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An independent academic psychologist, based in England, who has written extensively on different areas of psychology with an emphasis on the critical stance towards traditional ideas.

A complete listing of his writings at http://psychologywritings.synthasite.com/. See also material at https://archive.org/details/orsett-psych.

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1. WALKING

An individual's way of walking is known as their gait. "It takes dozens of muscles working together throughout the body to put one foot in front of the other. These subtle patterns of muscular flexes and strains are highly distinctive, so much so that scientists who study gait increasingly believe they are as unique to you as your fingerprint" (Adam 2020 p37). This offers the possibility of identification of an individual from their gait, through to diagnosing health problems (appendix A).

"Gait recognition" is defined as "the recognition of some salient property, eg: identity, style of walk, or pathology, based on the co-ordinated, cyclic motions that result in human locomotion" (Boyd and Little 2005 quoted in Conner and Ross 2018).

The nineteenth century author Honore de Balzac formally introduced "gait analysis" after watching people walking in the streets of Paris (published as "Theory of Walking") [1]. Technological development has aided the study of the gait, including cameras in the 19th century, 3D motion capture technology in the 20th century, and accelerometers in smartphones in the 21st (Conner and Ross 2018).

Today there is computerised gait analysis from CCTV footage or silhouettes (Adam 2020) [2]. The reliability of the modern systems is the issue. For example, mid to high 90% accuracy in identification with data from many individuals (Conner and Ross 2018).

One problem is that computerised gait analysis requires a series of sequential pictures to cover the stages of walking. "Processing these images requires serious computing heft and most gait analysis systems don't have enough of this to work in real time" (Adam 2020 p38).

Gait analysis focuses on the "gait cycle", which is the interval between two consecutive heel strikes of the same foot. "Suppose one gait cycle starts from the heel strike of right foot, the right foot rotates on the heel to touch the floor ('stance phase') to support the body while the left foot is swinging forward ('swing phase') until the left heel strikes the floor. Then the roles of the two feet switch, the left foot remains flat on the floor whilst the right foot is swinging forward. When the

[1] Studies of the gaits of animals had a longer history (eg: Aristotle in 350 BCE) (Conner and Ross 2018).

[2] Gait analysis is a branch of "activity recognition", which involves identifying individuals based on different unique aspects (Sun et al 2021).

right heel strikes the floor again, then a gait cycle is complete" (Sun et al 2021).

Gait features include stride length, joint angle ranges, and centre of mass, as well as the influence of emotional state (Conner and Ross 2018). Patricia Murray in the 1960s (eg: Murray et al 1964) characterised individual gaits using 20 parameters (eg: pelvic, chest, and ankle rotation) (Conner and Ross 2018).

Is there a link between a particular gait and personality characteristics? For example, there is the common belief that a long, quick stride goes with a confident or arrogant individual, and a shuffle with an introvert (Adam 2020).

In one of the first studies on the subject, Satchell et al (2017) explored the relationship between gait and certain personality traits. Twenty-nine volunteers were recruited in the UK. They were filmed walking on a treadmill with reflective markers attached to places on the thorax (to track upper body motion) and the pelvis (for lower body motion). Subsequently, the participants completed the "Big Five Inventory" (measuring Conscientiousness, Agreeableness, Neuroticism, Openness to experience, and Extraversion), and a standard measure of aggression.

Aspects of gait significantly correlated with personality measures, including:

i) Relative movement between the upper and lower body (Thorax-Pelvis ROM [range of motion]) - Greater relative movement and higher aggression score, especially for female participants. "Put simply, an aggressive walk is one where the rotation is exaggerated" (Satchell et al 2017 p43).

ii) Upper body movement (thorax) relative to the fixed horizontal plane (known as "the laboratory") (Thorax-Lab ROM) - High movement and low Conscientiousness for females, but high Extraversion for males.

iii) Lower body movement (pelvis) relative to the fixed horizontal plane (Pelvis-Lab ROM) - High Agreeableness and high movement for female participants.

iv) Gait speed - Faster speed and higher aggression for males only.

The researchers avoided "extensive theoretical

interpretation" (Satchell et al 2017 p43) of the findings. However, they speculated: "It is plausible that gait affects personality through the embodiment of a walking style, for example, adopting a confident style of gait and then self-rating high extraversion... Further research is required to establish whether gait affect personality or personality affects gait. It could also be the case that gait affects how participants complete self-report measures, with feelings of aggression or confidence (neuroticism or extraversion) being ameliorated or diminished by recently having their gait observed" (Satchell et al 2017 p43).

Key methodological issues with Satchell et al's (2017) study include:

a) Small sample of young adults (mean age 21 years) (-).

b) Use of validated measures of personality (+), but these rely on the accuracy of self-reports (-).

c) Controlled walk on a treadmill for one minute in a laboratory (+), but, even after allowing familiarisation with walking on a treadmill, it was not the natural environment (-).

d) Clearly defined biomechanical criteria of the gait (+), but these may be different to visual cues and perception of gait by humans in everyday life (-). Satchell et al (2017) admitted: "we opted to use the gait analysis more typical of the biomechanics literature as we are interested in the relationship between the actual movement involved in gait and personality (rather than how people make judgements about gait)..." (p41).

In terms of judgments of observers, "consensus at zero acquaintance" (Albright et al 1988) is where observers agree upon the personality traits of an observed individual after "thin slices of behaviour" (eg: a two-second video clip). This has even been reported with point-light studies where points of light attached to body joints show motion in darkness (eg: accurate judgment of emotions) (Thoresen et al 2012).

For example, Thoresen et al (2012) compared self-reported personality traits of twenty-six point-light walkers with the judgments of observers. The walkers wore eighteen retro-reflective markers attached to feet, knees, hips, torso, shoulders, head, elbows, wrists and

hands. The observers agreed on their impressions of the personality of walkers from the gait, but the impressions were different to the self-reported traits of the walkers.

Gait may also communicate vulnerability and insecurity. The serial killer Ted Bundy (purported a psychopath) is reported to have said that "he could tell a victim by the way she walked down the street, the tilt of her head, the manner in which she carried herself..." (quoted in Book et al 2013).

"Psychopathic individuals, in particular, should be skilled in non-verbal sensitivity given their adeptness at deceiving, manipulating, and exploiting others... Attention to body language, which is indicative of vulnerability, would give psychopathic perpetrators a definite advantage in selecting 'easy' victims" (Book et al 2013 p2369). Book et al (2013) tested this assertion with 47 inmates of a maximum security prison in Canada.

But what are the cues of vulnerability? Richards et al (1991), for example, found that men saw "smaller" or more subtle gestures with hands and feet as by "submissive" women, and more expansive gestures as by "dominant" women (based on short video clips). Specifically, in relation to gait, "motion cues to vulnerability included long or short strides, non-lateral weight shifts, gestured versus postural movements, and feet lifting. Overall, targets who were judged to be vulnerable to victimisation (mugging/assault) exhibited less synchronous movement in their walk" (Book et al 2013 p2371). Grayson and Stein (1981) drew out these characteristics from interviews with inmates convicted of sexual assault.

In the study by Book et al (2013), the participants viewed twelve video clips of people walking (eight women and four men), which had been filmed in everyday life by Wheeler et al (2009). The filmed individuals were asked about their experiences of victimisation, and two independent judges coded the gaits.

Book et al's (2013) participants also completed the "Psychopathy Checklist-Revised" (PCL-R) (Hare 2003). The participants rated each video clip for perceived vulnerability on a ten-point scale. "Victims" were classified based on a score of 6 to 10.

The score on the PCL-R was positively correlated with victim selection, particularly for participants with high interpersonal/affective traits of psychopathy (known as Factor 1 traits) (as opposed to anti-social traits; Factor 2).

Comments by the inmates for the choice of victims were classified into eleven vulnerability cues, including gait, fitness and body type (eg: able to defend self), and alone and in a dark environment. Gait was the strongest cue for individuals high in Factor 1 psychopathy traits.

Book et al (2013) ended that "inmates scoring higher on the core psychopathic personality traits (as measured on Factor 1 of the PCL-R) are more accurate in judging victim vulnerability and they are more likely to consciously attend to a target's gait when selecting a victim. It would seem, then, that Ted Bundy may have hit the nail on the head" (p2380).

Note that previous research (eg: Wheeler et al 2009) had used non-criminal samples, like college students, and asking them to imagine seeking victims for crime (Book et al 2013).

Gait is also linked to mood. Individuals with depression benefit from physical exercise because of the intensity of the exercise, it is believed. But Michalak et al (2015) argued that the style of physical activity affects mood (ie: gait pattern). Forty-seven volunteers walked on a treadmill, and they were encouraged to walk in a style associated with a depressed or a happy person. Gait pattern was changed by visual feedback as participants could see themselves on a large screen along with a gauge showing how they were doing. The gait pattern of fourteen depressed and fourteen healthy individuals from previous research was used as the templates for the two different walking styles. During the walk the volunteers had to learn twenty positive and twenty negative mood-related words.

Participants in the happy gait condition recalled 6.0 positive words on average and 3.8 negative ones compared to 5.5 and 5.6 respectively in the depressed gait condition. So, "changes in gait pattern affects the way people process negative and positive material" (Michalak et al 2015 p125). It was concluded that changing walking style could offer a therapy option for individuals with depression.

The study involved undergraduates and not a clinical population (ie: individuals with depression). Also "the experimenter who delivered the spoken list of 40 emotional words was not blind to the walking condition that the participant was in. To strictly rule out that para-linguistic cues affected the results in any subtle way, future research should use blinded experimenters or a word list displayed by an audiotape" (Michalak et al

2015 p125).

Establishing causality (ie: that gait pattern influenced recall of different types of emotional words) was not entirely possible as there may have been uncontrolled variables and confounders.

1.1. BALANCE

Balance is central to movement, and its loss end in falls, which are a health risk (eg: falls are second biggest cause of accidental death globally; Williams 2020).

Bipedalism is "far from easy", and standing upright is "indirectly unstable" as "bodies are top-heavy, with a tiny base of support relative to our height. Worse, our centre of gravity sits way up at pelvis height and slightly forward of our ankles. Even without a heavy head and chest swaying around, standing up would be risky" (Williams 2020 p35).

Balance involves muscles, eyes, the vestibular system of the inner ear, and key areas of the brain like the cerebellum, and the motor cortex.

Yang and Srinivasan (2014) attached reflective markers to the hips, ankles and feet of individuals on a treadmill. "They found that, even on a stable surface, walking is basically a refined version of a drunken stagger or a stumble after an unexpected nudge. 'Imagine you walking along and you get pushed to the right. Naturally you would stick your right leg rightwards and apply a leftward force', says Srinivasan. It turns out that every step, even on the smoothest surface, is a process of re-righting ourselves as our upper bodies lurch from side to side. Usually, we don't look as if we are staggering thanks to the way that the cerebellum, senses and muscles work together to make micro-corrections mid-stride" (Williams 2020 pp36-37).

