

# Impacts of a changed atmosphere: Do increased CO<sub>2</sub> levels decrease human cognitive performance?

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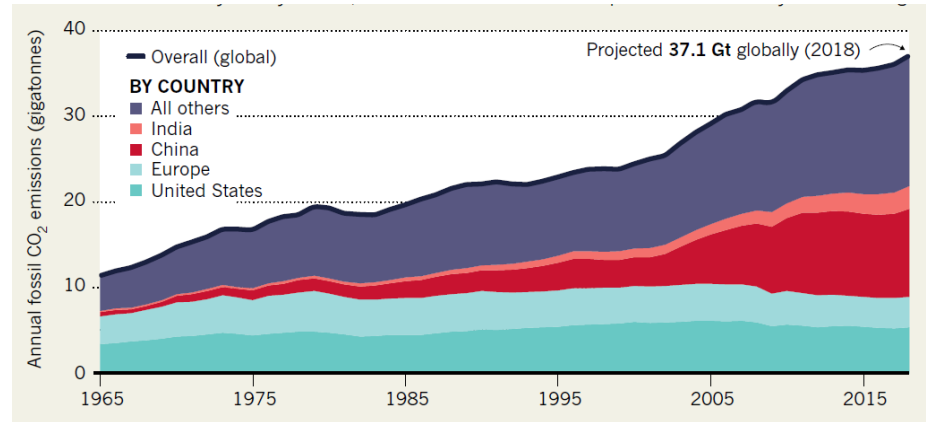
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# Moving towards a high(er) CO<sub>2</sub> world

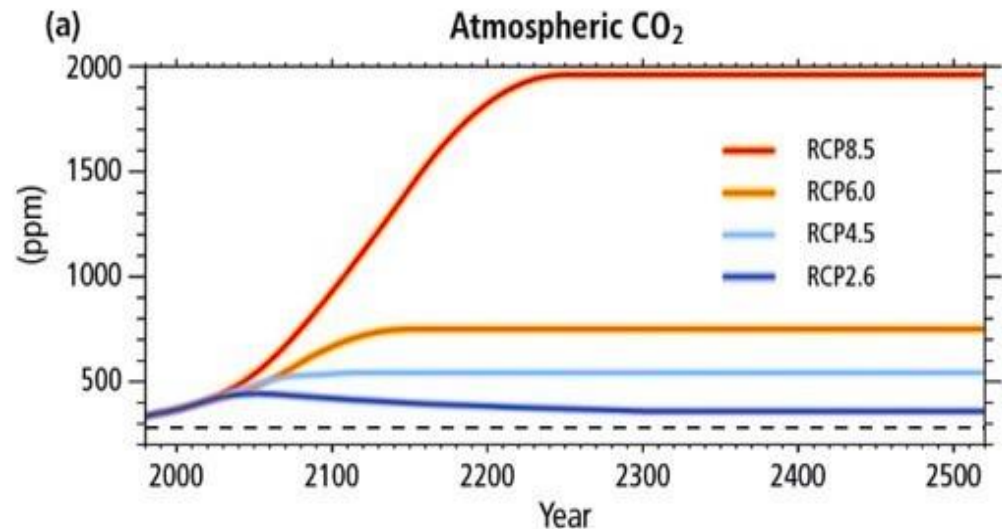
Emissions are still rising (after a brief lull).

*Figueres, C. et al. Emissions are still rising: ramp up the cuts. Nature 564, 27–30 (2018).*



IPCC 5<sup>th</sup> Assessment report: higher atmospheric CO<sub>2</sub> projected.

*IPCC. Climate Change 2014: Synthesis Report.*



# Consequences of climate change [on human health]

2018 Lancet Countdown Report: *'... unmitigated climate change has the potential to disrupt core public health infrastructure and overwhelm health services.'*

Effects resulting from the driver of climate change, i.e., the burning of fossil fuels

- Outdoor pollution
- Indoor pollution

Effects resulting from result of climate change, i.e., the changed climate

- Extreme temperatures
- Droughts & flooding
- Vector-borne diseases
- etc.

*The 2018 report of the Lancet Countdown on health and climate change: shaping the health of nations for centuries to come. Watts, Nick et al. The Lancet, Volume 392, Issue 10163, 2479 – 2514.*



Are there consequences from a changed  
atmosphere?

Is CO<sub>2</sub> a pollutant in its own right?



