The role of thermal and touch sense in the perception of skin wetness at rest and during exercise in different environments

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BOOK OF ABSTRACTS

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ARCHITECTURAL AND MORPHOLOGICAL ADAPTATIONS TO ECCENTRIC VS. CONCENTRIC CONTRACTIONS: POSSIBLE UNDERLYING MECHANICAL AND BIOCHEMICAL MECHANISMS

University of Nottingham

Introduction We investigated the architectural, functional, and molecular responses of human skeletal muscle to concentric (CON) or eccentric (ECC) training protocols, performed on a leg-press machine. Methods 12 male volunteers were randomly assigned to two different groups performing either a CON or ECC training regime (3×wk for 10-wk, 4×8-10 repetitions of 80% of CON and ECC 1-RM). ARI imaging was used to evaluate muscle volume and anatomical cross-sectional area was measured in the proximal, mid and distal portions of the VL. Ultrasound was used to determine muscle volume (fascicle length, L; pennation angle, PA). An additional fourteen male subjects performed a single bout of CON or ECC exercise for determining acute molecular signalling responses (in biopsies taken from VL 30 min after a bout of CON or ECC). This post-exercise biopsy time-point was chosen to gauge ‘remodelling pathways’ (i.e. MAP Kinases, inflammation (TNF-signaling), anabolism (mTORC1), and catabolism (Murf-1/MAFBx). The MAPKs were of particular interest since previous works suggested that molecular programs of ECC vs. CON signaling and growth are distinct (1, 2). Immuno-blotting was used to assess phosphorylation/abundance of signaling targets. Results Changes in muscle Vol (+8 CON vs. +6% ECC) and maximal voluntary contraction (MVC) (+9 CON vs. +11% ECC) were similar in both groups. Uf increased significantly after ECC but not CON (+12 vs. +5%) and PA increased markedly after CON (+30 vs. +5%). Hypertrophy in the distal and mid part of the VL was different between the groups (CON +2 vs. ECC +8%; ECC +7 vs. CON +11%, respectively). Discussion In terms of whole-muscle hypertrophy, despite the ~12 fold greater training load of the ECC group, similar increases in VOL and MVC in were found after training. However, distinct architectural changes were found between the two loading regimes: increases in Uf were greater after ECC than CON while in contrast, PA increased more in CON vs. ECC. These adaptations in (according to 3) reflected differences in fascicle behaviour in the two contraction modes, i.e., lengthening in ECC vs. shortening CON. When examining regional hypertrophy, the changes in architecture induced by the two regimes induced preferential growth in the distal region of VL for ECC while for CON, VL growth occurred mainly at mid-belly. In terms of signalling, while MAPK activation (i.e., p38MAPK, ERK1/2, p90RSK) was exclusive to ECC, neither mode affected AKT-mTOR or inflammatory signalling. To conclude, hypertrophy in response to CON vs. ECC yields distinct architectural and regional adaptations, rather than in whole-muscle growth despite the greater loading intensity of ECC protocol. These morphologic and architectural changes to ECC vs. CON were associated with discrete acute fascicle behaviour, which we speculate to underlie the preferential activation of MAPK signaling, and perhaps the ensuing distinct muscle adaptions. References 1- Kehat et al. Circ Res, 2011 2- Wretman et al. J Physiol, 2001 3- Reeves et al. Exp Physiol, 2009.

THERMOREGULATORY RESPONSES OF ATHLETES WITH A SPINAL CORD INJURY DURING INTERMITTENT WHEELCHAIR EXERCISE IN COOL CONDITIONS

