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Citation: Beal, Harry, Goodall, Stuart, Modhwadia, Akash and Barwood, Martin (2021) Testing traditions in cycling: newspapers are effective thermal insulators during simulated downhill cycling. Journal of Sports Medicine and Physical Fitness, 61 (1). pp. 109-116. ISSN 0022-4707

Published by: Edizioni Minerva Medica

URL: https://doi.org/10.23736/S0022-4707.20.11091-0 <https://doi.org/10.23736/S0022-4707.20.11091-0>

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Testing traditions in cycling: Newspapers are effective thermal insulators during simulated downhill cycling

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Submission type: Original Investigation
Running head: Thermal perception and exercise performance

Abstract Word Count: 250
Manuscript Word Count: 3858
Number of Tables: 0
Number of Figures: 3

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Author Conflicts of Interest: None

Abstract

BACKGROUND: Cycling downhill accelerates heat loss and requires lower work rates leading to cold discomfort. Historically, cyclists have behaviorally thermoregulated prior to cycling downhill by inserting newspapers into their jerseys. Yet, there is no experimental data to support such a method showing improvements in thermal perception and profile; we hypothesized it would. **METHODS:** Two cohorts (*n*=8 each) of male participants completed two main trials each involving 30-minutes simulated uphill cycling (65% VO_{2peak} 188 (41)W; no fan) followed by 15-minutes downhill cycling (35% VO_{2peak} 41 (12)W) in front of an industrial fan (wind speed: 4.6 (0.1)$m \cdot s^{-1}$). In one trial participants inserted one (study 1) or two (study 2) tabloid newspapers into their jerseys (PAPER) prior to downhill cycling; the other was a control (NOPAPER). Whole body and torso thermal sensation (TS) and comfort (TC), aural temperature (T_{au}), skin temperature (T_{skin}), and newspaper mass change (Δ) were measured. Data were compared using ANOVA and t-test to 0.05 alpha level. **RESULTS**: After uphill cycling thermal and perceptual profiles were similar. In study 1, only TC was transiently improved 1-minute after newspaper insertion. In study 2, T_{skin} rate of decline was lower in the PAPER condition (−0.11 (0.12)°C.min^{-1} *cf* −0.53 (0.16)°C.min^{-1}; p = .001) and T_{chest} remained higher (28.83 (3.17)°C *cf* 24.39 (3.22)°C). This improved TS but not TC. Newspaper mass increased indicating impaired sweat evaporation (Δmass: 5.7 (4.9)g; p=0.01). **CONCLUSIONS:** Thermal perception and profile during downhill cycling was improved by inserting two newspapers but not one newspaper into the jersey, supporting our hypothesis.

Keywords. Cycling, dynamic thermal environments, grand tour cycling, temperature change.

Introduction

Competitive cyclists cover daily distances from 1 to 300 km over race periods of 1 to 21 d and have annual training volumes of up to 35,000 km.[1] Grand tour and stage race cycling typically requires cyclists to cover flat, undulating and mountainous terrain.[2,3] Mountainous stages require cyclists to spend prolonged periods cycling up, and downhill, during which exercise metabolic heat production and retention varies mainly as a function of power output, topography and the extant environmental conditions.[4,5] Cycling uphill can lead to an increase in deep body and skin temperature, as higher external and metabolic workloads are required to offset gravitational resistance. Inevitably power output is raised (e.g. 392 (60)W)[4] but speed is reduced, thereby lowering forced convection (airflow) and sweat evaporation contributing to heat storage. During uphill cycling cyclists are able to behaviourally thermoregulate and often adjust their clothing to facilitate heat loss by opening vents, zips or removing layers. Nevertheless, even in temperate conditions the sensation of feeling hot and uncomfortable may limit performance.[6] By contrast, cycling downhill reverses the effects of gravitational resistance, thereby providing a mass (i.e. body and bicycle) contribution to acceleration.[5,7] Thereafter the cyclists' acceleration and speed are only impeded by mechanical (e.g. internal anatomy when pedaling and bicycle), rolling (e.g. tyres and road surface) and air mass resistance coupled with less opportunity to behaviourally thermoregulate.[5,7] Hence, the requirement to pedal is reduced and this transition reduces metabolic heat, accelerates heat loss and leads to cold discomfort.[8]

