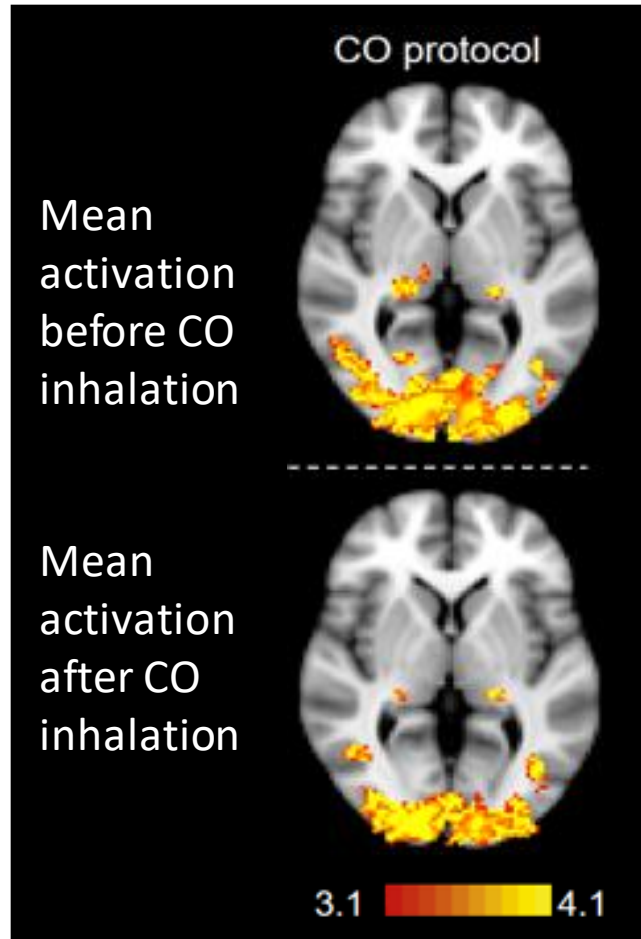


Raut et al. NeuroImage: Clinical 12 (2016) 173–179

Neurological impact: Visual processing

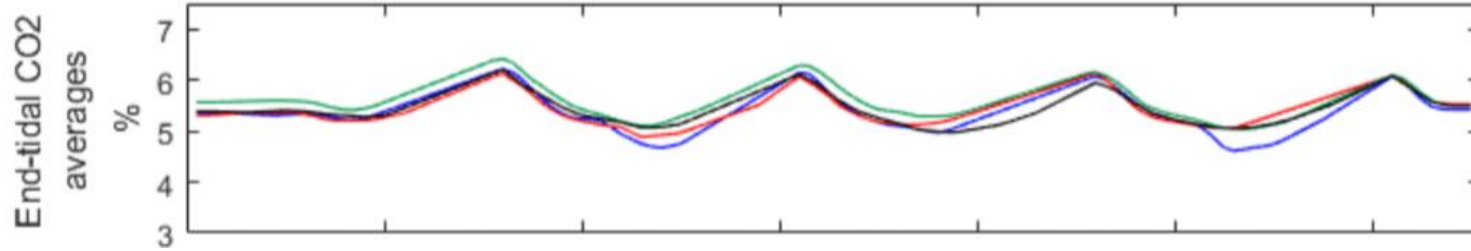


CO inhalation significantly reduces activation during visual processing. Control (air) inhalation does not alter activation.

