Is CO_2 an indoor pollutant?

Higher levels of CO_2 may diminish decision making performance

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Prior research has found that with higher indoor levels of CO_2, indicating less outdoor air ventilation per person, people tend to be less satisfied with indoor air quality, report more acute health symptoms (e.g., headache, mucosal irritation), work slightly slower, and are more often absent from work or school. It has been widely believed that these associations exist only because the higher indoor CO_2 concentrations occur at lower outdoor air ventilation rates and are, therefore, correlated with higher levels of other indoor-generated pollutants that directly cause the adverse effects. Thus CO_2 in the range of concentrations found in buildings (i.e., up to 5 000 ppm, but more typically in the range of 1 000 ppm) has been assumed to have no direct effect on occupants' perceptions, health, or work performance. A small study from Hungary [1] cast doubts about this assumption. The results from Hungary stimulated our effort to evaluate effects of variation in CO_2 alone on potentially more sensitive high-level cognitive functioning.

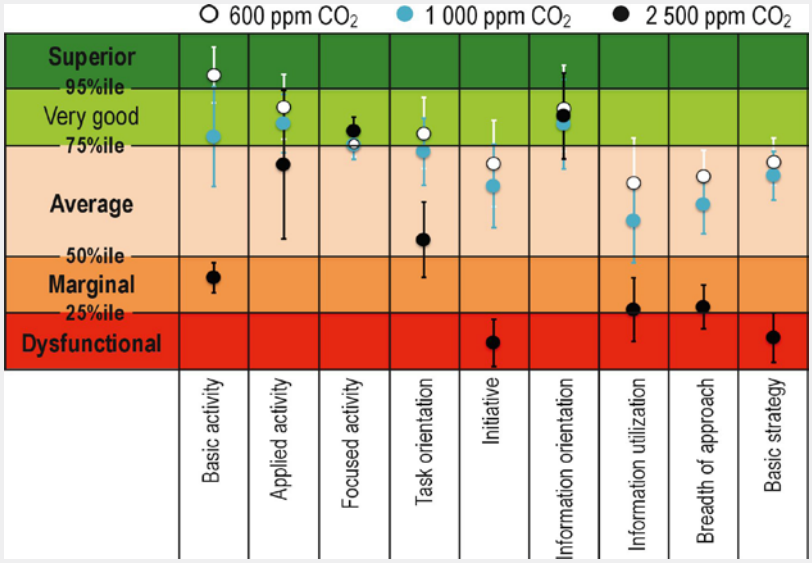

Figure 1. Impact of CO_2 on human decision-making performance. Error bars indicate one standard deviation.

In our experiment 22 subjects completed tests of decision making performance when exposed to low, medium, and high CO_2 concentrations for 2.5 h periods in an exposure chamber. During sessions with low CO_2, subjects and outdoor air were the only sources of CO_2, and measured CO_2 concentrations were approximately 600 ppm. In sessions with CO_2 at the medium and high levels of pure CO_2 was added to increase the CO_2 concentration to either 1 000 or 2 500 ppm. All other conditions remained unchanged. Each subject experienced all three CO_2 conditions on the same day and the order of sessions (low, medium, high; medium, low, high; etc.) was varied, as needed, among the subjects to cancel out effects of order of exposure.

The main results are depicted in **Figure 1**. The data indicate that at 1 000 ppm CO_2, relative to 600 ppm, there were moderate and statistically significant decrements in six of nine scales of decision-making performance. At 2 500 ppm, large and statistically significant reductions occurred in seven scales of decision-making performance, but a small increase in performance was seen in the focused activity scale. For some scales of performance, the reductions were dramatic. More details are provided in reference [2].

The dramatic direct influence of CO_2 on decision making performance was unexpected and the study needs to be replicated. The findings of this study, if replicated, have implications for the standards that specify minimum ventilation rates in buildings, and indicate the need to adhere more consistently to the existing standards. There is a current interest in reducing ventilation rates to save energy and reduce energy costs. Yet large reductions in ventilation rates could lead to increased CO_2 concentrations that adversely affect decision-making performance, even when indoor air concentrations of other air pollutants are maintained low through implementation of pollutant source control measures or application of gas-phase air cleaning systems. ■

References

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