Eur J Appl Physiol (2010) 108:1281–1282
DOI 10.1007/s00421-009-1324-y

REPLY

On the origins of cold-induced vasodilation

Andreas D. Flouris · Stephen S. Cheung

Accepted: 3 December 2009 / Published online: 18 December 2009

Recent work by our group showed that cold-induced vasodilation (CIVD) is a centrally originating phenomenon caused by sympathetic vasoconstrictor withdrawal; it is dependent on excess heat, and it may be triggered by excess heat with the purpose of preserving thermal balance (Flouris et al. 2008; Flouris and Cheung 2009a, b). To this effect, Daanen and Layden (2009) recently argued that, instead, our data show that CIVD is of peripheral origin. Thus, our aim in this letter is to briefly clarify misconceptions that may have led Daanen and Layden to questionable inferences.

We have reported a sympathetic withdrawal during CIVD (Flouris and Cheung 2009b) in line with the evidence that CIVD is attributed to an interruption of adrenergic neurotransmission (Johnson et al. 1986). Given that sympathetic activity is generally inversely associated with core temperature (Sawasaki et al. 2001), Daanen and Layden derived that "…the sympathetic activity must have been continuously increasing during the cooling period" which led them to the conclusion that CIVD in our study "…was of peripheral rather than central origin". Since our experiment demonstrated a sympathetic withdrawal—not activation—during CIVD, the logic and conclusion of Daanen and Layden are fallacious.

Communicated by Susan Ward.

A. D. Flouris (✉)
FAME Laboratory, Institute of Human Performance and Rehabilitation, Centre for Research and Technology Thessaly, 32 Siggrou Street, GR42100 Trikala, Greece
e-mail: aflouris@cereteth.gr

S. S. Cheung
Department of Physical Education and Kinesiology, Brock University, St. Catharines, Canada

In their letter, Daanen and Layden argue that careful reading of the literature does not support our claim that CIVD can be induced by whole body cold exposure. Indeed, Montgomery and Williams (1977) did not investigate CIVD and we were misled by their reference to "cold vasodilation" in their discussion. However, the remaining claims of Daanen and Layden are inaccurate as Berry et al. studied CIVD ["…the occurrence of cold-induced vasodilation (CIVD) found in the present study agrees with that observed by…" (1984)], while Steegmann ["…90 min of exposure to 1°C air moving over the face and body at about 6 m/min" (1979)] as well as Brajkovic and Ducharme ["…subjects walked comfortably (4.8 km/h) on a treadmill during exposure to four 90-min tests, each at a different environmental condition…" (2006)] did, in fact, expose the entire body to cold, not just the face. Moreover, Shitzer's group did induce CIVD via whole body cold exposure in the papers that we referenced (Shitzer 1998; Shitzer et al. 1991, 1998a, b). There is, obviously, a mistake here as Daanen and Layden refer to papers by Shitzer's group (Shitzer et al. 1996, 1997) that we never referenced. A final point of Daanen and Layden was that the phenomenon we interpreted as CIVD in our original experiment (Flouris et al. 2008) was a normal heat loss mechanism because, at times, finger temperature was up to 33.5°C. However, finger temperature for a large part of the experiment was below 15°C and was very often as low as 5°C, confirming that the cold stimulus to the hands was strong enough to evoke CIVD. Also, similar insulation of the body and hands has been used in several studies in the past (Santee et al. 1990; Shitzer 1998; Shitzer et al. 1991, 1998a, b), all of which incorporated shorter and less severe exposures compared to ours but reported a large number of CIVDs.

In conclusion, no salient data or arguments have thus far been presented refuting that CIVD is a centrally originating

phenomenon caused by sympathetic vasoconstrictor withdrawal with the purpose of preserving thermal balance.

References

Berry JJ, Montgomery LD, Williams BA (1984) Thermoregulatory responses of rats to varying environmental temperatures. Aviat Space Environ Med 55:546–549

Brajkovic D, Ducharme MB (2006) Facial cold-induced vasodilation and skin temperature during exposure to cold wind. Eur J Appl Physiol 96:711–721

Daanen HA, Layden JD (2009) Reply to A. D. Flouris and S. S. Cheung reply letter regarding "cold-induced vasodilation". Eur J Appl Physiol (in press)

Flouris AD, Cheung SS (2009a) Authors' response to H. Daanen's 'Cold-induced vasodilation' letter. Eur J Appl Physiol 106:317–319

Flouris AD, Cheung SS (2009b) Influence of thermal balance on cold-induced vasodilation. J Appl Physiol 106:1264–1271

Flouris AD, Westwood DA, Mekjavic IB, Cheung SS (2008) Effect of body temperature on cold induced vasodilation. Eur J Appl Physiol 104:491–499

Johnson JM, Brengelmann GL, Hales JR, Vanhoutte PM, Wenger CB (1986) Regulation of the cutaneous circulation. Fed Proc 45:2841–2850

Montgomery LD, Williams BA (1977) Variation of forearm, hand, and finger blood flow indices with ambient temperature. Aviat Space Environ Med 48:231–235

Santee WR, Endrusick TL, Penscotti LS (1990) Comparison of light duty gloves with natural and synthetic materials under wet and dry conditions. In: Das B (ed) Advances in industrial ergonomics and safety. Taylor and Francis, London, pp 347–354

Sawasaki N, Iwase S, Mano T (2001) Effect of skin sympathetic response to local or systemic cold exposure on thermoregulatory functions in humans. Auton Neurosci 87:274–281

Shitzer A (1998) On the thermal efficiency of cold-stressed fingers. Ann N Y Acad Sci 858:74–87

Shitzer A, Stroschein LA, Santee WR, Gonzalez RR, Pandolf KB (1991) Quantification of conservative endurance times in thermally insulated cold-stressed digits. J Appl Physiol 71:2528–2535

Shitzer A, Stroschein LA, Gonzalez RR, Pandolf KB (1996) Application of a lumped-parameter heat exchange model to cold-induced temperature and blood flow measurements in the finger-tip. J Thermal Biol 21:213–222

Shitzer A, Stroschein LA, Sharp MW, Gonzalez RR, Pandolf KB (1997) Simultaneous measurements of finger-tip temperatures and blood perfusion rates in a cold environment. J Therm Biol 22:159–167

Shitzer A, Bellomo S, Stroschein LA, Gonzalez RR, Pandolf KB (1998a) Simulation of a cold-stressed finger including the effects of wind, gloves, and cold-induced vasodilatation. J Biomech Eng 120:389–394

Shitzer A, Endrusick TL, Stroschein LA, Wallace RF, Gonzalez RR (1998b) Characterization of a three-phase response in gloved cold-stressed fingers. Eur J Appl Physiol Occup Physiol 78:155–162

Steegmann AT Jr (1979) Human facial temperatures in natural and laboratory cold. Aviat Space Environ Med 50:227–232