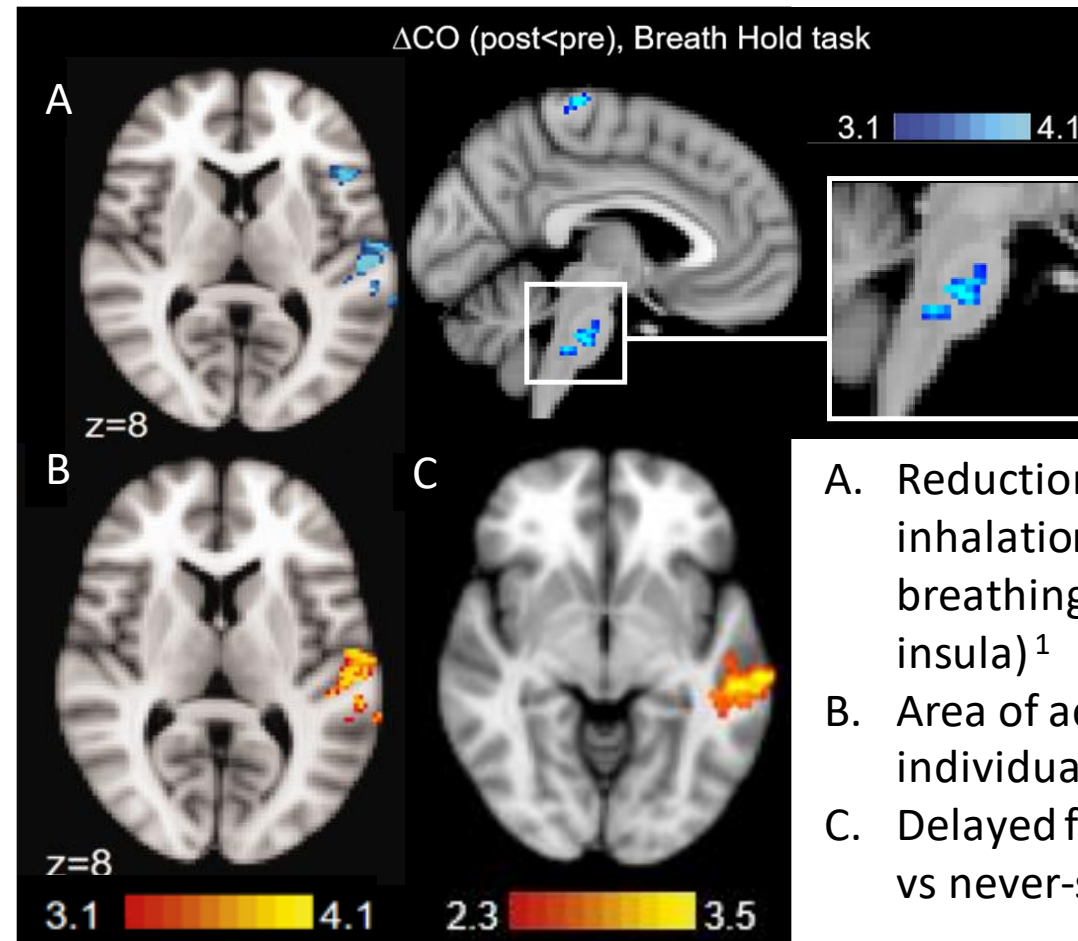
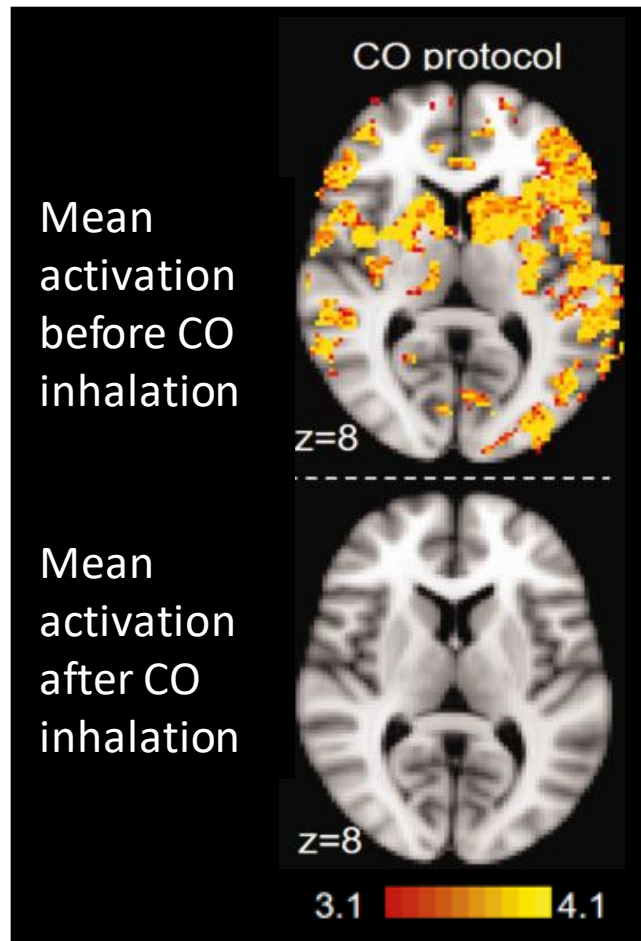