<https://www.thetimes.co.uk/article/greenhouse-gases-are-making-us-more-stupid-xq5pvv6l7#>



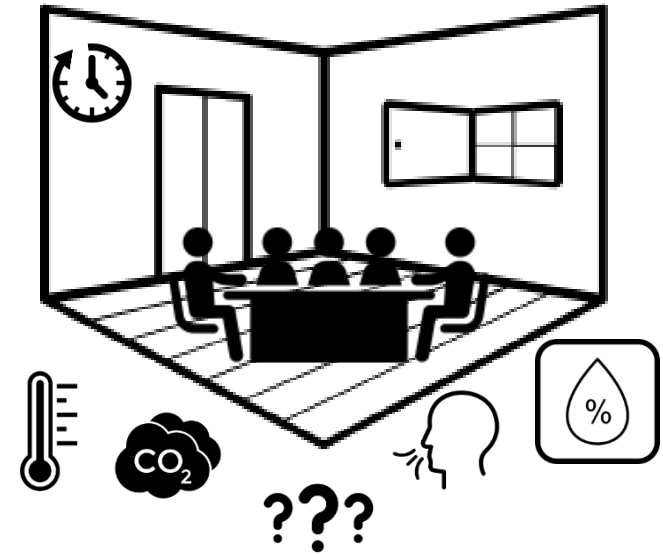
# Does CO<sub>2</sub> impact on performance?

We have:

Correlational evidence:

*Higher CO<sub>2</sub> ~ Lower performance*

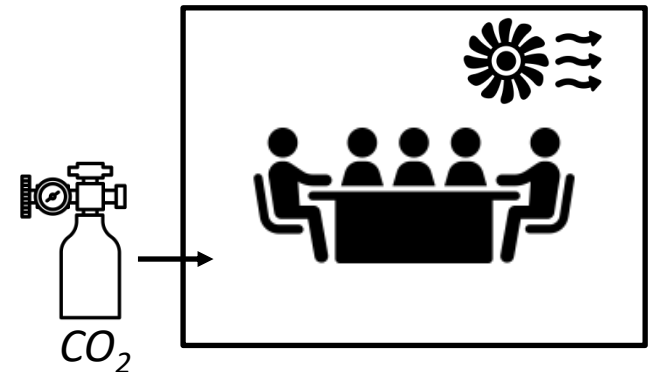
(e.g. Seppänen, O., Fisk, W. J. & Lei, Q. H (2006); Twardella, D. et al. (2012).



We need:

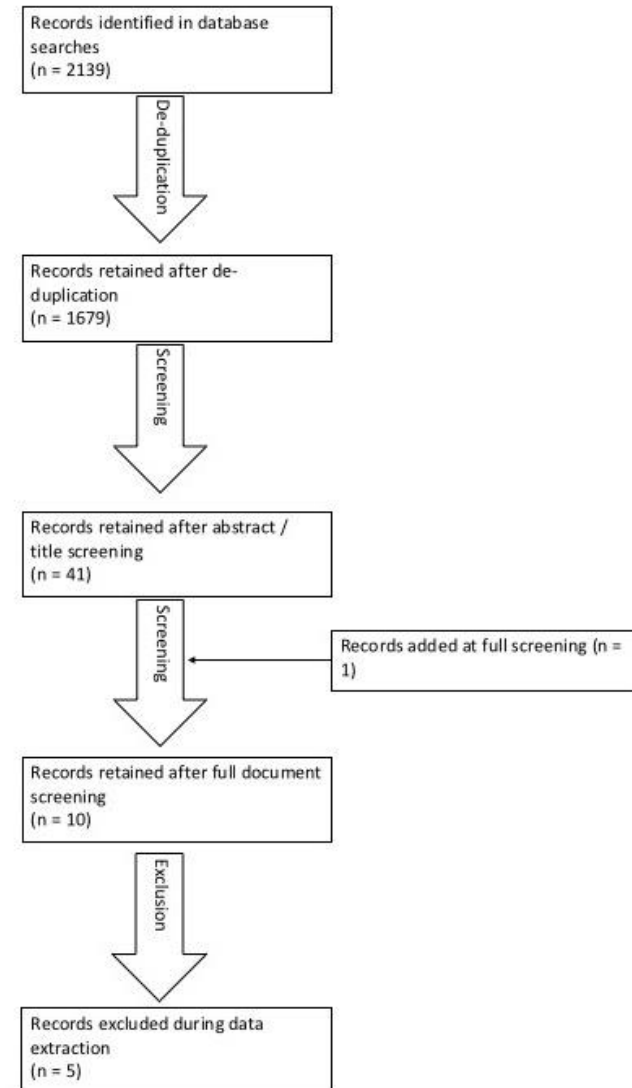
Causal evidence:

*Higher CO<sub>2</sub> → Lower performance*



# Rapid evidence assessment (REA) - Method

- Search terms (+variations)
  - ‘CO<sub>2</sub>’ & ‘Performance’ & ‘Building’
- Data bases
  - *Scopus*
  - *Web of Science*
- Exclusion criteria:
  - *Modelled data*
  - *Correlational data*
  - *Animal studies*
  - *Specific populations*
  - *Qualitative data*



# REA - Results

1 <sup>st</sup> author, country, year	Sample size & type	CO2 conditions (ppm)	Exposure (minutes)	Tests	Effect
Zhang Denmark, 2017	25 Students	500, 1000, 3000	≈255	Office work Neuro-behavioural tests	NO
Zhang Denmark, 2017	10 Students	500, 5000	≈153	Typing Addition Connecting numbers	NO
Kajtár Hungary, 2012	10 ?	Exp1: 1500, 2500, 600, 5000 Exp2: 500, 3000, 600, 4000	Various	Proofreading	Exp1: NO Exp2: YES
Allen USA, 2016	25 Employees	550, 945, 1400	360	SMS (Strategic Management Simulation)	YES
Satish USA, 2012	N = 22 Students	600, 1000, 2500	≈60	SMS (Strategic Management Simulation)	YES

Additional evidence:

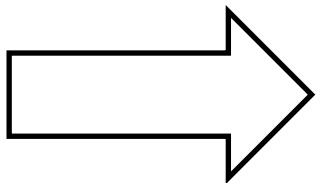
YES: Absence of expected learning effect (Snow, S. *et al.*, 2019)

NO: No effect in astronaut-like subjects (Scully *et al.*, 2019)



## RAE – Conclusions

- Evidence is mixed
  - Research design issues
  - Task specific effects
  - Task difficulty
  - Subject effects
- None of the studies have linked this to climate change.



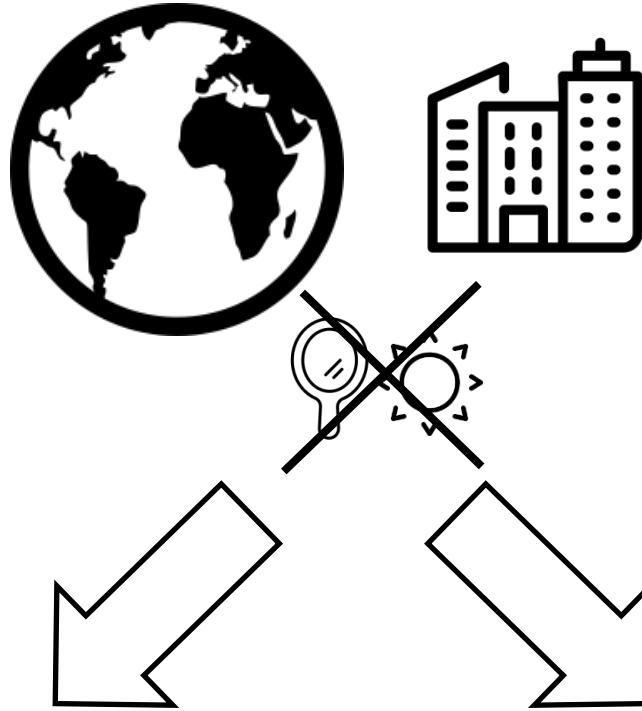
**We need more and better research!**

Lowe, R. J., Huebner, G. M. & Oreszczyn, T. Possible future impacts of elevated levels of atmospheric CO<sub>2</sub> on human cognitive performance and on the design and operation of ventilation systems in buildings. *Build. Serv. Eng. Res. Technol.* 1–14 (2018).





# Global issue



Most people (will) live in cities & spend most time indoors.

Option 1:  
No mitigation.

Option 2:  
Mitigation of increased CO<sub>2</sub> through diluting internal air with more external air.

Reduced performance.



Reduced productivity.  
Reduced income.



Increased energy use through more ventilation, space heating, and space cooling



# Thanks!



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Icons for "thank you" 379 icons

<https://thenounproject.com/search?q=thank%20you>