Given that stage races and grand tour cycling events are typically won and lost by fine margins,[9,10] it is critical that every thermal and perceptual advantage is taken, particularly during mountainous stages, to maximize the chances of being able to respond to tactical race moves as they unfold.[2] The modern-day professional cycling team is accustomed to focusing on achieving such “marginal gains”[10] in pursuit of grand tour success. However, even the most organized cycling teams occasionally fail to meet the needs of their team members. Consequently, the riders can become exposed to extremes of heat and cold particularly atop mountain summits where hazardous weather conditions can be problematic.[11] For example, live coverage of stage 19 of the 2019 Tour de France showed professional cyclists competing in hail, snow and mudslides in the French Alps with the stage eventually cancelled and the cycling team cars’ unable to reach their stranded riders for an extended period after the stage ended. The potential thermal disturbance posed by cycling downhill preceded by cycling uphill is well known[8,11] and anecdotal reports show that cyclists have tried to mitigate the problem by inserting newspapers up their jerseys presumably to provide a barrier to heat loss. Social media reports suggested that, as recently as the 2018 Giro D’Italia, cyclists were offered standard tabloid newspaper(s) to insert into their jerseys prior to descending on a mountain stage. However, at present only anecdotal evidence supports this long-standing practice.

Few studies have described thermal and perceptual dynamics during uphill compared to downhill cycling using ecologically valid protocols despite the thermal extremes that are likely during this transition. Corbett et al[8] examined the influence of clothing insulation on the thermoregulatory and perceptual responses of trained cyclists in temperate conditions (14.5°C). Participants completed simulated flat cycling followed by uphill cycling at 55% peak power output (PPO) in modest winds ($3.6\ \text{m}\cdot\text{s}^{-1}$) and simulated downhill cycling at 50 W (~12.5% PPO) in high winds ($16.7\ \text{m}\cdot\text{s}^{-1}$). Irrespective of clothing assembly, large thermal and perceptual differences were observed between the simulated uphill and downhill sections of the protocol. Indeed, chest temperature lowered by 8 to 10°C on transition from uphill to downhill cycling and thermal sensation changed from "*hot*" to *"cool"* in line with this dynamic change in thermal conditions. Theoretically, such drastic changes in perception potentially interfere with strategic racing decisions in real-life scenarios. Given that the chest is known to be thermally sensitive because of its high density of cold responsive thermoreceptors,[12] preventing or minimising rate of change in temperature may also improve thermal perception a factor known to influence onward performance.[6] Inserting a newspaper within the cycling jersey prior to the descent, may serve this function. In addition to providing a barrier to heat loss, a newspaper might also prevent the evaporation of sweat, which in turn will reduce the extent of cooling. The quantified extent of the thermal and perceptual improvement has never been reported.

Accordingly, the present study examined whether inserting newspaper(s) into a cycling jersey provides any thermal or perceptual benefit during simulated downhill cycling. We hypothesised the newspaper(s) would slow the rate and absolute value achieved in skin and chest temperature and reduce sweat loss (hypothesis 1; H_1). This would result in less of a disturbance in thermal comfort (TC, and thermal sensation [TS]) producing a benefit to thermal perception; H_2. It was also hypothesised that these changes would be achieved with only one newspaper inserted to the jersey; H_3.

Materials and Methods

Design

Two ethically approved studies were performed. Differences in cohort aerobic fitness excluded the possibility of direct data comparisons.

We used a within-participant, repeated-measures design in which participants completed three laboratory visits. Visit one established maximal power output (P_{Max}) and oxygen uptake (VO_{2peak}) to prescribe representative intensities for simulated uphill and downhill cycling in subsequent visits which were counter-balanced; i.e PAPER *vs.* NOPAPER (control) trial. Tests took place at the same time of day (± 1 hour), with standardised preparatory procedures and $\geq$ 48-hours between tests.