Sedentary lifestyles may be negatively impacting balance (eg: weaker muscles). For example, 10 year-olds in England in 2014 were one-fifth weaker in muscle strength than in 1994 (Sandercock and Cohen 2019). Some of those muscles will be needed for balance (Williams 2020). This is also the case as individuals get older, and risk of falls increases (eg: Skelton 2001).

1.2. WALKING SURFACE

Hard surfaces of pavements in urban areas are not ideal for walking humans. "The human species was not evolved to walk on concrete... We evolved to walk on savannah" (Nick Tyler in King 2021). The upshot is hip and knee problems. Hard surfaces are also a problem with falls, and impact after being hit by a car on a bicycle (around 30% of the damage is due to impact with asphalt) (King 2021).

Tessutti et al (2012), for example, compared foot pressure during running on four different surfaces - asphalt, concrete, rubber, and natural grass. Forty-seven recreational runners (ie: at least 20 km per week) in Brazil with no musculo-skeletal injuries in the last six months were recruited. They wore shoes with pressure-sensitive insoles and carried a backpack containing the measuring equipment.

After a brief run to practice with the equipment, the participants ran forty metres at 12 km/h twice on each of the four surfaces. Data on the middle 20 m were used in the analysis.

Running on grass produced significantly lower pressures on parts of the foot than the other surfaces. This would translate into a reduced risk of injuries over longer distances and many runs. Unexpectedly for the researchers, the rubber surface produced similar results to the hard surfaces of concrete and asphalt.

So a grass surface would be recommended for running, but, Tessutti et al (2012) observed, "the non-uniformity of natural grass, due to such factors as holes and tree roots, and also the higher energy expenditure by the runner are disadvantages that should be taken into account when considering it as a training surface, weighing it against the advantage of lower peak pressures on the rear and forefoot. When competitive runners are considered, the longer contact time observed when running over grass would produce slower speeds and may also increase the runner energy expenditure, which have to be considered as disadvantages of this surface in competitions" (p1549).

A similar comparison of the four surfaces by Tillman et al (2002) had found no differences. But this study measured force load rates on the foot, for example, and with only eleven male runners (Tessutti et al 2012).

Two key factors in the research, then, are what is measured, and the sample size. Another important methodological issue is the length of the run. Tessutti et al (2012) used a controlled length and speed, but this

was not the same as running many kilometres. Also the participants ran wearing a backpack which they probably did not normally.

King (2022) talked on "pavement poverty", where vehicles have priority over pedestrians, and there may not even be sidewalks or footpaths. Safe sidewalks encourage walking and physical activity, which has health benefits. This is a case for proving pavements made of appropriate materials for the individual and the environment.

2. STRETCHING

Stretching is viewed as a good thing, and it is common in many animals after long periods of being still (known as pandiculation in this situation; Williams 2021a). More general stretching is linked to flexibility and physical fitness. For example, the American College of Sports Medicine recommends stretching all major muscle groups at least 2-3 times per week, and holding the stretch for up to a minute in some cases (Williams 2021a).

"For people who sit a lot and are under a lot of stress, then, stretching and mobilising stiff parts does relieve tension and lengthen muscles - at least temporarily. It is also well known that, when done regularly, stretching can lengthen muscles and connective tissue, restoring their length and a full range of motion to underused joints" (Williams 2021a p35).

Stretching links to flexibility (appendix B) [3], and this has been associated with arterial stiffening (which is a risk for cardiovascular problems) in a Japanese study (Yamamoto et al 2009), for example. A sample of 526 adults of varying ages were assessed for flexibility via a sit-and-reach test, and for arterial stiffening (by brachial-ankle pulse-wave velocity; baPWV). The sit-and-reach test involves sitting on the floor with the back against a wall, and then bending forward to reach as far as possible (measured in centimetres). Individuals were categorised into "high flexibility" (average of 40 cm reach) and "poor flexibility" (around 30 cm reach).

In the middle-aged (40-59 years) and older (60-83 years) groups, flexibility was negatively associated with arterial stiffening. "The association was independent of cardio-respiratory fitness and muscular strength. These findings suggest the possibility that flexibility may be a predictor of arterial stiffening, independent of other components of fitness" (Yamamoto et al 2009 pH1318).

Flexibility of neck, shoulder and lower extremity were not measured. The sit-and-reach test only measures trunk flexibility.

The opposite to movement is prolonged physical inactivity (as in sitting, for instance), and there are health issues related to this (including cardiovascular and musculo-skeletal). Concentrating on musculo-skeletal

[3] "Flexibility refers to the intrinsic properties of body tissues that determine maximal joint ROM without causing injury. Static flexibility refers to joint ROM usually in relaxed muscle... Dynamic flexibility refers to stiffness of the muscle-tendon unit within normal ROM" (Nuzzo 2020 p853).

health, "prolonged sitting may lead to adaptive changes in passive tissue stiffness or osseous restriction which may, in turn, lead to postural malalignment and/or movement dysfunction" (Boukabache et al 2021 p1).

Boukabache et al (2021) investigated hip flexibility and prolonged sitting with 144 adults at a university and a large commercial organisation in the UK. Physical activity was measured by the "Global Physical Activity Questionnaire" (GPAQ) (Chu et al 2015), which covers intensity, frequency, and duration of physical activity over a typical week in three domains - occupational, transport-related, and leisure time. A calculation of total time spent sitting was also made.

Hip flexibility was measured by the "Thomas Test" (TT). "With this test, the patient lies supine with the non-tested knee held against the chest and the tested limb hanging freely off the end of the examination table. If the tested limb is inclined above the horizontal, this indicates shorter/stiffer hip flexor muscles (iliacus, psoas, rectus femoris, anterior portion of gluteus medius, tensor fascia latae, adductor longus and pectineus) or osseous/capsular restriction at the hip. In contrast, if the limb is inclined below the horizontal, this indicates longer/more compliant hip flexor muscles and no bony restriction" (Boukabache et al 2021 p2).

The participants were divided into three groups based on the GPAQ responses - (1) low activity (<150 minutes physical activity per week) and prolonged sitting (≥7 hours per day); (2) high activity (≥150 minutes) and minimal sitting (≤4 hours per day); and (3) high activity and prolonged sitting.

The TT scores differed significantly between the three groups, such that Group 1 had the least hip flexibility followed by Group 3, and then Group 2. Group 1 differed significantly from Groups 2 and 3, but there was not a significant difference between Groups 2 and 3. The study showed that "prolonged sitting could lead to increased passive stiffness in the hip flexor muscles" (Boukabache et al 2021 p4).

Table 1 summarises five methodological issues with the study.

Stretching is recommended as a warm-up before exercise. But there are different types, including static stretching, dynamic stretching, and proprioceptive neuro-muscular facilitation stretching (table 2).

Behm et al (2016) performed a systematic review of studies on the effect of pre-activity stretching. All forms induced range of movement improvements in the short

ISSUE	STRENGTH	WEAKNESS
Measurement of hip flexibility.	TT is a commonly used clinical test to assess passive hip extension.	The test "does not exclusively assess musculo-tendinous structure" (Boukabache et al 2021 p5).
Measurement of physical activity.	A standardised measure in the GPAQ.	Depends on recall with the risk of over- and under-estimation. There was no independent verification of information.
Cut off points for three groups.	Two separate measures used - total sitting time per day, and total physical activity time per week.	Subjective decisions were made about ≥7 hours as prolonged sitting, and <150 minutes for physical activity. Different cut off points would give different results.
Sample.	Healthy volunteers; 50% female; average age 37-38 years; normal body mass index (BMI) range.	Only data on 98 individuals were used in the analysis. Sample was volunteer.
Data.	Cross-sectional.	Correlational, so it cannot be ruled out that individuals with hip stiffness sit for longer rather than prolonged sitting causing hip stiffness.

Table 1 - Five methodological issues with Boukabache et al's (2021) study.

- Static stretching - "lengthening a muscle until either a stretch sensation... or the point of discomfort is reached... and then holding the muscle in a lengthened position for a prescribed period of time" (Behm et al 2016 p2).
- Dynamic stretching - performance of a controlled movement.
- Proprioceptive neuro-muscular facilitation stretching - a combination of static stretching and a cyclical pattern of joint movement.

Table 2 - Three types of stretching.

term (eg: for 30 minutes afterwards). It was "not possible to confidently rank stretching methods on their effectiveness in increasing flexibility" (Behm et al 2016 p7).

There were methodological issues and differences between the studies, including:

i) The number of studies found - eg: 125 for static stretching compared to eleven for proprioceptive neuro-muscular facilitation stretching.

ii) The activity being measured - eg: vertical jump height; sprint running time.

iii) The length of stretch durations (eg: more or less than sixty seconds per muscle).

iv) The muscles stretched.

v) The length of monitoring time after stretching.

vi) Randomisation of participants to conditions or not.

vii) Risk of bias from expectancy effects.

viii) The amount of descriptive detail of stretches.

ix) The warm-up components, including the similar in warm-up to the real world (ecological validity). Whether participants were allowed task rehearsal or not.

x) Sample - eg: military recruits; professional soccer players; US college footballers.

xi) Risk of bias from not reporting non-significant findings.

xii) Activity of control group (eg: no stretching), or comparison of different types of stretching.

xiii) Length of study - eg: whole football season.

3. COLD WATER SWIMMING

Swimming outdoors has grown in popularity in recent years, including in the winter (ie: swimming in very cold water) (George 2021). Known as cold water swimming, winter swimming, or ice swimming, though these are all slightly different (Knechtle et al 2020).

"Ice swimming", in terms of a sport, is carried out in freezing water. Classic feats include Lynne Cox swimming 1.7 km in 25 minutes in Antarctic waters in 2002, and Lewis Gordon Pugh swimming 1 km in water at an open point in the ice at the North Pole (Knechtle et al 2020). Such extreme feats are performed by few individuals, and a study of Pugh (Noakes et al 2009) found that he was able to raise his body temperature by 2 °C (known as "anticipatory thermo-genesis"). This has been observed in other ice swimmers (Knechtle et al 2020).

Health benefits are being claimed by the advocates of cold water swimming. What is the evidence to support these claims?

Knechtle et al (2020) undertook a narrative review of academic publications up to August 2020, using database terms like "cold water swim" and "winter swim".

Though there is no agreed strict definition of "cold water", less than 15 °C can be used as "the majority of observable dangerous reactions to cold water appears to peak when immersed between 15 and 10 °C" (Knechtle et al 2020 p2).

The response to cold water can be divided into three phases - initial (first 3 minutes), short-term (after three minutes, when breathing under control), and long-term (after 30 minutes, with the risk of hypothermia and death) (Knechtle et al 2020).

The first response to the water is the "cold shock" response, which is a variation on the fight-flight reaction. The body prepares for action, which can include high levels of dopamine released (giving a rewarding feeling). There is an involuntary gasp, followed by hyper-ventilation to get more oxygen into the system, but if the gasp happens under water, the drowning is a risk. A heart attack is a risk at this point (George 2021). As the body temperature cools, then there are particular risks (table 3). "Overweight people who are acclimatised to the cold water and have the appropriate experience are more likely to tolerate a longer stay in the cold water than people with little body fat tissue and those who are

not acclimatised" (Knechtle et al 2020 p11).

