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Whole-Brain Approaches for Investigating Iron Accumulation by MRI Show No Excess From Occupational Exposure to Welding Fumes

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Welders inhale large quantities of metal particulates from welding fumes, including iron (Fe) and manganese (Mn). Increased brain Mn deposition in welders has been shown by magnetic resonance imaging (MRI) and is considered neurotoxic. R1 and R2* are MRI contrasts proportionate to Mn and Fe accumulation, respectively. However, measurements of brain Mn can be confounded by accumulated Fe, altering mainly R2*, but also R1 to a lesser degree. Thus, studying Fe accumulation in welders is of consequential interest. While some research reports increased R2* levels in region-of-interest (ROI)-based analyses, such findings are inconsistent and target relatively few brain regions. Here we used a more comprehensive analysis, using machine learning.

In this study, principle component analysis (PCA), k-means clustering, and support vector machine (SVM) were utilized to evaluate differences between brain Fe levels in 196 brain regions of welders and controls. Using PCA, the best statistic to evaluate the data was the median, as it significantly narrowed the number of principle components (PCs) needed to explain 90% of data variance from 196 down to 28. K-means clustering, in conjunction with SVM, was unable to differentiate between the two groups. Null results in distinguishing between welders and controls using SVM, PCA, and k-means clustering suggest that R2*, and thus brain Fe accumulation, cannot distinguish these groups. This suggests that in spite of much larger Fe concentrations in welding fumes, measures of manganese accumulation are not confounded by an elevation of iron levels.

Research advisors Ulrike Dydak and David Edmondson write: "Changes in MRI R2 image contrast representing elevated iron content in the human brain are traditionally done with simple region-of-interest comparisons. Jennifer has taken her research on welding fume toxicity to the next level, applying machine-learning algorithms to make full use of the multi-dimensional information in whole-brain MRI images."*

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