Griggs, K., Leicht, C., Price, M., Goosey-Tolfrey, V.
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Introduction Individuals with a spinal cord injury (SCI) have impaired thermoregulatory control, resulting in a loss or reduction in sweating capacity and an inability to make effective vasomotor adjustments. Individuals with high level cervical lesions (tetraplegia, TPI) possess a greater impairment in thermoregulatory control than individuals with lower level lesions (paraplegia, PA). Although the thermoregulatory responses of athletes with SCI have been reported, no data has compared the responses of athletes with TP and PA during an intermittent sprint protocol (ISP). The purpose of this study was to investigate the thermoregulatory responses of athletes with TP and PA during intermittent wheelchair exercise and recovery. Methods Eight wheelchair rugby players with TP (lesion level C4/5-C6/7, body mass 65 2 ± 4.4 kg, VO2peak 1.55 ± 0.37 L·min−1) and eight wheelchair basketball players with PA (lesion level T4-5, body mass 68 ± 12.3 kg, VO2peak 1.92 ± 0.47 L·min−1) completed a 60 min ISP at maximal effort on a wheelchair ergometer, followed by 15 min of passive recovery in cool ambient conditions (20.6 ± 0.1°C and 39.6 ± 0.8% relative humidity). Core temperature (Tcore, telemetry pill), mean (Tsk) and individual skin temperatures were measured throughout. Heat storage (HS) was calculated every 15 mins. Results: Sprint speed (3.16 ± 0.59 m/s and 3.51 ± 0.44 m/s for athletes with TP and PA, respectively) was similar between groups. There were larger increases in Tcore and Tsk for athletes with TP compared to athletes with PA during exercise and recovery (p<0.05). Back, chest, lower arm and forehead skin temperatures all increased during recovery in athletes with TP compared to a decrease in athletes with PA (p<0.05). Heat storage was higher in athletes in TP (p<0.05), with end of recovery values of 3.42 ± 1.42 J·g−1 and -0.51 ± 1.30 J·g−1 for athletes with TP and PA, respectively. Discussion The results of this study show that athletes with TP experienced a greater increase in Tcore and Tsk in comparison to athletes with PA. Although only exercising in cool conditions, this suggests athletes with TP have a greater inability to dissipate heat than athletes with PA during intermittent sprint exercise and recovery, possibly due to the greater loss of sweating capacity. This is also reflected by the gain in HS for athletes with TP and the net loss for athletes with PA by the end of the recovery period.

THE ROLE OF THERMAL AND TOUCH SENSE IN THE PERCEPTION OF SKIN WETNESS AT REST AND DURING EXERCISE IN DIFFERENT ENVIRONMENTS

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Introduction The type and amount of physical activity an individual performs is influenced by the level of comfort achievable with the surrounding environment (Vanas et al., 2012). Skin wetness has been shown to be a critical determinant of thermal and clothing comfort (Fukazawa et al., 2009). Clarifying the neurophysiological bases of wetness perception (WP) is critical to improve sporting garments’ design and thus comfort. WP seems to result from the integration of temperature (cold) and mechanical (pressure) inputs. The aim of this study was to investigate the role of thermal and touch sense in the WP. Methods Six cold-dry stimuli ([3 temperatures (4, 8, 15°C lower than local skin temperature) X 2 pressures (7 and 10 kPa)] were applied (10 sec) on the bare, upper and lower back of 11 [8F/3M] participants using a thermal probe (contact surface: 25 cm²), during 5 experimental conditions: rest 22°C; rest 33°C; low intensity cycling (30W) 22°C; moderate intensity cycling (60W) 22°C; moderate intensity cycling 33°C. No information about the stimuli was given to participants. Mean and local skin temperature, thermal, wetness and pleasantness sensations (perceptual scales) were recorded. Results Different cold-dry stimuli produced significantly different (P<0.05) levels of local skin cooling (range -0.7 to -4°C). Cold-dry stimuli were reported as wet at least once by 9 out of 11 participants. Stimuli applied with a mechanical pressure of 7 kPa, producing a skin cooling rate of 0.36°C/s, induced the most frequent (59% of times) cold-wet sensations. When applied with a pressure of 10 kPa, they were less often
(45.8% of times) perceived as cold-wet (P=0.09). No effect of conditions was observed on WP. Some cold-dry stimuli produced displeasure during resting at 22°C and pleasure during exercise at 33°C. Discussion Cold sensations play a primary role in characterizing the WP. The touch sense interacts in the perception of cold-dryness/wetness, with greater pressures decreasing WP. Daanen (2009) proposes 0.05°C/s to 0.2°C/s as the cooling rate evoking WP when water evaporates from the skin. We observed a greater cooling rate (0.36°C/s) for WP resulting from contact with a cold-dry surface. Thus, sensory integration seems to vary according to the type of cooling (evaporative vs. direct contact). No effect of conditions was observed, suggesting the level of skin cooling and mechanical pressure as critical determinants of WP. References Daanen, H. (2009). EP Patent 2,110,108. – http://www.tno.nl/content.cfm?context=kennis&content=P_patent&laag1=35&item_id=35&Taal=2 Fukazawa, T., Havenith, G. (2009). Eur J Appl Phys, 106(1), 15-24 Vanos, J., Warland, J., Gillespie, T., & Kenny, N. (2012). Int J Biometeorol, 56(1), 21-32

