

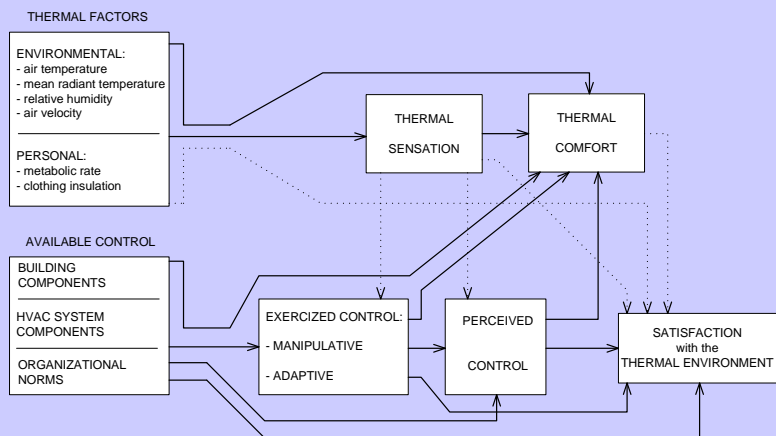


AIVC Ventilative Cooling workshop
Brussels - March 19+20, 2013

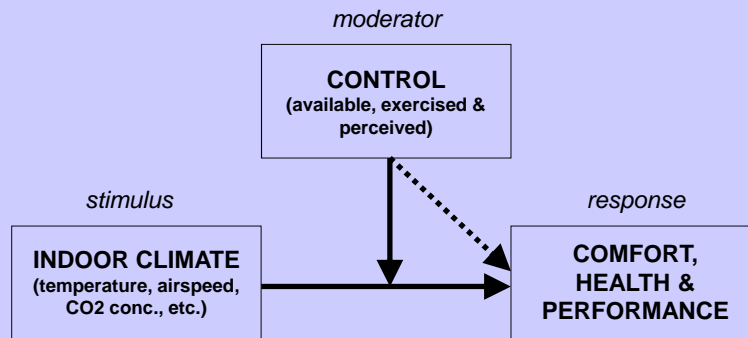
PERSONAL CONTROL OVER INDOOR CLIMATE AND THE USE OF OPERABLE WINDOWS IN OFFICES

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THEORY I: CONCEPTUAL MODEL PACIUK (1990)



THEORY II: CONCEPTUAL MODEL BOERSTRA ET AL (2013)



Assumption is that human responses to sensory stimuli are modified when those exposed have control over the stimuli...
(after Bell et al, 2002, Paciuk, 1990 and Brager & DeDear, 1998)

AIR MOVEMENT IN WARM ENVIRONMENTS

Dr. Angela Simone, DTU, 2012:

'Everyday experience and numerous climatic chamber and field studies show that in warm environments air movement is perceived as pleasant'

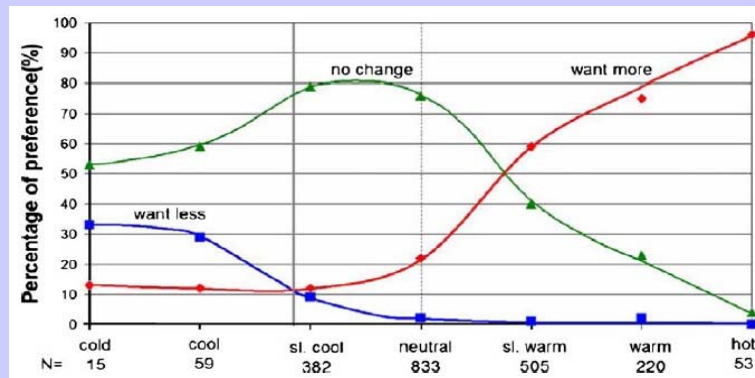


DRAFTS IN WINTER ARE PLEASURABLE BREEZES IN SUMMER!

