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Department of Psychology

Du B, Tandoc M, Mack M, Siegel JA. 2020. Indoor CO_2 concentrations and cognitive function: A critical review. *Indoor Air*, **30(6)**, 1067-1082. DOI: 10.1111/ina.12706

Abstract

Poor indoor air quality indicated by elevated indoor CO_2 concentrations has been linked with impaired cognitive function, yet current findings of the cognitive impact of CO_2 are inconsistent. This review summarizes the results from 37 experimental studies that conducted objective cognitive tests with manipulated CO_2 concentrations, either through adding pure CO_2 or adjusting ventilation rates (the latter also affects other indoor pollutants). Studies with varied designs suggested that both approaches can affect multiple cognitive functions. In a subset of studies that meet objective criteria for strength and consistency, pure CO_2 at a concentration common in indoor environments was only found to affect high-level decision-making measured by the Strategic Management Simulation battery in non-specialized populations, while lower ventilation and accumulation of indoor pollutants, including CO_2, could reduce the speed of various functions but leave accuracy unaffected. Major confounding factors include variations in cognitive assessment methods, study designs, individual and populational differences in subjects, and uncertainties in exposure doses. Accordingly, future research is suggested to adopt direct air delivery for precise control of CO_2 inhalation, include brain imaging techniques to better understand the underlying mechanisms that link CO_2 and cognitive function, and explore the potential interaction between CO_2 and other environmental stimuli.

Main findings

1. The effects of CO_2 on cognitive function depend on a variety of factors and thus the findings in the literature may be highly case-dependent.
2. Improving indoor air quality by increasing ventilation rates may facilitate cognitive function.
3. Simply maintaining low CO_2 concentrations may have more limited benefits in non-specialized populations.
4. Current ventilation standards based on CO_2 concentrations may not suffice to improve or maintain cognitive function.

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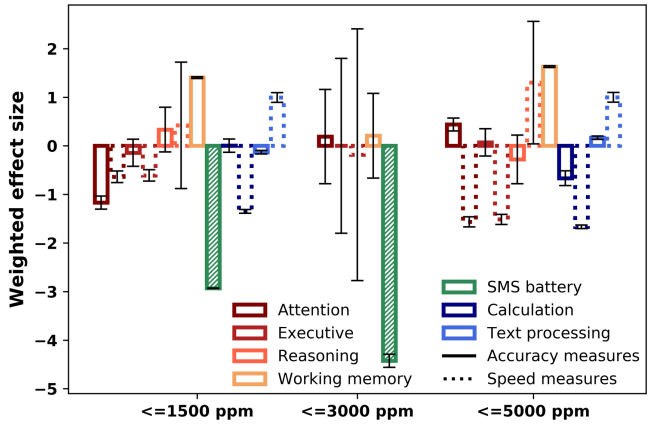

Figure 1: The weighted average effect size of cognitive results from selected CO_2 addition studies (x-axis shows the tested CO_2 concentration achived by adding pure CO_2; averaged from cognitive tests assessing the same cognitive function from one or multiple studies, with error bars representing the weighted standard error, shading indicating the percentage of cognitive tests that have found significant responses, and outline pattern differentiating accuracy and speed measures; SMS = Strategic Management Simulation).

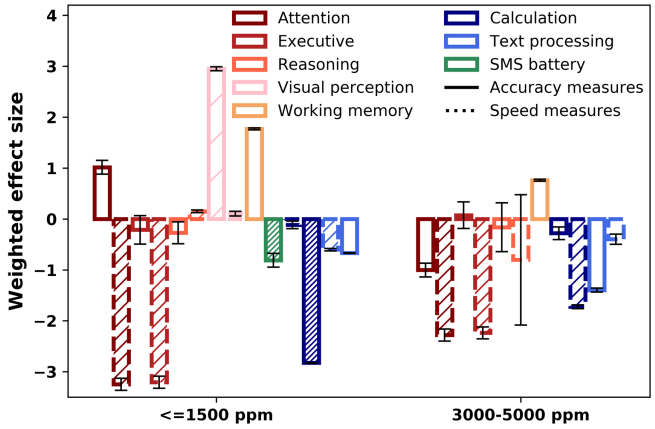

Figure 2: The weighted average effect size of cognitive results from selected ventilation manipulation studies (x-axis shows the tested CO_2 concentration achived by adjusting ventilation; averaged from cognitive tests assessing the same cognitive function from one or multiple studies, with error bars representing the weighted standard error, shading indicating the percentage of cognitive tests that have found significant responses, and outline pattern differentiating accuracy and speed measures; SMS = Strategic Management Simulation).