- A. Quantification of individual % change in fMRI signal correlated with individual CO levels. The visual activation is negatively correlated with exhaled CO ¹
- B. Reduction in activation following CO inhalation in areas associated with visual processing (visual cortex) ¹

Neurological impact: Breath hold activation (hypercapnia)

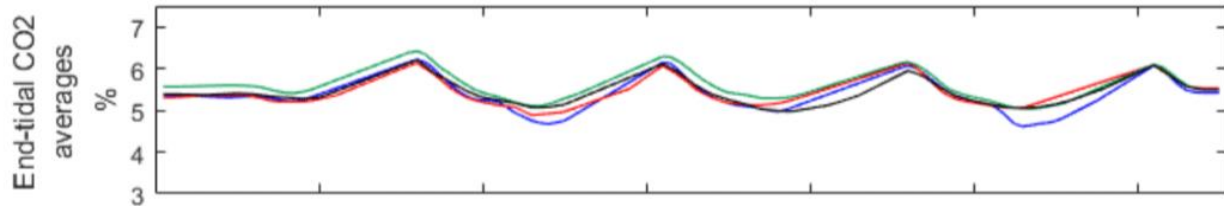


CO inhalation significantly reduces activation during breath holds. Control (air) inhalation does not alter activation.

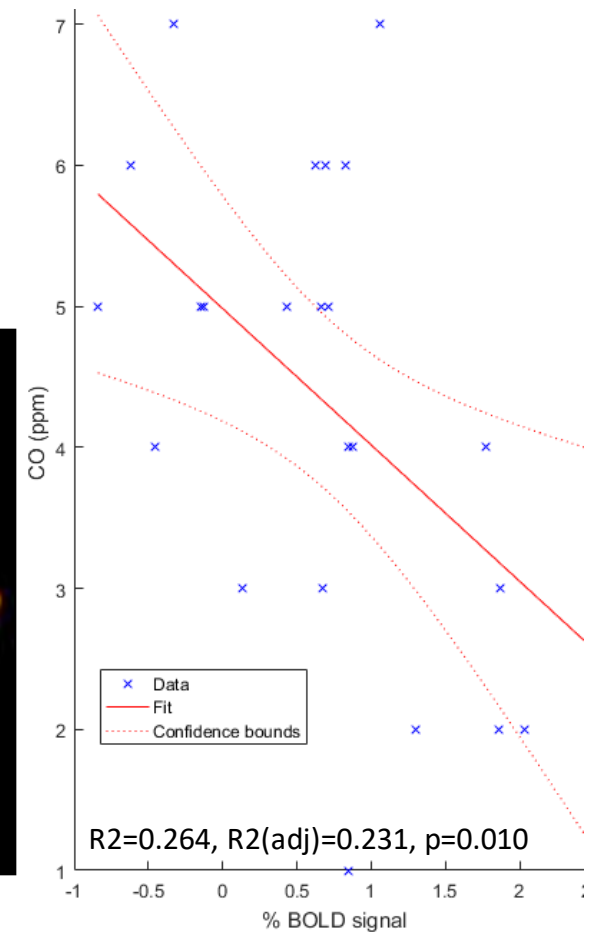
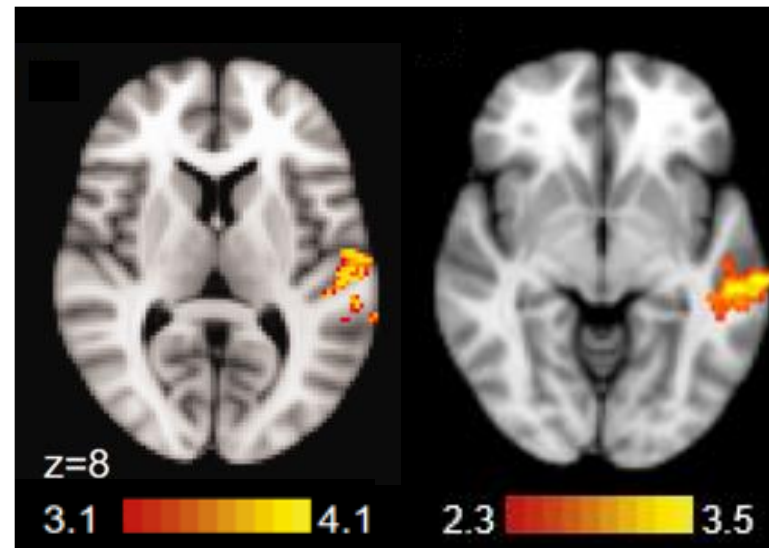


