(SD = 3.2%). The effects of jogging could be explained by more rapid gas ecchange, increased capillary movement and adaptive carboxyhemoglobin transport to and from muscular tissue. Since the formation of carboxyhemoglobin is a reversible process, pinpointing the exact pulmonary physiological mechanisms responsible for such a lowering effect awaits further study.

Smokers usually have higher levels of carboxyhemoglobin than non-smokers (often 5–10% more). Based on this study, jogging and cigarette smoking thus seems to have antagonistic effects, with the former functionally similar to non-smoking as far as CO level is concerned. Since cigarette smoking has been documented to be linked with respiratory and cardiac problems, jogging is highly recommended for smokers as a precaution against excessive CO build-up.

1 Acknowledgments. The author is deeply indebted to Mrs Katy Seifert and Ms Susan Reichmann for their encouragement throughout the study.
2 American Conference of Governmental Industrial Hygienists: Threshold Limit Values for Chemical Substance and Physical Agents in the Work Environment. Cincinnati, Ohio, 1980.
3 I.R. Tabershaw, H.M.D. Utidjian and B.L. Kawahara, in: Chemical Hazards in Occupational Diseases, A Guide to their Recognition. Public Health Service, National Institute of Occupational Safety and Health, 1977.
4 K. Morgan and N.L. Lapp, in: Diseases of the Airways and Lungs in Occupational Diseases, A Guide to their Recognition. Public Health Service, National Institute of Occupational Safety and Health, 1977.
5 J.D. Blackmore, Analyst *95*, 439 (1970).
6 I. Sunshine, ed., Manual of Analytical Toxicology. Chemical Rubber Company, CRC Press, 1971.

Postural effects of neck muscle vibration in man

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Summary. Vibration of the dorsal neck muscles in man induces falling reactions, walking and 'marche en étoile', probably by muscle afferent activation. It can be used as a reproducible error signal in analyzing the interaction between neck muscle proprioception and vestibular as well as ocular motor systems. These interactions are important for posture and coordinated head-eye movements.

Muscle vibration in man induces postural and kinesthetic changes by muscle afferent activation[1]. Earlier studies have been restricted to the effects from vibrated arm, leg and trunk muscles. The neck muscle contains a high density of muscle spindles and is a powerful source for afferent input concerned in postural reflexes of the cat[2,3]. The present study was undertaken to investigate postural effects in man following neck muscle afferent activation induced by muscle vibration.

The vibrator used (Keydon) is an excentrically loaded electric motor set at 150 Hz. It was fixed to the dorsal neck muscles by a rubber strip around the forehead in normal persons. The vibrator was fixed either in the midline or more laterally on one of the splenius capitis muscles. The subjects tested, adults or children, were tested both blindfolded and with eyes open. The test was performed in the Romberg position, i.e. erect with feet together and the subjects were asked not to voluntarily overcome falling reactions.

After the onset of vibration there is a subjective experience of forward tilt as well as a real falling reaction of the whole body forward. The reaction differed somewhat in magnitude in different subjects, but has been observed in all 40 persons so far tested. The latency for the onset of the forward falling reaction is approximately 0.5 sec. If the vibration was kept on for a sufficient time, 3–5 sec, many of the persons tested were forced to make rather gross compensation movements, i.e. stepping forward, moving arms etc., to avoid a completed fall. If, on the other hand, vibration was stopped after a minor sway forward, the initial position was immediately regained without any 'over shoot' and the subjective experience of dysbalance was likewise quickly eliminated. Midline neck muscle vibration in small children (age 2–5 years) induced walking which looked quite natural and stopped when the vibrator was stopped.

The falling reaction was greatly reduced if the subjects kept the eyes open and it was also reduced by voluntary effort, or if successive trials were made within some min.

If the vibrator was fixed over the left splenius capitis muscle during a 'marche en étoile' test, deviation occurred anticlockwise and vice versa. The same effect was seen at a simple stepping test on the spot.

Tests were also performed on an inclined plane. Subjects were asked, blindfolded to turn around slowly during stepping. If neck muscle vibration to the midline was added the test became impossible to perform with precision. Actually the subjects stopped stepping and took a stable immobile position with knees bent.

Infiltration with a local anesthesia (xylocain) in the skin surrounding the vibrator had no effect on the falling reaction but infiltration in the splenius capitis muscles abolished the effect as long as the anesthesia was maintained. If the vibrator was placed over the occipital bone no falling reactions were obtained.

It is concluded that muscle receptors, probably within the splenius capitis muscles, are responsible for the effects. It is interesting to note that unilateral neck muscle vibration in man can induce a clinical sign (marche en étoile) sometimes found in patients with cerebellar diseases. Proprioceptive afferent input signalling position of head versus body can interact with postural effects evoked from the vestibular system. It is not known whether these neck muscle induced postural effects participate in this interaction. Neck muscle proprioception is a vital part of coordinated head-eye movements. Also in this quite different task for the proprioceptors of the neck muscles the vibrator could be a useful tool in clinical studies, e.g. at oscillopsia. Further studies are in progress.

1 G. Eklund and K.E. Hagbarth, Exp. Neurol. *16*, 80 (1966).
2 V.C. Abrahams and S. Falchetto, J. Physiol. *203*, 435 (1969).
3 R. Magnus, Körperstellung. Springer, Berlin 1927.