Participants

All participants provided written informed consent. Study 1 mean (SD) characteristics were: n = 8, age 22 (2)yrs; height 1.76 (0.1)m; body mass 75.9 (7.7)kg; body surface area[13] 1.92 (0.1)m^2; P_{Max} 246 (57)W; VO_{2peak} 3.35 (0.8)$L \cdot min^{-1}$) and study 2 characteristics were: n = 8, age 26 (4)yrs; height 1.73 (0.1)m; body mass 66.9 (10.0)kg; body surface area[13] 1.79 (0.1)m^2; P_{Max} 338 (78)W; VO_{2peak} 4.40 (0.9)$L \cdot min^{-1}$. Participants were recruited by email, posters and word of mouth within the University environment in study 1 and at local cycling clubs as well as within the University in study 2.

Participants were considered trained if they achieved a minimum P_{Max} of $\geq$300 W[14] consequently, participants in study 1 were considered recreationally active. Participants were excluded if they reported any cardiovascular problem or contraindication to performing maximal exercise as indicated by a physical activity readiness questionnaire (PAR-Q); if they had a PMax $\leq$300 W[14] (study 2 only) or had any form of current musculoskeletal injury. Participants abstained from alcohol, caffeine consumption and strenuous exercise 24-hours before each test and were non-smokers. They also replicated their dietary intake prior to visits two and three.

Procedures

Visit One – VO_{2peak} and P_{Max}: Participants arrived at the laboratory wearing cycle clothing, were instrumented with a heart rate monitor (FT1, Polar Electro Oy, Kempele, Finland) and mounted the cycle ergometer (Velotron, Racermate, Seattle, USA); bicycle set-up was replicated thereafter. Participants warmed-up for 5-minutes at 100W (cadence ~80rev·min^{-1}) and stretched. They remounted the ergometer and recommenced cycling at a sub-maximal power output (e.g. 100-150W; aerobic fitness dependent) and cadence. Power output was increased by 25W every 4-minutes for 4 stages and then 25W·min^{-1} until volitional exhaustion. VO_{2peak} was estimated using the Douglas bag method with samples analysed using calibrated gas (Servomex 5200, Crowborough, U.K; two-point calibration against certified gas concentrations - BOC Gas, Guildford, U.K) and volume analysers (Harvard Dry Gas Meter, Harvard Instruments, USA).

Visits Two and Three: Participants were instructed to arrive hydrated and did not drink during the trials. Participants first voided and dressed into their cycling shorts following which body mass was measured (Seca, 770, Vogel & Halke, Germany). They were then instrumented with a calibrated, aural thermistor inserted into the external auditory meatus insulated with cotton wool and headband. They were also instrumented with skin thermistors (All thermistors and loggers: Grant Instruments Ltd, Cambridge [Shepreth], U.K) at eight body sites[15] secured by breathable tape (TransporeTM,1527-1, 3M Health Care, MN, USA). Aural temperature (T_{au}) and skin temperature (T_{skin}) were logged every 10-s (Squirrel 2020 series); T_{skin} was subsequently calculated.[15] Following instrumentation participants completed dressing in socks, (cycling) shoes and a close-fitting t-shirt; identical clothing worn thereafter. Ambient temperature (T_a) was measured by a wet-bulb, globe, temperature (WBGT) station (Squirrel 1000 series) secured to the handlebars of the static bike.

Participants mounted the cycle ergometer and provided their thermal perceptions; TS and TC for their whole body and torso.[16] After one-minute rest participants cycled for 5-minutes at the same intensity as their first stage in the VO_{2peak} test and then at 65% of VO_{2peak} for 25-minutes with no active convection simulating “uphill cycling.” After 30-minutes of exercise the cycling intensity was reduced to 35% VO_{2peak} and simultaneously an industrial fan, 85cm in front of the Velotron (Clarke Air, CDF20HV-P, Clarke International, U.K), was switched on. Wind speed produced by the fan was verified for consistency by an anemometer (Proster Anemometer, PST-TL107, Proster Trading LtD, Hong Kong; speed ~4.5 and $5.0 m \cdot s^{-1}$). Exercise intensity (VO_2) and perceptual responses (including RPE[17]) were recorded every 5-minutes during exercise. In order to capture the dynamic effect of the change in environmental conditions, thermal perceptions were also measured after 1-minute of downhill cycling. In one of the two visits, participants inserted either one (study 1; dry newspaper mass 125 (1) g) or two (study 2; dry newspaper mass 442 (3) g) standard tabloid (L:43.2 × W:27.9 cm; 1205.3 cm^3) newspapers into their jerseys in the 30th minute of uphill cycling. Pre and post-trial newspaper mass (g) was measured by calibrated weighing scales (1000G