See for example:

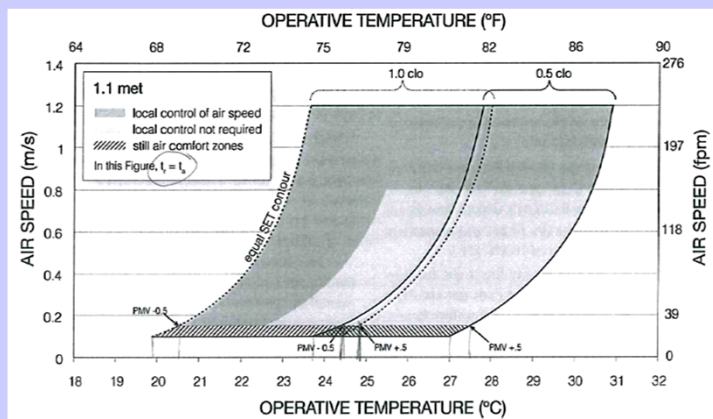
Ishii et al (1990)	Brager GS et al. (2004)
Chow & Fung (1994)	Gong N et al. (2006)
Fountain et al. (1994)	Atthajariyakul &
Mallick (1996)	Lertsatittanakorn (2008)
Kubo et al. (1997)	Yang & Zhang (2009)
Kitagawa et al. (1999)	Zhang et al. (2007)
Cena & deDear (1999)	Baizhan et al. (2010)
Donnini et al. (1997)	Cândido et al. (2010)
Khedari et al. (2000)	Chow et al. (2010)
Xia YZ et al. (2000)	and many more...

AIR MOVEMENT PREFERENCE AND THERMAL SENSATION



Zhang et al. 2007

'NEW' TEMPERATURE / AIRSPEED GRAPH IN ASHRAE STANDARD 55: 2010



'Breeze figure' in EN-ISO 7730: 2005

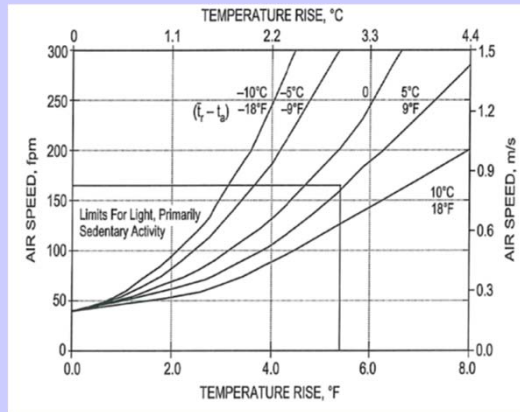
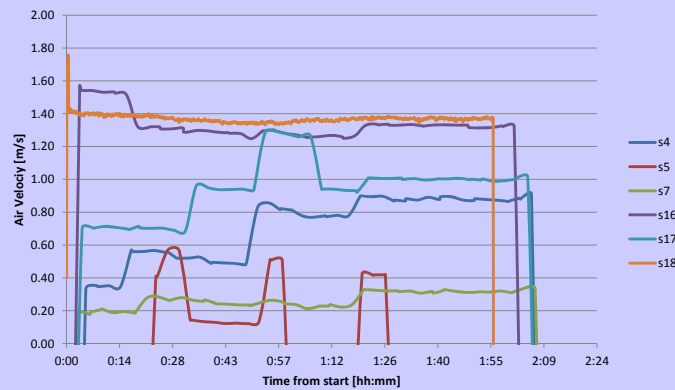


Fig. 5.3 Air velocity required to offset increased temperature

LARGE INDIVIDUAL DIFFERENCES (direct control is essential)

Example results of preferred airtpeed in a laboratory room of 28 °C for 6 subjects; airtpeed was under direct control at workstation level and could be changed at free will

Air Velocity Fans



Te Kulve et al, 2013

WHAT HAPPENS IF ONE IS TOO WARM?

OPTION 1: SUE the engineer that designed the cooling system

OPTION 2: ADAPT (psychological, behavioral, physiological)

Ad 2, based on unpublished results from a field study, this is what people do when warm:

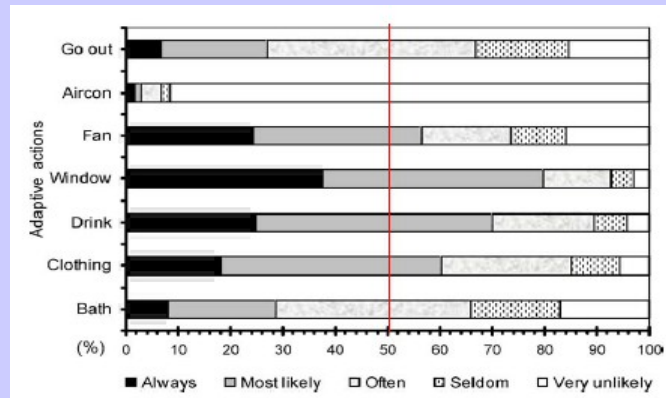
1. **Open a window**
2. Take of jackets, sweaters etc
3. Close blinds, curtains etc
4. Drink something cold
5. Start (table) fan
6. Move to other space where it is cooler
7. Just accept that it is warm (internal coping)
8.