Any benefits come after surviving the initial shock. Acute stress, particularly regularly, can help the body become resilient to future stressors (known as "hormesis": small doses of a harmful stimulus at high doses prepares the body) (George 2021).

- 36 - Shivering, rapid heart and breathing rate
- 35 - Confusion and disorientation, decreased muscle co-ordination
- 33-30 - "Clouding of consciousness", shivering stops, rigid muscle tone
- 30-25 - Stupor/unconsciousness, loss blood pressure, low respiration, cardiac arrest, death

(Source: Knechtle et al 2020 table 3)

Table 3 - Selected core body temperatures (°C) and physical symptoms.

The potential health benefits can be grouped as follows:

1. Cardiovascular

Positive effects included reduced lipid profile and blood pressure, which are cardiovascular risk factors (Knechtle et al 2020).

2. Endocrine

For example, a reduction in insulin resistance among cold water swimmers studied for six months (Gibas-Dorna et al 2016).

3. Boost the immune system

Initially case studies (eg: Kox et al 2012), but subsequently controlled studies show that cold exposure can be beneficial here. Individuals involved in ice swimming have training programmes that combine meditation, exposure to cold, and breathing exercises. The cold exposure element includes a period in cold water

each day.

Harper (2022) emphasised the benefits in relation to excess inflammation: "The cold water affects inflammation in two ways: first, baseline and peak levels of inflammation are both lowered by the repeated exposure; second, putting your face in cold water directly stimulates the vagus nerve, and thereby the parasympathetic nervous system, which results in a further, short-term reduction in levels of inflammation" (p25).

Zwaag et al (2022) studied a cold exposure programme in controlled conditions. This was a four-day intensive programme that included standing in snow with bare feet for up to thirty minutes, lying in snow in shorts for up to twenty minutes, and sitting and swimming in cold water for up to three minutes, as well as daily sixty-second cold water showers. A small number of male Dutch participants were given an immune challenge (injection of lipopolysaccharide). Cold exposure and breathing exercises were particularly effective in reducing an inflammatory response.

Comparing adapted cold water swimmers and unadapted volunteers, the former had lower stress and inflammatory responses (Tipton et al 2017).

"There is rising evidence that winter swimmers are more resistant to certain illnesses and infections, experiencing them less frequently and more mild" (Knechtle et al 2020 p7).

For example, Hermanussen et al (1995) followed individuals cold water swimming three times per week over six weeks, and noted small changes in the immune system. Often measures are taken immediately after swimming and so the longer term changes are not known (Knechtle et al 2020).

Studies do find contrasting results, and this may be in part due to the study protocols, which vary between a short bath in ice-cold water, static cold water swimming (ie: not moving), and experienced long-distance swimmers (Knechtle et al 2020). Table 4 outlines the key methodological aspects of three studies on cold water swimming and the immune system.

Because of the difficulties of measuring immune function adequately, upper respiratory tract infection is often used as a proxy. For example, 40% less frequency such infections in winter swimmers than controls (Siems et al 1999). But the measure of illness was self-reported (Knechtle et al 2020). Tipton et al (2017) commented on

Study	Participants	Protocols
Brenke (1990)	85 ice swimmers	Swam regularly for <5 minutes in water temperature -1 to +4 °C); retrospective questionnaire on illness
Huang et al (2011)	14 middle-aged male swimmers, and eleven middle-aged male sedentary controls	Swam five times per week for around one hour in water temperature 13-19 °C; blood samples
Collier et al (2015)	21 habitual cold water swimmers and co-habiting non-swimming partners, and 23 habitual pool swimmers and co-habiting non-swimming partners	Weekly report of common cold symptoms over thirteen weeks from December to March

(Source: Tipton et al 2017 table 2 pp1347-1348)

Table 4 - Three studies on cold water swimming and immune function.

retrospective self-reports of illness: "first, it is difficult to remember having had colds in the past as Brenke (1990) asked participants to do; and second, many cold water swimmers are deeply convinced that the practice is beneficial and so may under-report infections, whether consciously or otherwise" (p1348).

Collier et al (2015) showed both the positive and negative effects of cold water swimming. Compared to partners, cold water swimmers had significantly fewer episodes of respiratory tract infections. But these episodes were more severe. "While short-term exposure in cold water can certainly improve the activity of the immune system, repeated exposure without sufficient recovery may actually lead to a reduced immune function" (Knechtle et al 2020 p9).

Cold water swimming could be beneficial for the exercise element and/or the psychological aspect of being in nature as much as the cold water (appendix C). The alternative is laboratory-based static cold water immersion (CWI). For example, Jansky et al (1996) took ten unacclimatised men and gave them CWI three times a week for six weeks. There were changes in the immune function that were "small and of uncertain significance" (Tipton et al 2017 p1345).

4. Reduce depression

The use of cold water swimming as an alternative therapy for major depressive disorder (MDD) has been hypothesised. For example, some individuals with MDD have elevated immune responses, and cold water could reduce aspects of this, and consequently MDD, or a post-swim "high" may be beneficial. While psychological benefits in terms of sociality or a sense of achievement could help with MDD (van Tulleken et al 2018).

van Tulleken et al (2018) presented a case report of a 24 year-old woman with MDD, who undertook twice weekly open water swimming between April and September in England. "Within a month of open water swimming, she was able to reduce her medication and no longer required drug treatment after 4 months" (van Tulleken et al 2018 p2).

The researchers hypothesised two mechanisms to explain the findings:

a) The physiological changes of adapting to immersion in cold water. This is an example of "cross-adaptation" (or "cross-tolerance"), "whereby exposure to one stressor impact on the response to another stressor" (van Tulleken et al 2018 p1) [4].

b) A sense of empowerment and achievement in mastering a new task.

The patient made this statement: "I really did struggle with depression and anxiety and have tried everything, CBT [cognitive-behavioural therapy], talking, several different drugs and nothing worked or I feel numb and in a chemical fog. Although I didn't enjoy the cold to start with, the effect it had was like a weight being lifted off my shoulders. Open water swimming works for me, it gets me out and about in to the fresh air and has lifted my mood. I still feel down occasionally, but that is more part of what life throws my way rather than the state I was in before" (quoted in van Tulleken et al 2018).

Exercise generally has been reported to benefit individuals with MDD (eg: Kvam et al 2016).

[4] For example, Lunt et al (2010) found that adaptation to CWI (six 5-minute immersions in 12 °C water) improved the body's response to moderate exercise in a low-oxygen environment.

5. Combat dementia

Studies with mice have found neuroprotective benefits from "therapeutic hypothermia". Cold shock produces a protein (RBM3) which prevents synapse loss in mice genetically engineered to be Alzheimer's-type models (Bastide et al 2017). The applicability of such work to humans is debated.

Overall

Many of the benefits of cold water exposure may be related to the initial shock and the consequent changes in skin temperature. "It may not even be necessary to chill the whole body" (George 2021 p49).

The studies of cold water and ice swimming vary in methodology, and it is important to be aware of such differences. Here are a number of methodological issues to consider:

i) Sample (eg: experienced or inexperienced swimmers; athletes; non-humans).

ii) Age group of participants.

iii) Type of activity (eg: dynamic swimming; static immersion).

iv) Acclimatisation period.

v) Length of study (eg: six months).

vi) Measures (eg: self-reports of illnesses).

vii) Water temperature (including time of year).

viii) Length of immersion.

ix) Frequency of activity (eg: once a week).

x) Laboratory-based study or natural environment.

xi) Type of research method (eg: case report; controlled study).

xii) Control or comparison group (present or absent; who is involved).

Knechtle et al (2020) concluded: "Regular swimming training in cold water seems to have a positive effect on various systems such as the cardiovascular system, endocrine system, immune system and the psyche. However, cold water swimming still poses a significant health risk for inexperienced and untrained swimmers. It is recommended that in order to fully benefit from the metabolic and thermogenic effects of cold water swimming, a grade and progressive acclimatisation programme is required and preferably done under supervisor" (p14).

Table 5 sums up the key risks and benefits of CWI based on the level of evidence.

Evidence	Risks	Benefits
Best (systematic reviews)	Drowning from cold shock Hypothermia	Prolonged underwater survival
Better than average	• Cardiac arrest from cold shock • Drowning from cold-induced neuromuscular incapacitation • Cold injury	• Pre-cooling improves performance in hot environments • Improved recovery post-exercise (but depends on exercise)

Table 5 - Key risks and benefits of CWI based on evidence (according to Tipton et al 2017).

The experience of cold water has a subjective element. This is "thermal perception", "defined as the mental state of how a person experiences ambient temperature and is composed of two basic elements: thermal sensation and thermal comfort... The thermal sensation is the conscious state of distinguishing hot and cold stimuli, while thermal comfort is the mental state related to ambient temperature satisfaction" (Ntoumani et al 2023 p2). The subjective perception is usually measured by thermal scales (eg: seven categories: from "very cold" (0-12 °C), "cold" (12-18 °C), to "hot" (37-40 °C), and "very hot" (40-43 °C); Ledo 1996).

Ntoumani et al (2023) noted: "Currently there are no common accepted definition for cold and hot water temperatures" (p8).

In terms of research on subjective perception, Wakabayashi et al (2008), for instance, had participants fully-body immerse in 26 °C water for one hour. Reports

were taken of the sensation every five minutes. In the first ten minutes, "cool" was the main response, "cold" at thirty-five minutes, and "severe cold" by the end (Ntoumani et al 2023).

3.1. VIEWS OF OUTDOOR SWIMMERS

Among outdoor swimmers there is a perception of it as health-benefiting. Massey et al (2022) surveyed online 722 such swimmers in the UK between November 2018 and March 2019. The survey was advertised in "Outdoor Swimmer" magazine, and involved fourteen items. Overall perceived impact on health of outdoor swimmers was scored on a four-point scale ("a lot of impact", "some impact", "little impact" and "no impact").

The sites of swimming included lakes, rivers, the sea, lochs, quarries, lidos, and reservoirs. Around two-thirds of the respondents swam all-year round. The main reasons for partaking were training for an event, feeling connected to nature, and improved well-being in that order.

Only 10% reported no medical condition. The most common conditions were mental health, followed by musculo-skeletal, neurological, and cardiovascular. Overall, 95% reported at least "some impact" of outdoor swimming on their medical symptoms and health, especially for mental health conditions.

The medical conditions were divided into five general categories by the researchers. The benefits of outdoor swimming were subjective perceptions only. It could be that "symptoms are not changed by the act of outdoor swimming, but the participants' perceptions of their symptoms or feelings of well-being are temporarily changed. However, it is important to separate well-being from mental health rather than them occupying the same continuum. Therefore, it may be that outdoor swimming does not reduce their symptoms, but they do have a sense of greater well-being" (Massey et al 2022 p11). This fits with the "Common Sense Model of Illness Perception" (Leventhal and Brissette 2002), "which proposes that the positive beliefs that a person holds regarding their illness directly lead to better mental well-being and the development of active coping strategies" (Massey et al 2022 p12).