Mini-Scale, BV & Jo, China) to estimate sweat absorption. After 15-minutes of downhill cycling the fan was switched off, loggers were stopped and participants were re-weighed. Subsequently they completed an active cool down at a sub-maximal intensity.

Statistical Analysis

Mean (SD) were calculated for perceptual, thermal (T_{skin}, T_{chest}, ΔT_{au}), exercise intensity (VO_2), sweat (production and newspaper mass) and environmental variables. The rate of change in T_{skin} and T_{chest} were calculated for the first 5-minutes of downhill cycling to examine the dynamic phase of thermal change. The normality of distribution was verified using a using Shapiro-Wilks test. Data were compared at fixed points during uphill (i.e. 25th minute) and downhill cycling (i.e. 31st, 35th, 40th and 45th minutes); RPE and VO_2 not examined at the 31-minute time point. Accordingly, a 2 (condition; NOPAPER vs. PAPER) by 4 or 5 (time) repeated measures analysis of variance (ANOVA) was conducted. Sphericity was checked using Mauchley's test and a Huynh-Feldt adjustment was applied where necessary. Significant effects were examined *post-hoc* using pair-wise comparisons. Environmental conditions, rate of T_{skin} and T_{chest} (ºC·min^{-1}) change and sweat variables were compared using paired samples t-tests. Tests used an alpha level of 0.05 and were conducted using SPSS (*v*21, IBM, Chicago, Illinois, USA) and Prism (Graphpad, Prism *v*6, San Diego, USA). Partial eta squared (ηp^2) indicates ANOVA effect size.

Results

We report ANOVA condition and interaction effects only as these relate to our specific hypotheses. NOPAPER mean (SD) appears first followed by PAPER unless otherwise stated. In study 1 data are *n* = 7 for T_{skin} and T_{chest} due to a corrupted data file in one of the experiments.

Environmental Conditions

Study 1 T_a averaged 12.8 (2.1) and 12.9 (1.3) ºC (t =.067, p=.480). Study 2 T_a was 12.0 (0.8) and 12.4 (1.1) ºC (t=1.930, p=.095). T_a was not different ($p>0.05$) within studies.

Sweat Responses

In study 1 sweat production was 440 (190) and 460 (170) mL (t = .16, p = .877). Study 2 sweat production was 410 (220) and 480 (270) mL (t = .917, p = .390). Study 1 newspaper mass before and following the trial was 125 (1) and 126 (1) g respectively and were different (t = -3.0, p = .020). Study 2 newspaper mass was 442 (3) prior and 448 (5) g following the PAPER trial and were again different (t = -3.268, p = .014).

Oxygen Uptake

Study 1 VO_2 during uphill cycling was 2.12 (0.16) and 2.18 (0.50) $L.min^{-1}$ and 1.30 (0.25) and 1.30 (0.20) $L.min^{-1}$ during downhill cycling (no condition effect $f_{(1,7)} = .175$, p = .689, $\eta p^2 = .024$ or interaction $f_{(4,28)} = .451$, p = .719, $\eta p^2 = .061$); equating to 65 (8) and 42 (11) % VO_{2peak} (grand mean). Study 2 VO_2 during uphill cycling was 2.81 (0.45) and 2.82 (0.42) $L.min^{-1}$ and was 1.47 (0.24) and 1.46 (0.31) $L.min^{-1}$ during downhill cycling (no condition effect $f_{(1,7)} = .185$, p = .680, $\eta p^2=.026$ or interaction $f_{(4,28)} = .427$, p = .736, $\eta p^2 = .057$); equating to 65 (4) and 34 (7) % VO_{2peak}; fig.1.