- A. Reduction in activation following CO inhalation in areas associated with breathing (brain stem, motor cortex, insula)¹
- B. Area of activation that scales with individual CO level during breath holds¹
- C. Delayed fMRI activation in ex-smokers vs never-smokers. From²

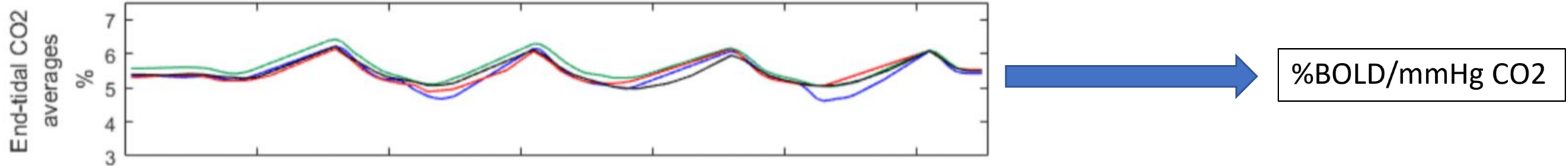
Neurological impact or vascular effect?



- Standard tests to assess neurovascular coupling/cerebrovascular reactivity
- Impact could be related to neurological function or to vascular effects (indirect measure)
- Task-specific activation areas suggest neurological basis (at least in part). Lingering impact in ex smokers suggest some element of persistent vascular and/or neurological effects (but sample group is not 'pure')
- Subsequent steps:
 - Determine global vascular reactivity
 - Determine CO impact on fMRI signal during a behavioural task (link performance and CO exposure)