The sample was convenience, and the researchers accepted that "the survey was conducted on people currently swimming in open water, and therefore, those who are likely to have a very positive viewpoint about

the activity. Although the views expressed in this paper... have been commonly heard by the authors, it is not clear if this is representative of all outdoor swimmers or those who do not continue to swim outdoors. However, the research was conducted as an internet-based open survey; therefore, no coercion took place for swimmers to participate or give particular answers" (Massey et al 2022 p12).

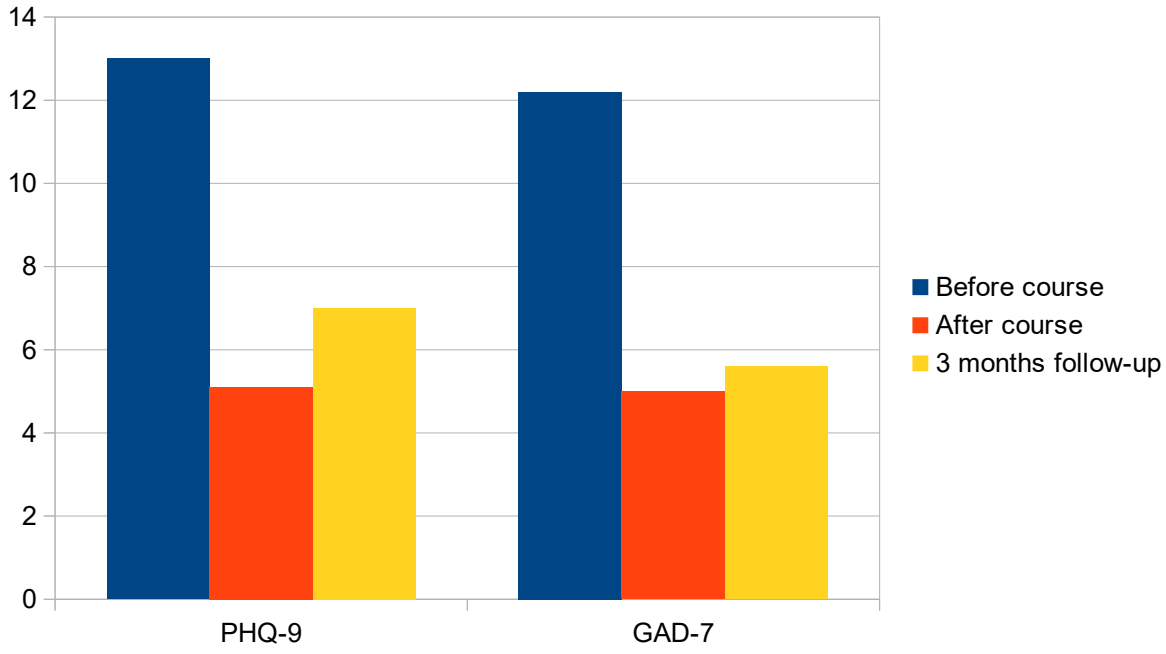
3.2. SEA SWIMMING

In a slightly different vein, Burlingham et al (2022) undertook a feasibility study of sea swimming to help with depression and anxiety. Sixty-four adults with depression and/or anxiety who enrolled on a sea swimming course in Devon (south-west England) in July or October-December 2022 were studied. Experienced lifeguards ran the small groups of eight people (to ensure social distancing during the covid-19 pandemic) who swam twice a week over four weeks, or once a week over eight weeks. Each session lasted towards one hour, beginning with warm-ups, cold water acclimatisation (eg: walking into the water waist deep), and finally a swim for no more than thirty minutes. Self-reported mental health questionnaires (including the Patient Health Questionnaire (9-item version) (PHQ-9) and the Generalised Anxiety Disorder Assessment (7-item version) (GAD-7)) were completed online prior, after the course, and three months later. Complete data on 53 adults covered the full study. Around 90% of the participants were female.

At the three-month follow-up, 34 participants were still swimming at least once per week. There was an improvement in all mental health measures between the baseline, and after the course, and at three-month follow-up (figure 1). No statistical significance tests were performed on the data.

Participants were offered the opportunity to keep a diary of their experiences (and fourteen participants did so). The researchers drew out a number of themes from these and the post-course evaluation forms including:

a) "Confronting challenges" - eg: "I felt so proud of myself and I'm so happy I started this group because I feel like I've really accomplished something both physically emotionally and mentally" (Participant 2; p6).



(Data from table 2 Burlingham et al 2022)

Figure 1 - Mean scores on two mental health measures.

b) "Becoming a community" - eg: "I really loved coming together as a group and the feeling of inclusion and togetherness that gave" (Participant 47; p7).

c) "Appreciating the moment" - eg: "When I am in the water I think of nothing but how beautiful it is to be immersed in the natural sea that nature has provided" (Participant 2; p7).

This was a feasibility study, and it took place during the covid-19 pandemic. In terms of the implications, firstly, the courses were "fully-subscribed, retention and attendance rates were high, and drop-outs low" (Burlingham et al 2022 p6). Secondly, there were no serious adverse events, and finally, there were mental health benefits of attending the course. Burlingham et al (2022) explained: "Conclusive inferences cannot be made given this was a feasibility study, without a control group. However, the effect size was large in the reduction of severity scores of both PHQ-9 and GAD-7 pre- and immediately post-course. This reduction in symptoms was seen across the severity range. In the main, there was no return to pre-intervention severity levels three months after the end of the course, although this was seen in a small proportion of

individuals" (p8).

The benefits of the course appeared to be in the sense of achievement, and of being part of a group, in particular. Also "an increased appreciation of the moment and in particular of being in nature. The intensity of the experience perhaps encourages people to become focused on the present moment, giving them a break from their day-to-day worries" (Burlingham et al 2022 p8).

Note that the courses were not all cold water swimming (in July), but the sea around the UK rarely gets very warm. Anyway, there was an overlap between sea swimming and cold water swimming here.

3.3. HOT-TO-COLD SHOWERING

"Cold bathing is a common custom in many parts of the world. Ever since the introduction of civilised bathing, humans have experimented with water temperature variation to expose the body to extreme conditions. In ancient times, Roman bathing was based around the practice of moving through a series of heated rooms culminating in a cold plunge at the end. In modern times, the traditional ritual of the 'frigidarium' has been kept in most saunas and spas around the world" (Buijze et al 2016 p2).

Concentrating on hot-to-cold (HTC) showering, Buijze et al (2016) reported a randomised controlled trial from the Netherlands. Over 3000 employed adults without routine experience of cold showering were recruited in early 2015 to the "Cool Challenge". They were randomised to one of four groups for thirty consecutive days (with a further 60-day follow-up) - three intervention groups and a control. The intervention groups showered with warm water, and ended with a period of cold water (either 30, 60 or 90 seconds in length). The control group showered with their preferred water temperature (ie: not cold). The study took place between January and March, and the average cold water temperature was estimated at 10-12 °C.

The outcomes measures were self-reported online. Primarily, number of days on sick leave, and illness days, as well as symptoms of cold or flu. Secondary outcomes included quality of life, work productivity, and anxiety.

The main findings was all three intervention groups had significantly less "sickness absence days" than the control group at 30 days, but there was no statistically significant difference between the intervention groups. In terms of "illness days", only the 60-second cold

shower group differed significantly from the control group. There were no significant differences at 90 days. Though individuals were free to shower as they wanted during the follow-up period. No serious adverse events were reported with cold showering. "The only secondary outcome that showed a slight beneficial effect – on the short run – was quality of life (mental component summary) although this was deemed too small to be clinically relevant" (Buijze et al 2016 p7).

HTC showering reduced self-reported sick leave, but not illness days as a generalisation. The benefits were greater for individuals in the study who undertook regular physical activity compared to no exercise.

Key limitations of Buijze et al (2016) study:

i) The participants "could not be blinded for the intervention nor for their own outcome assessment, hence potentially introducing important bias. Specifically, a placebo-effect of this intervention cannot be ruled out" (Buijze et al 2016 p11). But the study did take place in the context of their normal lives rather than in an artificial, controlled environment. The participants were randomised to the conditions, and the groups were parallel.

ii) The measures were all self-reported. Objective measures of health and the effects of HTC showering (eg: neuroimaging) would be the ideal.

iii) The study population "extremely healthy compared to the general Dutch population" (Buijze et al 2016 p11) (eg: individuals with severe co-morbidities excluded; employed only; 18-65 years old). There was a relatively large number recruited via advertisements and (social) media.

iv) An attrition rate of 20% between enrolment and 90-day follow-up. "In the intervention groups, large numbers of participants discontinued the intervention because of its burden or a sickness making them choose for their preferred routine. In contrast, in the control group discontinuers were much fewer as the control group instructions to shower as regular did not cause any burden or preference to discontinue due to sickness" (Buijze et al 2016 p12). There was no independent verification of compliance [5]. No restrictions on overall length of shower.

[5] Thus it was called a "pragmatic trial" (Buijze et al 2016).

v) Because of "the relatively short follow-up period and the very healthy character of the study group resulted in the fact that most participants did not have any sickness absence days at all" (Buijze et al 2016 p12).

vi) A cold shower only group would have been interesting to include.

3.4. DELIBERATE COOLING

Deliberate cooling generally has been studied in relation to athletes. Firstly, there is pre-cooling before performance in a hot environment. For example, Booth et al (1997) asked eight athletes to run for thirty minutes in hot, humid conditions (32 °C; 60% relative humidity) on two occasions. Before one of the occasions, the participants spent sixty minutes in progressively cooler water, and subsequently were able to run further than in the control condition (ie: no pre-cooling).

"However, it should be noted that, in accordance with Newton's cooling law... and the heat transfer equation..., in a hot environment pre-cooling increases the rate of heat transfer between the human body and the environment as a consequence of an increased thermal gradient... The onset of sweating is also delayed during exercise after pre-cooling..., which will diminish evaporative heat loss. As a result, a pre-cooled individual will gain heat more rapidly than a hotter individual until convergence at a common temperature... Thus, although pre-cooling by CWI represents an effective strategy for enhancing endurance exercise performance in a hot environment, its efficacy may be limited to exercise durations shorter than the time taken for body temperature to converge with that in non-pre-cooled conditions" (Tipton et al 2017 p1341).

Then there is post-exercise CWI to aid recovery. The mechanisms of benefit are "not entirely clear" (Tipton et al 2017 p1341), and studies also vary in their findings. Studies have methodological differences related to timing of immersion after exercise, and temperature, duration and depth of immersion, as well as outcome measures used. The nature of the control condition is important (ie: active recovery or rest). However, CWI appears to be effective in reducing perceived post-exercise muscle soreness (Tipton et al 2017).

4. SITTING AND POSTURE

Posture is traditionally viewed as linked to health issues like low back pain (LBP), with ideas like "head up, shoulders back, sit up straight" dominating. But evidence is emerging that is challenging this (George 2022).

"A lot of what we think of as good posture is about aesthetics and ideas about what is deemed elegant, attractive, interested or motivated" (Kieran O'Sullivan in George 2022). The "optimal posture" is described as "a balanced one, which is comfortable, stable and symmetrical and doesn't overstrain any specific muscle or joint" (George 2022 p42).