Insert figure 1 near here

Thermal Responses

T_{au} increased throughout uphill cycling reaching a peak change in the 25th (study 1 ΔT_{au} 0.85 (0.44) and 0.85 (0.52) ºC) and 30th minute of uphill cycling; study 2 0.98 (0.26) and 1.11 (0.50) ºC). During downhill cycling, no condition effects ($f_{(1,7)}$ = .780, p = .407, ηp² = .1.00; $f_{(1,7)}$ = .522, p = .493, ηp² = .069) or interaction effects were evident in either study ($f_{(4,28)}$ = 2.205, p = .094, ηp² = .240; $f_{(4,28)}$ = .643, p = .471, ηp² = .084); fig.1.

The insertion of the newspaper in study 1 did not culminate in any condition ($f_{(1,6)}$ = .241, p = .241, ηp² = .220) or interaction effects in T_{skin} ($f_{(4,24)}$ = 1.095, p = .381, ηp² = .154). The rate of decline in T_{skin} during downhill cycling was -1.06 (0.44) and -0.57 (0.44) ºC.min^{-1} (t = 1.924, p = .103). T_{chest} data showed a similar pattern for ANOVA (no condition effect: $f_{(1,6)}$ = 4.895, p = .069, ηp² = .449) or interaction effects ($f_{(4,24)}$ = .779, p = .550, ηp² = .115) and rate of change was -0.87 (0.60) ºC.min^{-1} and -0.63 (0.62) ºC.min^{-1} respectively (t = 1.307 , p = 0.239).

In study 2 T_{skin} was 28.06 (1.20) and 27.18 (1.60) ºC by the end of each trial (no condition effect ($f_{(1,7)}$ = 2.636, p = .149, ηp² = .274 or interaction effect ($f_{(1,7)}$ = .544, p = .108, ηp² = .230). Yet, the rate of decline in T_{skin} in the first 5-minutes of downhill cycling was lower (t = 5.238, p = 0.001) in the PAPER condition and was -0.11 (0.12) compared to -0.53 (0.16) ºC.min^{-1}. By the end of the downhill cycling period T_{chest} remained higher in the PAPER condition which averaged 28.83 (3.17) and 24.39 (3.22) ºC respectively (near significant condition effect: $f_{(1,7)} = 4.539$, $p = .051$, $\eta p^2 = .393$ and significant interaction effect: $f_{(4,28)} = 3.155$, $p=.044$, $\eta p^2 = .311$). The rate of decline in T_{chest} during downhill cycling was also lower in the PAPER condition; -0.61 (0.34) compared to -1.22 (0.66) $ºC.min^{-1}$ ($t = 2.412$, $p = 0.047$); fig.2.

Insert figure 2 near here

Perceptual Responses

In both studies RPE was *hard* to *very hard* at the end of uphill cycling and *very light* at the end of downhill cycling (no condition effect: $f_{(1,7)} = .025$, $p = .878$, $\eta p^2 = .004$ or interaction: $f_{(4,28,)} = 1.225$, $p = .323$, $\eta p^2 = .149$); study 2 no condition effect: $f_{(1,7)} = .395$, $p = .549$, $\eta p^2 = .053$ or interaction effect: $f_{(4,28)} = 1.233$, $p = .319$, $\eta p^2 = .150$).