**15:00 - 16:30**

**Invited symposia**

**IS-BN05 Specificity in strength training in elite sport**

### SPECIFICITY IN STRENGTH TRAINING NEEDS TO FOLLOW THE PRINCIPLE OF COORDINATIVE AFFINITY

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In elite sports the quality of conditioning training can be improved, above all, by using special technique-specific exercises. Numerous studies prove that the training of general conditioning leads to considerable improvements of particular physical parameters. However, training of this kind hardly succeeds in increasing competitive capacity. On the other hand, it could be shown in many cases that the use of technique-specific means of training - parallel to general conditioning training - leads to considerable improvements of performance also among athletes with many years of training experience [Manolopoulos et al., 2006; Manuel et al., 2010; C. Hysomalis 2012; Mueller et al. 2000]. Consequently, it is important to direct one’s attention to the development of highly specific means of training. This applies chiefly to so-called seasonal sports such as alpine ski racing. For the development of specific training exercises the principle of kinematic and kinetic correspondence has to be taken into consideration. This principle states that the special exercises must be in harmony with those parameters of movement which characterize the structure of competition technique. A coordinative affinity between training and competition exercises has the advantage that it results in favourable training stimuli in the musculature relevant to the specific movement. It has the further advantage that the specific neuronal mechanisms are developed, which improve the strength utilizability in concrete execution of movement, as defined by the technique-specific muscle innovation scheme. Sport biomechanics deals with the development of sport specific training devices and exercises. The necessity of using highly specific means of training mainly applies to what are called seasonal sports such as alpine ski racing. Ski racing is one of those sports which makes high demands on technical and physical abilities. This is made even more difficult by the fact that technique-specific training can only be performed on snow which is difficult to execute during the summer season. Therefore the use of exercises which imitate the racing technique on snow is very important during the preparation period in summer. In various studies we were able to develop training devices which make the performance of skiing specific exercises possible. Using biomechanical methods we were able to prove that these exercises come very close to the kinetic and kinematic structure of the techniques on snow.

### DANGEROUS LIASONS OF STRENGTH AND ENDURANCE TRAINING. CAN BE MINIMIZED?

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Different studies have found compromised adaptation of strength, especially muscle power, when both strength and endurance were trained at the same time. Several strategies or mechanisms have proven effective in reducing the interference phenomenon of concurrent strength and endurance training as follows [1-4]: • Short training phases (5 weeks) using highly concentrated training loads (>50% of the total training volume) and which focus on the development of only two target fitness components in each training phase (i.e. one for strength and another for endurance), result in a more effective training stimulus for the improvement of performance in highly trained athletes when compared with a more traditional training periodization approach [2]. • Avoidance of the simultaneous development of muscle hypertrophy [8-10 RM] and aerobic power can reduce the interference phenomenon due to both training intensities inducing opposite adaptations on the same peripheral components. In contrast, due to the compatible training-induced adaptations associated with strength and power and aerobic power, as well as the compatible effects of development of maximal aerobic power, muscle hypertrophy and strength and power stimulus, no interference effects should be expected during the concurrent development of these fitness components [4]. • The residual fatigue caused by a previous endurance session could reduce and/or impair the quantity and quality of subsequent strength training sessions. For highly trained athletes, the strength training sessions should be placed before the endurance sessions, or at least separating both types of training sessions by more than 8 hours. Performing extra endurance training sessions at submaximal intensities that involve mainly non-specific muscle groups, may allow high-level athletes to achieve muscle peripheral adaptations, while the specific muscle groups recover for subsequent sessions of greater intensity [1,3]. • The training to repetition failure approach should be avoided in athletes at any performance level. A concurrent strength and endurance training program using a moderate number of repetitions for not to repetition failure training provides a favorable environment for achieving greater enhancements in strength, muscle power and specific performance when compared with higher training volumes of repetition to failure. The training for the not to repetition failure approach speeds up recovery from strength training, allowing rowers and paddlers to perform subsequent endurance training sessions of higher quality [3]. References 1. García-Pallarés J and Izquierdo M [2011]. Sports Medicine. 1:41(4):329-343. 2. García-Pallarés J et al. Eur J Appl Physiol. 110(1):99-107. 3. Izquierdo-Gabarren M, et al. Med Sci Sports Exerc (2011) 42(6):1191-9. 4. García-Pallarés J et al. (2010). Med Sci Sports Exerc 42(6):1209-14.