Research of Nico A.M. Schellart in diving and environmental medicine

During his scientific career as neuroscientist Nico Schellart only occasionally did research into environmental medicine, mainly physiology, especially regarding diving. More recently, he succeeded to do a little more in dive physiology and medicine.
Three types of interest can be distinguished as will be described below.

The performance of the visual system under water.

1. Nitrogen narcosis may dramatically affect the performance of the senses, e.g. the visual system, peripherally but especially centrally. One study was performed to establish whether during a dry simulation on air at 65 msw the visual acuity was diminished. It appeared not to be (1). Reanalysis of the data show that the test time (to decide the orientation of a Landolt C) increased, which should predominantly be caused by delayed central processing. Since processing of acuity, a simple visual feature, is mainly located peripheral; this is an indication that N_2 narcosis would especially affect central mechanisms.
2. Another study, performed in open water at 40 msw, considered visual contrast sensitivity. Also here the influence of N_2 narcosis was the study theme. It was found that at 40 msw the observed reduction of sensitivity could be transposed to a diminishing of seeing distance of 10% (2).
3. Another project considered red-green colour vision under hyperoxic and hypoxic conditions (3). In general, during moderate air-hyperbarism and HBO_2 colour vision seems to be normal, but evaluation of the coloured scene is probably less stable and slightly slower.

Neurophysiology, fundamental and clinical environmental studies

The metabolic gases O_2 and CO_2 are assumed to affect under non-normobaric conditions brain performance. This may be reflected in the spontaneous EEG.

4. Hypoxia was examined by spectral analysis, especially of the (10 Hz) alpha rhythm (4).
5. In the 90-thies, MEG (magneto-encephalography) was a new, promising objective neurophysiologic technique to quantify cortical activity. In a small paper EEG and MEG was compared and it was concluded that the combination of both techniques gives a more complete image of cortical functioning. It possibly may show cortical damage by acute AGE and by multiple neurological DCS events and improvement after HBOT. EEG&MEG was preliminary applied to normobaric apnoea's (5) and later more extensive.
6. With multichannel EEG&MEG and breath-holding of hardly or untrained subjects, alfa activity with open eyes was more similar to the closed-eye condition (alpha peak more pronounced), suggesting that during hypoxia alertness was lower (6). Systemic hypercapnia appeared ineffective.
7. A completely different study respects the use of HBOT with long-term brain tumor survivors with cerebral radiation damage. HBOT stimulates neovascularisation of hypoperfused tissue and may result in improved functionality of damaged tissue. With clinical neurophysiologic tests to assess the effect of HBOT on brain performance it was concluded tentatively that HBOT can improves neurophysiologic performance in long-term brain tumour survivors (7).

Diving physiology

Recompression physiology has been studied for more then 150 years, but even now often curious observations are reported. This is due to the fact that even to date elementary processes and mechanisms are still not well known. Schellart focussed to aspects that seemed to be well established, but critically considering the literature old 'insights' appeared sometimes not well proved.

8. When the deep stop idea was launched, it was immediately adopted in diving practise. In 2005 Schellart et al. performed a study into the deep stop. The deep stop results of previous papers could not be confirmed (8). Some years later, a DAN symposium was devoted the deep stop and it was concluded that the benefits were not established.
9. In diving practise one is generally not aware that a first dive, especially after a long period of not diving, has another physiology as a first dive in a series of diving days, irrespective the inert gas load-effects. A study was devoted to precordial Doppler measurements of a first dive and a second identical dive. Surprisingly, the second dive did not yield higher bubble grades, suggesting that bubble stress was enhanced with a first dive after a long period of no diving (9).
10. (&12) Body fat (BF) is seen as a predisposing factor for a century. Generally it is considered as a stressor (causality). In a field study it was showed that BF is not a stressor but only a with-age&VO_{2max} associated indicator for bubble stress. In the same study (10), data of another study were re-analysed, yielding the same results.
11. The classical reasoning is that BF has a 5 times higher solubility compared to watery tissues. In a recent study, the N_2 load of the blood was modelled with a lean and fat diver-model. It was shown that this BF difference does not result in a measurable difference in bubble stress. In the same study with divers with a narrow age and VO_{2max} range, it was experimentally shown that body fat is not at all related to bubble counts (maybe the reverse). This and the previous study, together based on 3 independent data bases, establish that BF is not a stressor but a rather poor associated indicator.