In study 1 during downhill cycling TS neared being different in the PAPER condition (no condition effect: TS body $f_{(1,7)} = 3.967$, $p = .087$, $\eta p^2 = .362$; TS torso: $f_{(1,7)} = .113$, $p = .747$, $\eta p^2 = .016$) or interaction effect: TS body $f_{(4,28)} = 1.005$, $p = .421$, $\eta p^2 = .126$; TS torso $f_{(4,28)} = .102$, $p = .981$, $\eta p^2 = .014$). By the end of downhill cycling they averaged 7.2 (2.9) and 7.4 (3.8) cm (descriptor *slightly cool*). TC whole body and torso reached a nadir of 6.0 (4.4) and 5.5 (4.6) cm (grand means; descriptor *uncomfortable*) during uphill cycling (no condition effect: TC body $f_{(1,7)} = 3.088$, $p = .122$, $\eta p^2 = .306$; TC torso: $f_{(1,7)} = 3.069$, $p = .123$, $\eta p^2 = .305$). However, TC body and torso briefly changed at a different rate during downhill cycling indicated by an interaction effect (TC body $f_{(4,28)} = 3.114$, $p = .031$, $\eta p^2 = .308$; TC torso: $f_{(4,28)} = 2.746$, $p = .048$, $\eta p^2 = .282$). Thermal comfort was improved immediately (1-minute) after newspaper insertion for the whole body (p = .018) and torso (p = .033) but this effect had dissipated by the subsequent time point; fig.3.

Insert figure 3 near here

In study 2, during downhill cycling TS body was unchanged (no condition effect: $f_{(1,7)} = 1.620$, $p = .244$, $\eta p^2 = .188$ or interaction effect: $f_{(4,28)} = .827$, $p = .519$, $\eta p^2 = .106$) and was similar to study 1. TS Torso was improved and averaged 6.3 (1.2) and 10.6 (1.1) cm in the NOPAPER and PAPER conditions respectively by the study end (descriptor *cool cf neutral*; condition effect: $f_{(1,7)} = 34.074$, $p = .001$, $\eta p^2 = .830$ and interaction effect: $f_{(4,28)} = 8.296$, $p = .004$, $\eta p^2 = .411$); fig.2. TC data followed a similar temporal pattern to study 1 but no differences were evident immediately after paper insertion (no condition effect: TC body $f_{(1,7)} = .155$, $p = .706$, $\eta p^2 = .022$; TC torso $f_{(1,7)} = .193$, $p = .674$, $\eta p^2 = .027$ or interaction effect: TC body $f_{(4,28)} = .603$, $p = .664$, $\eta p^2 = .079$; TC torso $f_{(4,28} = 2.086$, $p = .109$, $\eta p^2 = .230$).

Discussion

We tested the long-standing tradition of inserting a newspaper into the cyclist's jersey prior to undertaking (simulated) downhill cycling. Anecdotal evidence suggests this provides a thermal and perceptual benefit that positively influences onward race performance. When using one newspaper, transient improvements in thermal comfort were observed which soon dissipated (fig.3). However, inserting two newspapers, evoked changes in dynamic whole body and chest thermal profile indicated by our rate of change data. Absolute differences in thermal profile then developed and were sustained at the local (i.e. T_{chest}) but not whole-body level (i.e. not T_{skin}) until the end of the trial in study 2. Consistent with our thermal data, the onward perceptual benefits (i.e. a sensation of feeling *neutral* rather than *cool*) were primarily expressed at the local (TS torso) but not whole-body level. Accordingly, our data demonstrate that this long-standing tradition in cycling has thermal and perceptual benefits which may contribute, in part, to the critical "marginal gains" which are widely thought to summate to overall success in cycling.[10] Therefore, data from study 2 support the experimental hypotheses H_1 and H_2 (TS only). We also hypothesised these effects would occur with only one newspaper; H_3 is therefore rejected, a result which catalysed the undertaking of study 2.

These data demonstrate a fundamental truth of thermal physiology; that dynamic changes to the thermal environment are salient cues to thermal perception[18,19,20,21] that most likely affect onward behavioural thermoregulation[22] and performance[23]; although these latter factors were not assessed here. The null effect when using one newspaper was probably the result of variations in T_{skin} caused by greater air circulation around the less effective thermal barrier placed at the chest. Considering that the newspaper would primarily alter our estimate of T_{skin} by changing the fractional 0.196 contribution of T_{chest} to the T_{skin} equation used,[15] substantial changes in T_{chest} would be required to see an overall difference in T_{skin}. Hence, T_{skin} rate of change was only transiently altered by using two newspapers. However, the perceptual value of defending the chest against dynamic and sustained changes in thermal environment is clear.