Adaptive behavioural actions acc. to Boerstra et al (2013)

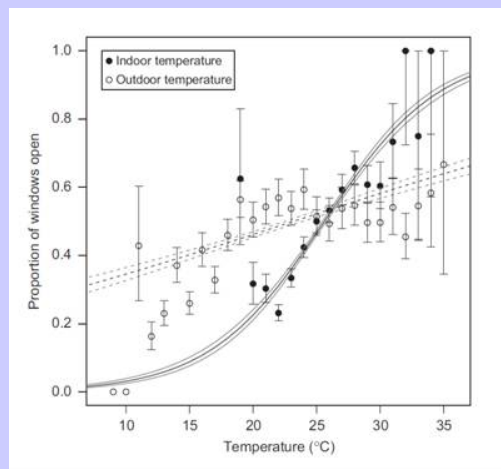
Use of controls - WINTER			
		Count	Perc.
Operable window use	daily	30	19%
	weekly	38	24%
	monthly	23	14%
	less than monthly / never	48	30%
	not applicable	20	13%
	Total	159	100%
Temperature knob use	daily	16	10%
	weekly	18	11%
	monthly	31	19%
	less than monthly / never	48	30%
	not applicable	48	30%
	Total	161	100%
Clothing adjustment	daily	33	23%
	weekly	38	26%
	monthly	26	18%
	less than monthly / never	48	33%
	Total	145	100%

Use of controls - SUMMER			
		Count	Perc.
Operable window use	daily	76	48%
	weekly	17	11%
	monthly	27	17%
	less than monthly / never	15	9%
	not applicable	24	15%
	Total	159	100%
Temperature knob use	daily	1	1%
	weekly	5	3%
	monthly	7	4%
	less than monthly / never	95	60%
	not applicable	51	32%
	Total	159	100%
Clothing adjustment	daily	33	24%
	weekly	26	19%
	monthly	30	22%
	less than monthly / never	50	36%
	Total	139	100%

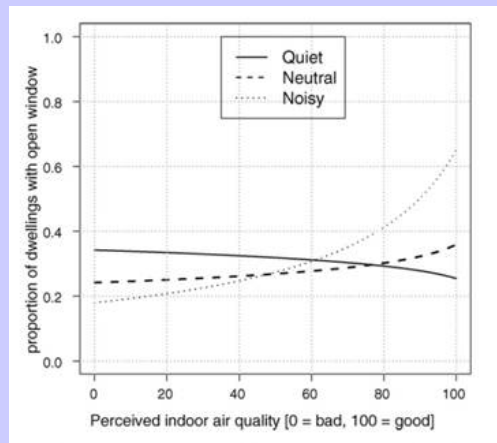
Adaptive behavioural actions acc. to Feriadi & Wong (2004)



Window opening probability in offices as a function of indoor and outdoor temperature (Haldi & Robinson, 2008)



Association between proportion of dwellings with open windows and perceived indoor air quality and outside noise situation (Andersen et al, 2009)