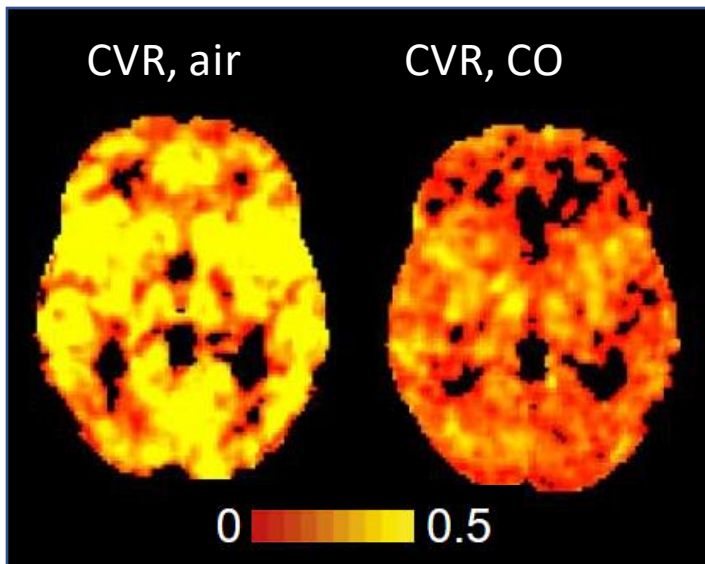


Cerebrovascular reactivity (CVR) and neurovascular coupling (NVC)

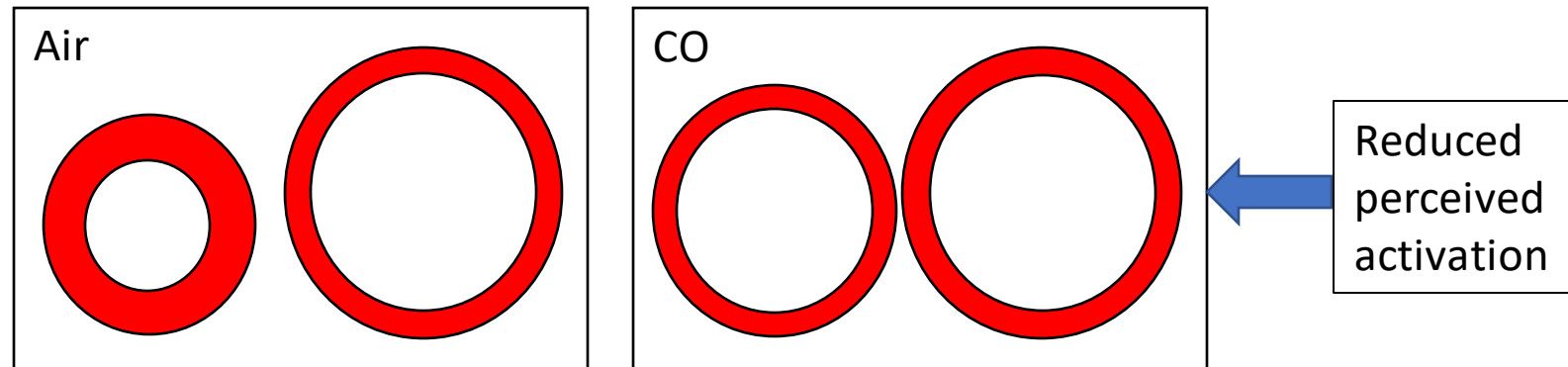


Cerebrovascular reactivity (CVR): the ability of the brain blood flow to respond to a stimulus

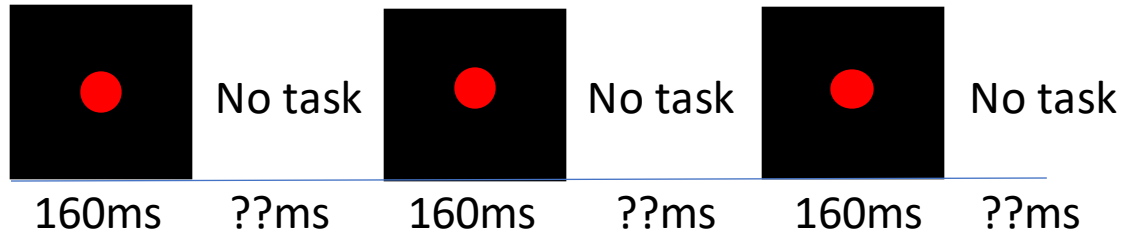
Neurovascular coupling (NVC): the mechanism that links neuronal activation and brain blood flow