The chest is most likely a salient perceptual driver because of its high density of cold sensitive thermoreceptors relative to other body areas.[12] When dynamic changes in T_{skin} or T_{chest} are experienced the number of nerve impulses per second from cold receptors overshoots and reaches a peak, coinciding with the conscious awareness of the change in thermal environment.[12] Following this occurrence the thermoreceptor firing frequency subsides and resets to a new level that represents the changed skin temperature (e.g. adapting temperature) at a higher frequency if the skin temperature is lower.[12,24] Consistent with our data, the findings of others confirm that substantial differences in adapting temperature are required to preserve the alterations in thermal perceptions that are seen after the dynamic phase.[25,26] Consequently, the extent of T_{chest} change when using two newspapers was only sufficient to change perceptions at the chest. It is also plausible that the summative input of the change in thermoreceptors activated at the chest was insufficient to drive a change in whole body thermoreception.[27] Therefore, covering a larger surface area with the insulating newspapers may improve this relationship although the practicalities of doing so whilst cycling may be limiting.

Very few studies have examined the thermal and perceptual consequences of varying insulation during uphill and downhill cycling. Corbett et al[8] reported increased forehead and whole-body sweating when comparing a high-insulation clothing assembly to moderate and low insulating assemblies. The onward effect of this high-level insulation was to increase cardiovascular load presumably because of reduced plasma volume that was compromised through sustained sweating. Consequently, Corbett et al[8] also showed on the commencement of downhill cycling the raised sweat rate and cardiovascular strain was sustained although thermal perception was improved. Clearly, a balance that must be achieved between thermal insulation to evoke perceptual improvement and the physiological strain that can be tolerated. The present study saw modest impairments to sweat evaporation in both studies (e.g. newspaper sweat absorption). A partial contribution to heat retention over the 15-minute downhill cycling period was caused by failing to evaporate either 1g (one newspaper) or 6g (two newspapers) of sweat. This is only likely to contribute an additional ~2.1 and ~12.5W respectively to stored heat; assuming a latent heat of vaporisation similar to water of $2260\text{kj}\cdot\text{kg}^{-1}$. Hence, the creation of an insulating boundary layer of air is the primary causative insulating mechanism provided by inserting two newspapers in study 2.

We accept that our studies are not without limitation as intervention blinding was not possible. Therefore, participants with an enthusiast knowledge of competitive cycling or a competitive background in cycling, likely characteristics of both of our cohorts of participants, may have expected changes to occur. However, the fact that we did not see consistent perceptual changes when using one newspaper and the perceptual changes when using two, were coupled with measured thermal differences suggests inadequate blinding wasn’t an influential factor. Moreover, the inclusion of trained cyclists in study 2 enabled representative intensities for this population to be included.[14] Secondly, the newspapers used in study 2 were not only numerically greater than in study 1 but also of greater individual mass (~1.8 times greater). Newspaper availability at the time of study 2 excluded the possibility of including exact multiples of the papers used in study 1. Hence the experimental effects seen in study 2 were also function of this greater mass difference. Thirdly, we were unable to achieve representative windspeeds for simulated downhill cycling due to technical limitations. Blocken et al[28] have reported that speeds >110 km.h^{-1} are reached descending in Grand Tour races. Comparatively the windspeed used in our studies were modest. Nevertheless, representative wind speeds such as those used by Corbett et al[8] and Altareki et al[29] are likely to have magnified the dynamic phase of temperature change thereby making this cue more salient. It is worth noting that the nadir chest temperatures seen in our study (fig.2A&C) by the end of downhill cycling were comparable to Corbett et al[8] (~24ºC; intermediate clothing assembly). Collectively, our experimental effects are more subtle but nonetheless have practical relevance.