But what is this in practice? It is not clear. For example, O'Sullivan et al (2012) surveyed 296 physiotherapists in four countries (Ireland, England, Germany, and the Netherlands) about "good seated posture". Nine sitting postures from slumped to upright were modelled by a young woman and photographed. The postures were randomly numbered and the participants were given black and white photographs of them to "select the best posture for the spine as a whole, especially the lumbar spine".

One participant refused to decide, claiming that there was no best sitting posture. Over 85% of the rest of the sample chose one of two postures. "Interestingly, these two most frequently selected postures were very different from each other" (O'Sullivan et al 2012 p432). So, there was "considerable disagreement" on the best sitting posture.

One of the most frequently chosen postures was more upright, and physiotherapists who picked this one had stronger views about LBP (as measured by the "Back Beliefs Questionnaire"; BBQ (table 6); Buchbinder and Jolley 2005).

- There is no real treatment for back trouble
- Back trouble must be rested
- Back trouble means periods of pain for the rest of one's life
- Back trouble makes everything in life worse
- Medication is the only way of relieving back trouble

(Source: Tingulstad et al 2019)

Table 6 - Example of items from BBQ.

However, even if the optimal posture is known, individuals do not necessarily adopt it. Korakakis et al (2021) asked ninety-three volunteers without a history of spinal pain to sit "as you usually do" while being video recorded. Sixteen reflective markers were placed on the body to aid posture assessment (eight variables were calculated - eg: head angle, head tilt angle). After thirty seconds, two questions were asked to the seated participants: "Do you believe that your current sitting posture reflects an 'optimal' sitting posture?", and if "no" was answered, "Can you please adjust your sitting into what you believe is an 'optimal' sitting posture?". No participants thought that their sitting posture was "optimal", and all changed to a more upright posture when asked.

The assumption is always that slouching is harmful. "For a start, although sitting with your neck or spine at an odd angle can cause temporary muscle soreness due to overactivity in certain muscles or a decrease in oxygen to tissues, the link between posture and longer-term pain is highly contentious" (George 2022 p43). O'Sullivan et al (2012) admitted: "While there is no clear evidence that prolonged sitting in isolation is a significant risk factor for developing LBP..., combined exposure to prolonged sitting, awkward postures and vibration may increase the risk of developing LBP" (p432) [6].

"Awkward posture" is another term used, which is defined as "body positioning that deviates from the neutral or natural position" (Tinitali et al 2021 p111). It is viewed as a risk factor for LBP. Occupational driving as in buses, trucks, and helicopters, say, often involves "the adoption of awkward driving postures due to the poor ergonomic design of vehicles" (Tinitali et al 2021 p112). Lis et al (2007), for example, in their review, found an association between occupational sitting and LBP.

But drivers of different vehicles were grouped together. Tinitali et al (2021) commented: "The trunk and upper limb movements required of a helicopter pilot or garbage truck driver are likely to differ to those required of a bus or truck driver, due to the need to operate additional or alternative controls within the vehicle, or to perform additional tasks such as repeated rotation of the trunk to ensure correct position of a lever picking up a garbage bin. Trunk movements in automobile drivers are also likely to differ when an individual is driving on an uneven surface, or at a high

[6] Micro-breaks can help (appendix D).

speed, in comparison with a standard public road. It is therefore difficult to make specific conclusions related to drivers of standard road vehicles based on a review of such a heterogeneous group of drivers" (p112).

Tinitali et al (2021) undertook a more recent review of studies on occupational driving posture and LBP. Seven relevant observational studies (published up to early 2018) were included, covering bus drivers, taxi drivers, police officers, and drivers of trucks and vans. Four of the studies found a significant association between LBP and "driving with the back in a bent or twisted posture" (Tinitali et al 2021 p118).The other three studies did not find a significant relationship.

The researchers found it difficult to draw a firm conclusion because of the heterogeneity of the studies, and of the methodological issues, which included:

a) Mostly male participants.

b) The use of posture measures that lacked validity and reliability. Self-reported questionnaires were common, while assessors were not blind to the participant characteristics.

c) Variations in definitions and scoring of awkward postures (eg: "personal posture score"; "physical load index"). No study had repeated measure of exposed.

d) Outcome measure - eg: current LBP or a history of LBP in last twelve months.

e) Ignoring potential confounders - eg: whole-body vibration; carrying weighty objects as part of the job).

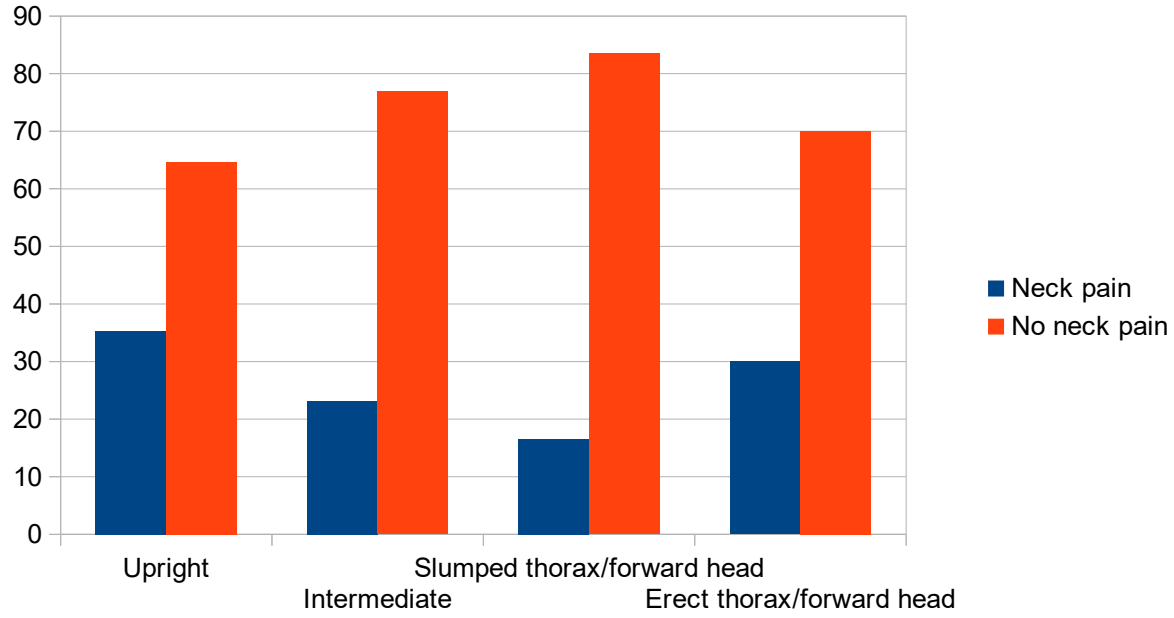
The conclusion of the review was that although a relationship was found between LBP and prolonged driving posture in more studies than not, the quality of the studies limited the confidence in that finding.

Posture is "commonly believed" to also be a risk factor for neck pain (NP) (Richards et al 2021). The evidence is, however, contradictory. One review did find that adults with NP had a more forward head posture (Mahmoud et al 2019), while a large-scale study of adolescents (Richards et al 2016), that distinguished four sub-groups of sitting neck posture, after "accounting for multiple factors (sex, height, weight, exercise frequency, depression), no association was found between neck posture sub-groups and NP" (Richards et al

2021 p2).

Prospective longitudinal studies would be the ideal method, and Richards et al (2021) investigated sitting neck posture at seventeen years old and subsequent NP five years later in an Australian sample. The participants were part of the "Raine Study" [7] (n = 2868 individuals in Western Australia). Postural data were available for 686 of them, and they were divided into the four groups distinguished by Richards et al (2016) - upright; intermediate; slumped thorax/forward head; and erect thorax/forward head sitting neck postures. Neck pain was measured by three questions - "Have you ever had neck pain?"; "Has your neck pain ever lasted more than 3 months continuously (it hurt more or less every day)?"; and "Has your neck pain ever lasted for 3 months on and off (it hurt once a week but not every day)?" (p2).

At 22 years old, 28% of the sample reported persistent NP (ie: longer than three months). The relationship to sitting neck posture at seventeen years old was only significant for female participants - highest for the upright sub-group, and least in the slumped thorax/forward head sub-group (figure 2). NP at 17 years old predicted NP at twenty-two years old.



(Data from Richards et al 2021 table 2)

Figure 2 - Participants with neck pain at 22 years old based on sitting neck posture sub-group at 17 years old (%).

[7] Details at https://rainestudy.org.au/.

Richards et al (2021) evaluated their research: "Strengths of this study include its longitudinal design, use of well-defined posture sub-groups, sex-specific analyses, and the consideration of a range of potential confounders. In terms of limitations, approximately 30% of participants did not attend follow-up" (p7). Posture was assessed by photograph in a laboratory setting, Richards et al (2021) continued, "providing a static view of posture, which may not be representative of their normal habitual posture or account for postural variation over time. Stability of posture sub-group membership over time is unknown. This study did not consider the cause of NP, aggravating activities, the severity of NP, or levels of impairment of the participants. Although this study considered depression as a confounder, we acknowledge that other psychosocial factors that may confound the neck posture and NP relationship were not accounted for" (p7).

The link between specific postures and pain may not be clear, but a sedentary lifestyle means that certain postures are held for long periods, and this could be the problem (eg: slouching over a computer or phone screen).

Plummer et al (2017) showed one problem in the research, namely diagnostic bias. Clinicians using a standardised assessment for shoulder problems came to different conclusions depending on prior knowledge of shoulder pain (unblinded examiner) or not (blinded examiner). Scapular dyskinesis ("altered movement or position of the scapula"; Plummer et al 2017 p530) was diagnosed more often by unblinded than blinded examiners (80% vs 68% respectively). "The differences in prevalence rates between examiners may be clinically meaningful and may indicate a potential confirmation bias, because a higher presence of scapular dyskinesis was reported when examiners knew they were rating an individual's painful shoulder" (Plummer et al 2017 p535).

Posture and mood have been linked. The influence of posture on emotions has been investigated in a small number of studies. "A handful of studies has suggested that adopting an upright spinal posture may lead to less negative and more positive emotions than a slumped posture, but this research is limited" (Nair et al 2015 p632).

The typical study involves participants doing a mental task while sitting erect or slumped, and then rating their mood (eg: Riskind and Gotay 1982).

Nair et al (2015) added an objective measure to

self-reports in their study of upright versus slumped seated posture and perceived stress. Seventy-four volunteers in New Zealand were asked to sit on a stool in a "slumped" experimental condition (bowed head, rounded shoulders, and stooped back) or an "upright" one (erect back, straight shoulders and back) while presenting themselves for the "dream job" to a video camera. This was designed to produce psychological stress. Mood was self-reported before and after the task, and heart rate was measured throughout.

It was found that seating in an upright posture had protective effects in the stressful situation compared to the slumped posture. "The upright participants reported feeling more enthusiastic, excited, and strong, while the slumped participants reported feeling more fearful, hostile, nervous, quiet, still, passive, dull, sleepy, and sluggish. The upright participants also reported higher self-esteem and reduced fear compared to slumped participants" (Nair et al 2015 p637). However, the upright posture group had a faster heart rate during and after the stressful task. "These results seem to reflect increased physiological arousal in the upright group compared to the slumped group. This increased arousal may be driving an active coping response in the upright group,compared to the slumped group who may be exhibiting more of a helplessness type response consistent with previous work" (Nair et al 2015 pp637-638).