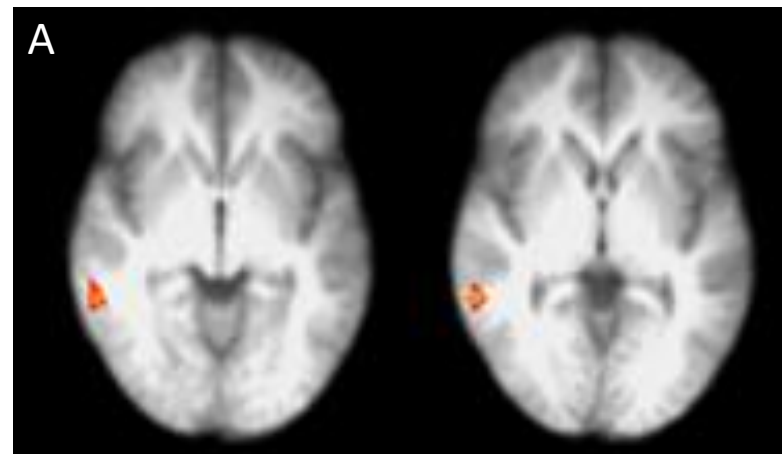
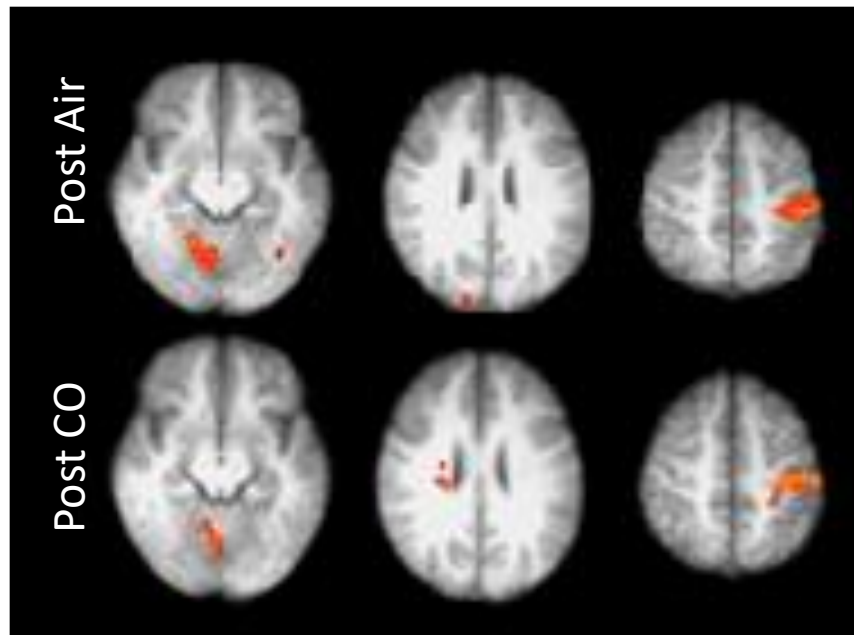
CO reduces global cerebrovascular reactivity. We found a significant difference between Air control inhalation (0.09 ± 0.06) and CO inhalation (0.04 ± 0.08 , $p < 0.05$). This could be caused by the vasoactive properties of CO.