Conclusions

From a practical perspective, inserting two rather than one, standard tabloid newspapers or newspapers with a net mass of up to 442g will transiently improve whole body thermal profiles and consistently improve local thermal and perceptual profile in a dynamically changed thermal environment during simulated downhill cycling. The newspaper should be secured close to the cyclist’s torso to maximise the chances of achieving an effective insulating layer of air which in turn will minimise the onward perceptual disturbance. From the perspective of safety this should be achieved prior to reaching peak velocity. In conclusion, we support the anecdotal evidence of the long-standing tradition of inserting newspapers into a cyclist’s jersey prior to cycling downhill. The onward performance benefit should now be established.

Acknowledgements

We would like to acknowledge the participants for their reliability and forbearance.

Declarations of Interest

The authors have no conflicts of interest to declare.

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Figure Legends

Figure 1. Mean (SD) oxygen uptake in study 1 (panel A) and study 2 (panel B) during simulated uphill and downhill cycling. Mean (SD) $\triangle T_{au}$ in study 1 (panel C) and study 2 (panel D) during uphill and downhill cycling; *indicates significant difference between conditions at a given time point; --- (panels A&B) and shading (panels C&D) indicate transition from uphill to downhill cycling (*n* = 8 for each study).

Figure 2. Mean (SD) T_{skin} (panel A), T_{chest} (panel C), TS body (panel B) and TS torso (panel D) in study 2 during simulated uphill and downhill cycling; *indicates significant difference between conditions at a given time point; shading indicates transition from uphill to downhill cycling (*n* = 7 study 1; *n* = 8 study 2).

Figure 3. Mean (SD) TS torso (panel A) and TC torso (panel B) in study 1 during simulated uphill and downhill cycling; *indicates significant difference between conditions at a given time point; shading indicates transition from uphill to downhill cycling (*n* = 8).

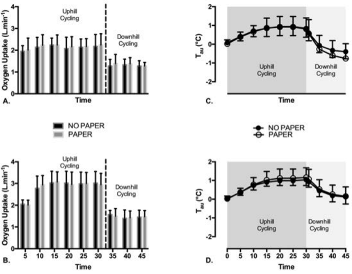
Oxygen Uptake (L.min⁻¹)
4
3
2
1
0
Uphill Cycling
Downhill Cycling
Time
A.
T_au (°C)
2
1
0
-1
-2
Uphill Cycling
Downhill Cycling
Time
C.
NO PAPER
PAPER
NO PAPER
PAPER
Oxygen Uptake (L.min⁻¹)
4
3
2
1
0
Uphill Cycling
Downhill Cycling
5
10
15
20
25
30
35
40
45
Time
B.
T_au (°C)
2
1
0
-1
-2
Uphill Cycling
Downhill Cycling
0
5
10
15
20
25
30
35
40
45
Time
D.

Fig 1

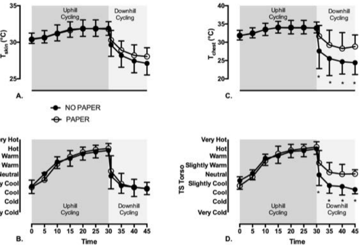A.
B.
C.
D.
T_{skin} (°C)
T_{chest} (°C)
TS Whole Body
TS Torso
Uphill Cycling
Downhill Cycling
NO PAPER
PAPER
Very Hot
Hot
Warm
Slightly Warm
Neutral
Slightly Cool
Cool
Cold
Very Cold
Time
0
5
10
15
20
25
30
35
40
45
25
30
35
20
*

Fig 2

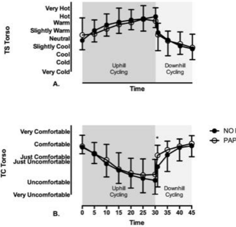
TS Torso
Very Hot
Hot
Warm
Slightly Warm
Neutral
Slightly Cool
Cool
Cold
Very Cold
Uphill Cycling
Downhill Cycling
A.
Time
TC Torso
Very Comfortable
Comfortable
Just Comfortable
Just Uncomfortable
Uncomfortable
Very Uncomfortable
Uphill Cycling
Downhill Cycling
*
B.
0
5
10
15
20
25
30
35
40
45
Time
NO PAPER
PAPER

Fig 3