The study did not have an usual posture control group.

In conclusion, the researchers stated: "Sitting upright may be a single behavioural strategy to help build resilience to stress" (Nair et al 2015 p632).

5. COMFORT

"Currently, the word 'comfort' is often used in relation to the marketing of products such as chairs, cars interiors, clothing (appendix E), hand tools and even airplane tickets" (Naddeo et al 2019 p194). But perceptions of comfort/discomfort are much wider in terms of postural, cognitive, physiologic, and environmental types, particularly human (or artefact)-machine interaction (Naddeo et al 2019).

Posture and movement include a range of motion, and the concept of the "comfortable range of motion" has been used (Naddeo et al 2019). Spinal postural comfort is important here. For example, in overall seating comfort and inter-vertebral disk pressure, the "lower the disc pressure is, the higher the perceived comfort is" (Naddeo et al 2019 p195).

Naddeo et al (2019) explored postural comfort with vending machines. The researchers filmed twenty volunteer users of a snack, a drinks, and a coffee vending machine at a university in Italy. Three tasks were considered - inserting coins, collecting change, and picking up the product. A questionnaire on comfort was subsequently completed.

It was found that "in a complex movement involving upper limbs movements and spine flexion, this last one, especially the mid/lower part, has the majority of the weight in perceiving (dis)comfort sensations" (Naddeo et al 2019 p200). An improvement, for example, would be to raise the height of the "change box".

5.1. MEASUREMENT

"A difficulty in studying comfort is that a product in itself can never be comfortable... It only becomes comfortable (or not) in its use" (Mansfield et al 2020 p1). This quote highlights the subjective nature of the concept of comfort [8]. That is not to say that comfort/discomfort is not studied. Vink and Hallbeck (2012) found over 100 000 academic papers between 1980 and 2010 that included the term "comfort" or "discomfort". "Most of the studies refer to temperature related discomfort or patient comfort" (Mansfield et al 2020 p2).

Attempting to measure comfort/discomfort, the Borg

[8] "Studies in recent decades have shown that comfort and discomfort are different phenomena. Although correlated, they can occur simultaneously" (Menegon et al 2019 p1).

scale (Borg 1990) has been developed. An individual holds a 1 kg weight with a horizontal extended arm for a period of time. At first there is little discomfort (low scores), but eventually there is much discomfort when the weight cannot be held any longer (maximum score = 10). Individuals take the knowledge of the scale and apply it to a seat, for example, After sitting for a while, they score different areas of the body (Mansfield et al 2020).

The CP-50 category positioning scale (Shen and Parsons 1997) is another method, where a score of 1-10 is "very slight discomfort", through to 41-50 "very severe discomfort". This has been used with seat design, as have shorter scales (Mansfield et al 2020).

Such scales are important because there is a common assumption that self-reported discomfort correlates with musculo-skeletal injuries, in the workplace, say. Hamberg-van Reenen et al (2008), for example, followed 1800 workers over a number of years, and found that self-reported posture discomfort predicted low-back, neck and shoulder pain years later.

Menegon et al (2019) constructed a scale specifically to measure aircraft seat discomfort. Thirty-seven items were initially included after a literature search, and 1500 passengers at an international airport in Brazil were asked to rate their last flight using them. Based on the responses, twelve items were removed. This left the "aircraft seat discomfort scale" with 25 items (table 7). Total scores could be grouped into six

ASPECT OF DISCOMFORT	EXAMPLE ITEMS
Psychological (eg: emotions, experiences, expectations)	"I was anxious during the flight"; "I was afraid during the flight"
Physical (eg: posture, movement, pain)	"I felt pain somewhere in my body when I was in the aircraft seat"; "My body was tense"
Object (seat) (eg: support of body areas)	"The seat was soft"; "The aircraft seat was old"
Context (eg: watching IFE)	"I missed an onboard entertainment system"; "I was unsatisfied with the food served during the flight"
Environment (general) (eg: noise, temperature, lighting)	"The smell inside the aircraft was bad"; "The lighting inside the aircraft met my needs"

(Source: Menegon et al 2019 table 2)

Table 7 - The five aspects of discomfort and items from the aircraft seat discomfort scale.

categories, from "without discomfort" (where positive emotions dominate), to "little discomfort" (with the appearance of negative emotions), "much discomfort" (general irritation - eg: disturbed by the person at their side), and finally, "maximum discomfort" (eg: find seat hard and have difficulties conducting activities like reading or sleeping).

A number of models conceptualise discomfort and comfort as two separate constructs - "discomfort is associated with feelings of pain, soreness, numbness and stiffness mainly attributed to physical constraints in the seat design; comfort is associated with feelings of relaxation and well-being. It is evident that reducing discomfort will not necessarily increase comfort, but in order to accomplish a high level of comfort, the level of discomfort should be low" (Vanacore et al 2019 p155).

Comfort is also a construct that is multi-faceted. Mansfield et al (2020) proposed a "cake model" as a metaphor for comfort in relation to products. There is "a cosmetic coating" that produces the first impression with hidden design elements in layers. "For example, there could be differing requirements for thermal properties, lateral support, vibration damping, breathability, adjustability etc depending on the application, customer and budget. For the whole experience to be acceptable all elements must exceed minimum levels of performance in order to support subsequent layers; if any element fails, the entire customer experience collapses" (Mansfield et al 2020 p2).

In terms of the "cosmetic coating", one study of office chairs found that users rated the comfort based on visual information (ie: without fully testing the seat) (Mansfield et al 2020). This suggests that comfort is more than just the physical experience.

5.2. SEATING

Comfort in seating has been explored, for example, during watching television. There is a preference to sit in a reclined posture. "A possible explanation for this preference for a reclined/slouched posture may be the relative low back muscle activity in this position... [while] a slouched posture also lowers pressure in the inter-vertebral disks" (Smulders et al 2019 p26) (table 8) [9].

[9] A seat's recline angle has been studied by NASA, for example, with the "neutral body position" or "zero-gravity position" (Campos and Xi 2020).

Study	Brief Details
Filho et al (2015)	Over 1100 adolescents watching TV at home - questionnaire. Around half preferred a slouched, reclined or lying posture.
Kninenberg (2005 quoted in Smulders et al 2019)	Watching TV in a passenger seat of a lorry - observation & interview. A slouched posture was chosen by the 20 participants.
Hiemstra-van Mastrist 2015 quoted in Smulders et al 2019)	28 individuals watching IFE in economy class aircraft seat - observation & questionnaire. A slouched posture with an upright head preferred.

Table 8 - Three selected studies on slouched posture when watching television.

However, being in this position without neck/head support is reported as discomfort in the neck (as in an economy class aircraft seat watching in-flight entertainment (IFE)). "No head support could have the effect that the head is less stable and more muscle activity is required to maintain (static) position" (Smulders et al 2019 p25).

Smulders et al (2019) found that a headrest was preferred to watch IFE in a simulated aircraft seating experiment. There was also a difference in posture. "In the condition without headrest the head was more upright compared to the condition with headrest" (Smulders et al 2019 p25).

In surveys of flight comfort (eg: Vink and Brauser 2011), the seat is often the most important factor mentioned, along with leg room, hygiene, and crew. A number of aspects of the seat were mentioned, including "too short seat pan length, too narrow seat width, no free should space, no living space when the frontal seat is fully reclined, no seat support for side sleeping..." (Wang et al 2018 p13).

In order to carry more passengers on a flight, airlines are increasing the number of rows in an aircraft by putting them closer together. This is a decrease of 2-5 inches in the last 30 years (Anjani et al 2020).

"Today's seat pitch sizes vary from 28 inches to 38 inches for economy class flights... The seat pitch itself is measured from a point in a seat to the exact same point of the seat in-front/behind it... The arrangement of the seat pitch will affect the legroom or knee space. Legroom, as a result of seating row arrangements, is an important factor in passenger comfort" (Anjani et al 2020

p1). The concept of "space experience" has been used (Anjani et al 2020).

Anjani et al (2020) arranged for 294 Dutch volunteers to experience economy class seats in a Boeing 737 with seat pitches of 26, 30, 32 and 34 inches. The pitch size was positively associated with comfort ratings, and negatively with discomfort scores. But the position of the seat in the row was also important (ie: higher discomfort scores for middle seats), and the passenger's body (ie: greater discomfort for larger individuals in shorter seat pitches).

In a comparison of aircraft seating with twenty Italian volunteers, Vanacore et al (2019) found gender differences in discomfort. Males perceived discomfort at the head and neck areas, and behind knees, and low legs. Gender differences in posture have been found in studies of office chairs and car seats - ie: "men tended to slouch against the back rest while females perched closer to the front of the seat pad" (Vanacore et al 2019 p162).

Individual differences in body size, and gender are often ignored or downplayed. "Larger sized seats are rated more comfortable by taller occupants vice-versa shorter occupants rate smaller seats as more comfortable...; males and females are exposed to different loading patterns and experience different discomfort pathways, due to fundamental biomechanical differences in their sitting posture" (Vanacore et al 2019 pp155-156).

Car seat comfort is a challenge for designers as they try "to develop an ergonomic and comfortable product, avoiding discomfort in the seat interaction zone and facilitate a variety of postures" (Wegner et al 2020 p1). The "interaction zone" between the human and the seat is influenced by the indentation process, and also includes the combination of objective and subjective aspects. Indentation is the moment of fully placing the body on to (or into) the seat. "The reaction of the seat components during the indentation could deform the human skin and the underlying tissue, also affecting the blood flow, musculo-skeletal system and tissues. Systems in the human body could react and amongst these the mechano-receptors in the skin record the changes in the stressed surface and send the information to the brain... influencing interpretation and evaluation of the seat comfort" (Wegner et al 2020 p2).

Objective aspects include the foam characteristics, which can be tested for different heights, and there is a

correlation between seat pressure and discomfort. Seat contour, seat dimensions, and seat adjustments are also relevant (Wegner et al 2020) [10].

Another element in the evaluation of the seat comfort is to divide it into three time periods - initial (first three minutes), short-term (up to thirty minutes), and long-term (after 30 minutes) (Mergl 2006 quoted in Wegner et al 2020). Discomfort scores are higher in the long-term than initial period (Wegner et al 2020).

In terms of experimental work, Mitsuya et al (2019) recruited eighteen adults in Japan to sit in a Nissan car driving seat. Nineteen seats were tested for body pressure distribution in the correct driving posture after participants had adjusted the seat position and angle, and the steering wheel to their preference. The rating of the seats, based on nine dimensions (eg: "sinking", "rebound", "bite"), were placed on two axes - hardness and supportability. Note that the participants only sat for three minutes in the driving posture in each seat.

Discomfort can also be experienced by vibration transmitted through the contact areas of the occupant of a vehicle seat. The frequency range of the vibration resonance of 10-60 hz has been been found (Kim et al 2020).