    For a century dive physiologist are hunting for predisposing factors. Until now, I only consider age, VO_{2max}, poor lung function (diffusion capacity, microcirculation), PFO and unexplained multiple DCI incidents as long-term demographic predisposing stressors. All others mentioned in literature are based on one or at most two well performed studies. However, more stressors may exist and one can ask whether haematological factors may play a role.

    Candidates are fatty acids, other plasma lipids, lipoproteins and plasma surface tension (ST; high ST can contribute to longer bubble life time and so more bubbles).
13. In a letter to the editor of ASEM it is argued that the conclusion of the paper: “The influence of high-fat diets on the occurrence of decompression stress after air dives.” is invalid and moreover poddibly unlikely.
14. FA is an ideal candidate to constitute surfactant monolayers around inert gas bubbles. In a study with a maximized range of FA in plasma in the study population, with excluding age and VO_{2max}, it appeared that bubble stress was not influenced by FA. It was concluded that FA probably does not contribute in formation of regular surfactant monolayers around bubbles.
15. In another study it was found theoretically that it is unlikely that blood lipids are surfactant candidates. Experimentally it was found that none of them modulated blood surface tension. Probably blood proteins, especially albumin may cover bubbles. This decreases surface tension but sibce albumin is in great excess modulation of surface tension by albumin and other proteins is impossible.

(Partial) Pressure related peer reviewed international-journal papers

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3. Schellart NAM, Pollen M, Van der Kley A. Effect of dysoxia and moderate air-hyperbarism on red-green color sensitivity Undersea Hyperb Med 1997:24:7-13.
4. Schellart NAM, Reits D. Transient and maintained changes of the spontaneous occipital EEG during acute systemic hypoxia. Aviat Space Environ Med Volume: 2001;72: 462-470
5. Schellart NAM, Reits D. Is magnetoenchephalography applicable in the clinical neurophysiology of diving? SPUMS Journal 1998;29:156-158. 6.
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7. Schellart NAM, Reits D, van der Kleij AJ, and Stalpers LJA. Hyperbaric Oxygen Treatment Improved Neurophysiologic Performance in Brain Tumor Patients After Neurosurgery and Radiotherapy. A Preliminary Report, Cancer. 2011;117:3434-44. Free article.
8. Schellart NA, Corstius JJ, Germonpré P, Sterk W. Bubble formation after a 20-m dive: Deep-stop versus shallow-stop decompression profiles. Aviat Space Environ Med. 2008 May;79(5):488-94.
9. Schellart NAM, Sterk W Venous gas embolism after an open-water air dive and identical repetitive dive. Undersea Hyperb Med 2012: 39: 577-587
10. Schellart NAM, van Rees Vellinga TP, van Dijk FH, Sterk W Doppler bubble grades after diving and relevance of body fat. Aviat Space Environ Med 2012: 83: 951-957
11. Schellart NA, van Rees Vellinga TP, van Hulst RA Body fat does not affect venous bubble formation after air dives of moderate severity: theory and experiment. J Appl Physiol 2013: 114: 602-610.
12. Schellart NA, van Rees Vellinga TP, van Dijk FH, Sterk W. In response to a letter considering “”Doppler bubble grades after diving and relevance of body fat.” Aviat Space Environ Med 2014: 84: 84-85.
13. Schellart NA, Sterk W. High-fat diets and decompression stress revisited. Comment on The influence of high-fat diets on the occurrence of decompression stress after air dives. [Undersea Hyperb Med. 2013]. Undersea Hyperb Med. 2014 Mar-Apr;41(2):167-8. No abstract available.
14. Schellart NA. Free Fatty acids do not influence venous gas embolism in divers. Aviat Space Environ Med. 2014 Nov;85(11):1086-91.
15. Schellart NAM, Rozložník M, Balestra C. Relationships between plasma lipids, proteins, surface tension and post-dive bubbles. Undersea Hyperb Med, 2015;42: 133-141.

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