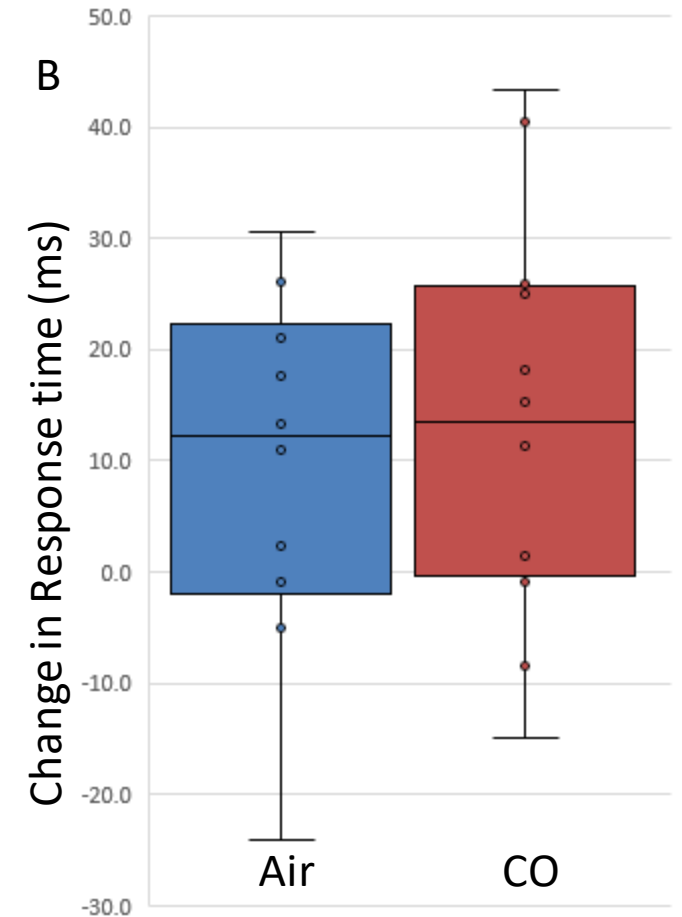
Neurological impact: Reaction time task



CO inhalation significantly reduces activation during a reaction time task. Control (air) inhalation does not alter activation. **Activation patterns are scaled to reaction times, linking fMRI signal with cognitive performance.**



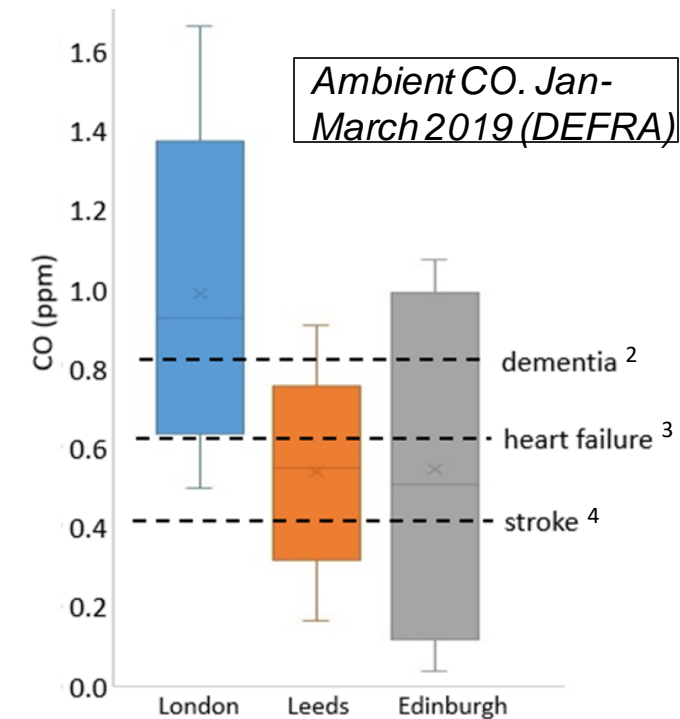
- A. Reduction in activation found in area associated with audio-spatial awareness (temporal lobe)
- B. Behavioural data shows no significant change in reaction time between protocols ($p=0.64$).



Where to next?

Data suggests that acute CO inhalation in low doses might affect both neurological and vascular function.

- Underlying mechanisms (link to potential target molecules)
- Larger samples to verify findings
- Dose dependency assessment using multimodal imaging, link to underlying mechanisms
- Explore disease links (impaired CVR correlates with declining brain health and may play a role in development of neurodegenerative disease)



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