Thigh support is a specific issue in car seat design, and improper thigh support produces problems from difficulty reaching pedals to "exhaustion from constant leg strain to support the chosen seating position, and lumbar misalignment due to poor positioning relative to the seat's support" (Romelfanger and Kolich 2019 p257). One study found that cushion-thigh interaction issues was third in factors linked to discomfort in the North American automotive seating industry. In particular, that the cushion length was too short (Romelfanger and Kolich 2019).

Romelfanger and Kolich (2019) found that cushion length that provided thigh support for 83-88% of thigh length was rated as most comfortable. This conclusion came from analysis of data from the 2016 Global Quality Research Survey covering over 92 000 new car owners.

Driving is a prime example of "postural fixity" (Grieco 1986). This is "the static head, neck and trunk postures of individuals that sit in the same position for long periods of time without significant postural

[10] Hiemstra-van Mastrigt et al (2017) included three mediating factors in seat discomfort - activity, posture, and inter-face pressure.

movement" (Varela et al 2019 p214). The consequences include musculo-skeletal discomfort (eg: pain, aches, numbness), fatigue, and potential long-term problems (Varela et al 2019) [11].

Shifts in posture help, for example, as one study found that a ten-minute walk in the middle of driving reduced discomfort (Sammonds et al 2017). "It is not always possible to take a break from a vehicle, but it has been found that even passive posture changes have positive effects on driver well-being" (Varela et al 2019 p215). A seat that moves automatically (eg: 8 mm increments every fifteen minutes) has been tried experimentally. Varela et al (2019) did so with ten volunteers in a one-hour driving simulation. There was less discomfort 9specifically buttock discomfort) reported at one hour with seat movement compared to a static seat. "Generally, passive seat movement was well received" (Varela et al 2019 p214). In conclusion, the seat movement should be "fixed speed, slow, smooth, relatively small range, slightly perceptible" (Varela et al 2019 p220).

Another type of seating is in classrooms. Fasulo et al (2019), for instance, measured the perceived (dis)comfort of 25 university students in a lecture theatre in Italy in a one-hour lesson using a pressure pad on the seat and a questionnaire. The hour was divided into three 20-minute sessions and the (dis)comfort questionnaire was completed three times.

It was found that "performing a high number of movements in a constrained space is due to the increase of discomfort; after a movement or a change of position, the decrease of discomfort is perceived; the decrease of postural discomfort concurs to a more overall comfortable state" (Fasulo et al 2019 p239). Discomfort decreased when the centre of pressure on the seat moved in either a left or right direction. Heavier participants reported greater discomfort.

The participants could not change the seat's position, and had a limited amount of space, while the position of the blackboard meant orientation towards the left. No attention was paid to upper-body posture (Fasulo et al 2019).

[11] "Musculo-skeletal sitting discomfort, specifically caused by long-term sitting, is primarily triggered by physiological fatigue on the human body due to its own weight. Passive seat designs can produce inadequate surface pressure zones on the body resulting in high musculo-skeletal stress leading to physical discomfort" (Campos and Xi 2020 p1).

5.3. MISCELLANEOUS

Comfort has also been studied in relation to movement with an object, for instance. Carrying heavy loads in backpack-carrying systems can lead to muscle injuries if not optimal. A hip belt can distribute part of the load from the shoulders to the pelvis, and increase comfort (Kratzenstein et al 2019).

Comfort during boarding a plane has also been studied. Based on research at a Dutch airport, Hiemstra-Van Mastrigt et al (2019) noted stressors for passengers via direct observations and questionnaires. At the gate area, the complexity of boarding compared to expectations, and delays on the plane due to other passengers storing luggage, say, emerged as key stressors.

6. BODY MOVEMENTS AFFECTING THE MIND

Williams (2022a) outlined the view that "body movements affect the mind" (Williams 2021b p34) [12]. Examples of this include (Williams 2021b):

1. "Get on your feet" - eg: walking or running at a comfortable pace allows the mind to wander and "broader, more creative ideas to flow" (Williams 2021b p35).

2. "Get strong" - eg: physical strength could provide cognitive benefits in later life, and higher self-esteem.

3. "Dance" - eg: a regular beat is easy to predict and can create the feeling of control (appendix F).

4. "Breathe" - eg: slow, controlled breathing is associated with deep relaxation.

5. "Straighten up".

6. "Stretch".

Research has shown physiological connections between areas of the brain and organs in the body, which supports the idea of the brain-body interaction in a concrete form. For example, connections between areas of the cerebral cortex involved in higher-order aspects of thinking, affect, and movement, and the adrenal glands (which releases adrenaline) (Dum et al 2016).

Dum et al (2016) drew this conclusion: "This means that mental operations like the preparation to move, the appreciation of conflict and feelings of sadness may be linked to the regulation of adrenal function. The cerebral cortex is a site of neural plasticity and information storage. As a consequence, aberrant plasticity could be a cause of or contribute to psychosomatic illnesses, just as the engagement of cortical plasticity through moving, thinking and feeling may help to cure or ameliorate them" (p9925).

One example of the body-brain interaction is the benefits of aerobic exercise on cognitive decline. Controlled experiments with rats, say, have found that aerobic exercise leads to neurogenesis (new neurons) in

[12] The connection between body and mind is seen in the sense of interoception - ie: the ability to detect bodily changes (even if at an unconscious level) (Williams 2022b).

the brain, particularly in the hippocampus (which is associated with memory) (eg: Van Praag et al 1999). "Exercise appears to trigger hippocampal neurogenesis primarily through the upregulation of neurotrophins and growth factors, with brain-derived neurotrophic factor (BDNF) playing a key role" (Raichlen and Alexander 2017 p409).

Raichlen and Alexander (2017) proposed the "adaptive capacity model" (ACM) to explain how and why physical activity improves brain functioning. Based on an evolutionary framework, the idea is that early humans had cognitively demanding foraging patterns that required high levels of physical activity with high demands on spatial navigation and executive functions. But, "when faced with chronic inactivity over the lifespan, as is common in modern industrialised societies, our brains adaptively reduce capacity as part of an energy-saving strategy, leading to age-related brain atrophy" (Raichlen and Alexander 2017 p409).

Exercise and cognitive training together has been studied in humans. For example, Anderson-Hanley et al (2012) compared participants using an exercise bike over three months (exercise only condition) with those who followed a route map on a computer screen to create a "virtual tour" while using the exercise bike (exercise and cognition condition). Both groups had increased BDNF levels, but the latter group had higher levels and improved executive functions (Raichlen and Alexander 2017).

Physical activity predicts cognitive ageing as a general rule, while specifically "greater leg power was associated with improved cognitive trajectory over a ten-year period" (Steves et al 2016 p139). Leg power was used as measure of muscular fitness.

Steves et al (2016) involved 324 female twins (aged 43-73 years old) in the UK in a ten-year longitudinal study. The outcome measures (taken in 1999 and 2009) related to cognitive abilities (eg: working memory; information processing speed), while leg extension muscle power (LEP) was measured in 1999. Self-reported physical activity generally was also recorded in 1999. Age-related cognitive change (ARC) was related to LEP. So, "increased leg power at baseline was associated with improved cognitive ageing over the following ten years" (Steves et al 2016 p145). There were also physiological differences in the brain in a sub-sample studied. The findings could be described in this way - the difference in LEP as in light versus moderate activity for eight hours per day

showed as the equivalent of approximately three years in "cognitive age" (Steves et al 2016).

Causation was not established because the study was observational, but four potential mechanisms to explain the association have been proposed - cardiovascular, immunological, neuroendocrine, and neurotrophic signalling (Steves et al 2016). Steves et al (2016) stated: "Future studies are needed to unpick whether aerobic measures, leg power measures or other measures of fitness are independently related to brain changes, or whether they are related through a common mechanism" (p146).

The strength of this study was the length, as well as the use of twins (to control for genetic differences between individuals). But "this cohort represents relatively educated women of middling occupational status who have marginally better health status than the general population. The age domain is between 43 and 73 at first testing, following women in mid-life to early old age, and therefore does not inform on changes occurring in older ages" (Steves et al 2016 p147).

6.1. Interoception

"Interoception is not a simple process but rather has several facets. The act of sensing, interpreting, and integrating information about the state of inner body systems can be related to different elements such as interoceptive attention, detection, discrimination, accuracy, insight, sensibility, and self-report (table 9). However, most interoceptive processes occur outside the realm of conscious awareness" (Khalsa et al 2018 p502). Put another way, interoception is "the conversation between the body and brain" (Khalsa et al 2018 p504).

Interoceptive processes can be linked to mental health conditions, though cause and effect are difficult to establish. For example, panic disorder and elevated heart rate, eating disorders and hunger and satiety bodily cues, and skin hypersensitivity in autism spectrum disorder (Khalsa et al 2018).

- Interoceptive attention - consciously noticing internal body sensations.
- Interoceptive detection - whether there is conscious awareness of body sensations.
- Interoceptive discrimination - ability to distinguish local source of body sensation (eg: heart; gut).
- Interoceptive accuracy/sensitivity - correct detection of body sensations.
- Interoceptive insight - confidence in accuracy.
- Interoceptive sensibility - individual differences in interoceptive attention and sensitivity.

(Based on table 2 p503 Khalsa et al 2018)

Table 9 - Features of interoceptive awareness.

7. APPENDICES

APPENDIX A - PARKINSON'S DISEASE

Parkinson's Disease (PD) is an example of a condition where there is progressive impairment of movement. So, it is possible to use gait analysis to observe the progression of the disease. Mico-Amigo et al (2019) reported a five-year longitudinal study of 49 middle-aged and older adults with idiopathic PD and 25 age-matched healthy controls. Participants walked a standard route at six-month intervals while wearing a body-fixed sensor placed on the lower back via an elastic belt. The data from this device were converted into twenty-four gait characteristics (eg: median stride time; stride regularity).

The PD group showed changes in gait (eg: a decrease in stride duration) over the study period, which the healthy controls did not. It was possible to map the changes in gait characteristics as the disease progressed.

They key limitations of this study included that the PD group comprised on individuals at different stages of PD. The twice yearly assessments missed day-to-day or shorter term differences or changes, and data were not available on medication (a potential confounder). "A major strength of this study is its longitudinal design, which allowed identifying markers of progression. However, as more severely affected participants have higher attrition rates than their peers with better health status, simply due to logistic reasons (approaching the hospital etc), the study may have under-estimated the overall rate of progression" (Mico-Amigo et al 2019 p10).

APPENDIX B - AGAINST FLEXIBILITY

Flexibility is viewed as an important aspect of physical fitness (eg: by the American College of Sports Medicine). Nuzzo (2020) challenged this idea, arguing that "flexibility has little predictive or concurrent validity with health and performance outcomes, particularly when assessed by the sit-and-reach and when compared to other fitness components" (p854).

Flexibility does not predict mortality as well as body composition or cardiovascular endurance, for instance, nor does it predict falls in older adults, or injury in sports. "High levels of flexibility might

increase injury risk. In dancers, increased lower-limb ROM or 'hypermobility' either increases injury risk or does not correlate with injury" (Nuzzo 2020 p855).