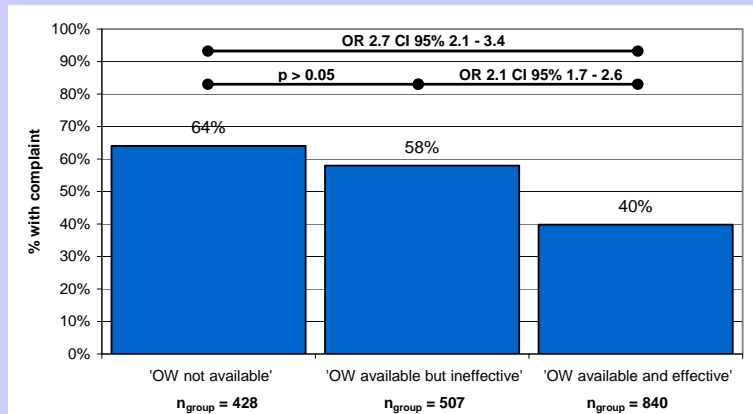


PROOVEN BENEFITS OF OPERABLE WINDOWS

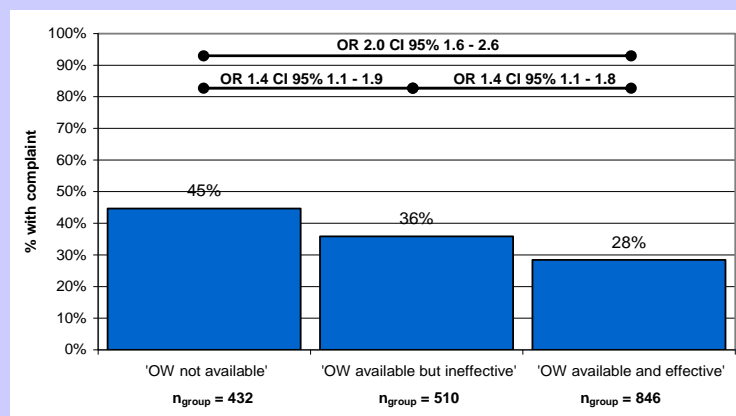
1. Free (ventilative) cooling
2. *Fast* control over temperature and indoor air quality
3. **Generally better thermal and olfactory comfort**
4. **Lower incidence of Sick Building symptoms**
5. **Higher productivity**
6.

(specific effects in a specific building depend upon floor plan, amount of colleagues one shares the room with, design of the operable window, window interface etc.)

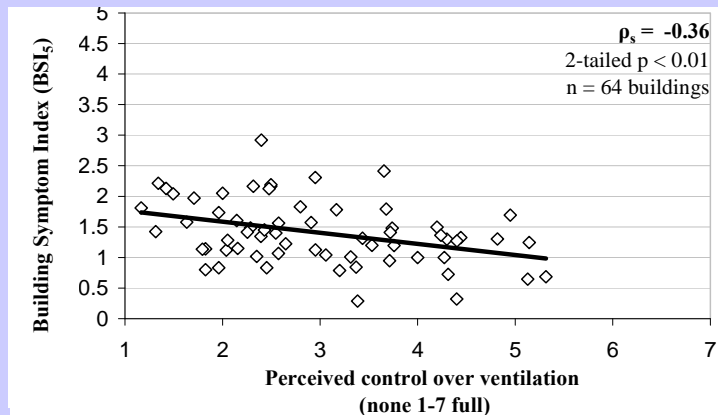
Access to Operable Windows (OW) and percentage of respondents 'often experiencing air as stuffy, smelly or stale' (Boerstra et al, 2011)



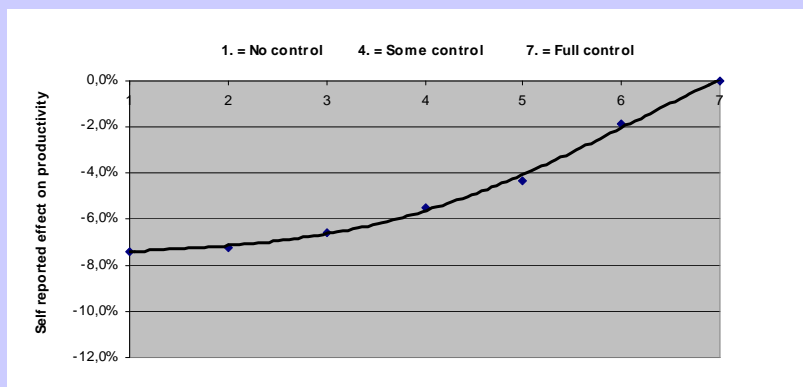
Access to Operable Windows (OW) and percentage of respondents with Personal Symptom Index > 2 (scale 0-5) (Boerstra et al, 2011)



Perceived control over ventilation and incidence of SBS symptoms (Boerstra et al, 2013)



The impact of perceived control over ventilation on self reported productivity (based on: Raw, 1990)



Conclusion:

- Operable windows are MORE than just tools to optimize the ventilative cooling performance of a building
- Offering (adequate) personal control over ventilation results in more comfortable and more healthy building occupants and enhanced productivity

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