Using sit-and-reach scores as the measure of flexibility, studies have found, for example (Nuzzo 2020):

a) Male cadet soldiers who developed non-contact cruciate ligament injuries had higher scores than non-injured cadets.

b) No correlation between scores and simulated firefighting, military, or police fast chase tasks.

c) No difference in scores between elite and non-elite athletes.

"Static stretching twice or more per week for several weeks increases sit-and-reach scores 9–43%. Other measures of ROM also increase after weeks of stretch training" (Nuzzo 2020 p857). But similar improvements in sit-and-reach scores occur after resistance training (Nuzzo 2020).

Nuzzo (2020) emphasised that he was "not saying flexibility is completely irrelevant for health and function; or that it should never be evaluated; or that it should be removed from educational curricula. This paper argues flexibility be demoted from a major component to perhaps a secondary component of health-related physical fitness for most populations" (p861). Nor was he arguing against dynamic stretches (eg: walking lunges). In summary: "De-emphasis of stretching in exercise prescriptions will ensure stretching does not negatively impact other exercise and does not take away from time that could be allocated to training activities that have more robust health and performance benefits" (Nuzzo 2020 p853).

APPENDIX C - BEING IN NATURE

Experiencing nature has a restorative effect, and this improves well-being, but in different ways, according to the two main theories. According to the "Attention Restoration Theory" (ART) (Kaplan and Kaplan 1989) directed attention can become fatigued, and nature is able to restore this capacity, along with "three other

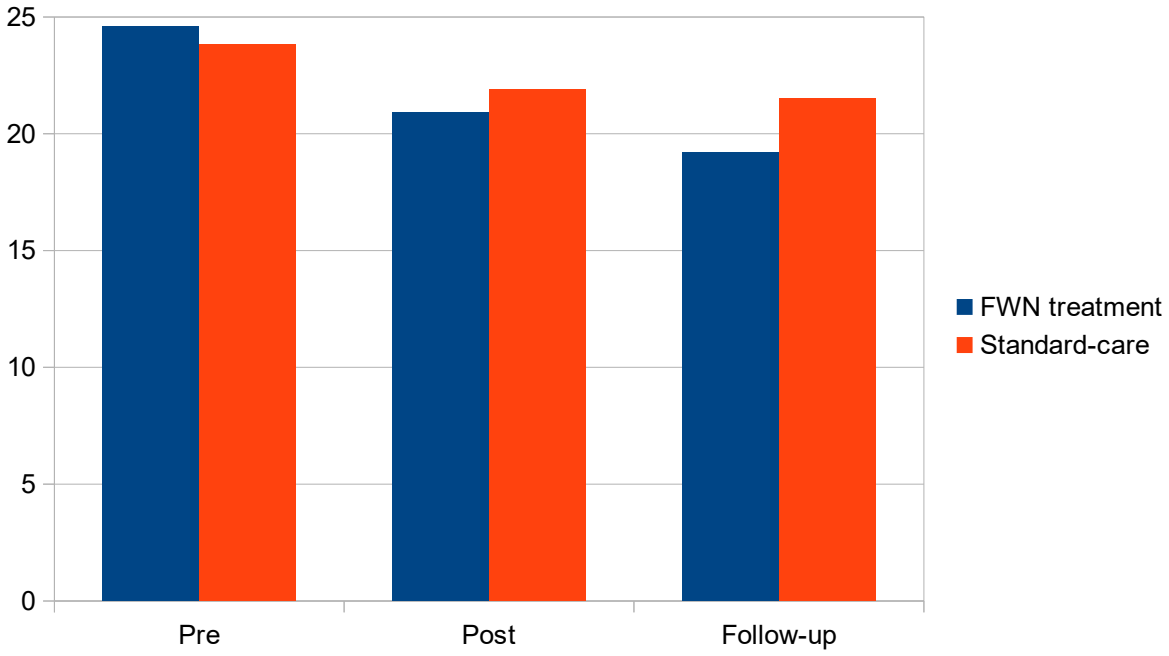
central elements in nature that contribute to attentional restoration: having the sense of being away, the extent to which the environment allows one to engage, and compatibility between oneself and the environment" (Hyvonen et al 2023 p2). The "Stress Recovery Theory" (SRT) (Ulrich et al 1991) proposes that "[N]atural environments promote positive changes in affect and emotions... That is, natural environmental factors can facilitate stress recovery through autonomic nervous system changes that increase relaxation... and positive mood" (Hyvonen et al 2023 p2) [13].

These theories suggest the benefits of being in nature for everyone, but specifically, what about nature-based intervention with depression? A meta-analysis by Coventry et al (2021), for example, found a large and positive effect on symptoms. While Kim et al (2009) reported that the same four-week cognitive behaviour therapy programme in an arboretum produced significant improvements in depression, anxiety and stress as compared to in a hospital room or an out-patient version.

Hyvonen et al (2023) evaluated a nature-based intervention called "Flow with Nature" (FWN) treatment, which aims "not only to expose participants to nature environments but also to encourage multi-sensory experiencing and connecting with favourite places and symbolic nature elements to support psychological processing and self-regulation" (pp2-3). In Finland, 136 individuals diagnosed with depression were randomised to FWN or a standard-care over twelve weeks. The FWN treatment involved ninety minute-sessions in a natural setting. Outcome measures related to depression were completed before treatment, after treatment (at Week 12), and three months after. The main measure was the "Beck Depression Inventory" (BDI) (Beck et al 1988) (containing 21 items with a maximum score of 63).

There was a significant reduction in BDI scores between pre- and post-treatment for both groups, but the reduction was greater in the FWN treatment group (figure 3). General psychological distress significantly declined in the FWN treatment group, but not in the control group, and perceived restorative effect also was significant in the FWN group, along with self-reported ability to work or study.

[13] Another possibility is this: "Urban vegetation can benefit people's physical health by absorbing harmful airborne particulates and other pollutants produced by fossil fuel-powered transport and industry. It may improve mental health in this way as well. Evidence is emerging that exposure to these pollutants can damage the central nervous system and is linked with certain mental health conditions such as depression. Urban vegetation also helps mitigate noise pollution, which causes stress and sleep disturbance" (Douglas 2021 p38).



(Date from table 2 Hyvonen et al 2023)

Figure 3 - Mean BDI scores (out of 63) (where a lower score signifies lower depressive symptoms).

The study involved volunteers, and although the trial condition was randomised, those "who took part in the nature-based treatment were probably very motivated to engage in this type of therapy. Participants were also asked in the screening interview whether they felt able to commit to the 12 nature-based group sessions" (Hyvonen et al 2023 p10). Also over 80% of the sample was female.

The measures were self-reported. "However, physiological changes take place in natural environments, and these could therefore be relevant when investigating the effectiveness of nature-based treatments" (Hyvonen et al 2023 p10).

The study took place in 2020. Hyvonen et al (2023) explained: "During spring 2020 when there were covid-19 restrictions in place, the participants in the treatment groups went to their own favourite places alone and met together in an online conference room. In autumn 2020, some group meetings were facilitated as hybrid meetings (eg: some participants were online due to mild flu symptoms). This raises at least two further questions regarding the applicability of our findings. Further research would be needed to replicate this intervention study when there are no restrictions in place, since this may have affected participants' experience of

participating a group. A further study comparing the experiences and changes in symptoms of participants in the nature-based treatment delivered in-person versus through hybrid/online meetings would be required to gain clarification concerning the effectiveness and applicability of these delivery methods" (p10).

MacKerron and Mourato (2013) used the "Mappiness" app for Apple devices to collect data on the environment and happiness. Over 21 000 UK volunteers rated their happiness twice a day when prompted, and their current activity. Each rating was linked via GPS data on the iPhone or iPad for user location. The study covered six months in 2010-11.

The rating of happiness was higher when the participants were in a natural environment compared to an urban one (after controlling for confounders like weather conditions, time of day, and companionship).

The participants were not asked if they were on holiday, during which they may have been more likely to visit a natural environment. MacKerron and Mourato (2013) explained, "then it is possible that happiness effects we have attributed to natural environments are actually due, in whole or in part, to enjoyment of such leisure time" (p998).

The sample self-selected from those with Apple devices who downloaded the app. MacKerron and Mourato (2013) admitted: "Self-selection might affect the generality our findings if there were meaningful differentials in individuals' sensitivity to the environmental characteristics we examine, and if these differentials played a part in individuals' decisions to participate in the study. We do not know whether or to what extent this may be the case" (p998).

The link between happiness and the natural environment was an association only. "Causal pathways may run in both directions, such that people choose an environment partly according to their mood (for example, individuals who already feel unhappy may be less likely to leave the home to engage in physical activity or experience natural habitats), and people’s moods are partly determined by their environment" (MacKerron and Mourato 2013 p998).

Analysing a large amount of data, White et al (2019) found that 120 minutes or more per week in natural environments was significantly associated with reported good health and well-being. "Positive associations peaked between 200–300 mins per week with no further gain. The

pattern was consistent across key groups including older adults and those with long-term health issues.
It did not matter how 120 mins of contact a week was achieved (eg: one long *vs*. several shorter visits/week)" (White et al 2019 p1).

The data were nearly 20 000 English participants in the "Monitor of Engagement with the Natural Environment Survey" (MENE) (2014/15 - 2015/16). Monthly measures were available including self-reported health (on a five-point scale, from "very bad" to "very good"), subjective well-being (on a ten-point scale), and recreational nature contact in the past week (in sixty-minute blocks). Control variables included neighbourhood green space, deprivation, and air pollution.

The data were self-reports, and the time in nature was an estimate. The researchers accepted that "self-reported duration is likely to be less accurate than measures obtained from geo-tracking individuals during specific visits, or over several days..." (White et al 2019 p6).

White et al (2019) made a further point: "We also remain cautious about any potential ≥120 mins 'threshold'. In part its emergence may be a consequence of the clustering of duration responses around the hour mark and subsequent stratification, rather than anything materially different occurring at this level of exposure" (p7).

Another point to note is the "quality" of nature exposure. "Research considering the quality of the natural environment in terms of plant and/or animal species richness suggests that experiences may be better in more biodiverse settings. Contact with nature is more than just a complex multi-sensory experience, to varying degrees personal histories and meanings, long-standing cultural practices, and a sense of place play some role in the benefits realised" (White et al 2019 p7). Time spent in own garden was not included, but this "can be an important form of meaningful nature contact for many people" (White et al 2019 p7).

Many people are detached from the natural world from choice. For example, in a survey in England of over 16 000 people who did not visit natural environments regularly, around one-fifth were "not interested" or believed that nature was "not for people like them" (Boyd et al 2018). "Such lack of interest, feelings of alienation, and apathy may, in part, be due to competing demands of other daily activities and to the growth of other forms of entertainment, particularly electronic

technology... Equally, less exposure to nature in childhood with each consecutive generation, the so-called 'extinction of experience'..., may undermine familiarity, connection with, and appreciation of, the natural world" (Vitale et al 2022 p2). Thus, the importance of childhood exposure to nature [14].

Concentrating on "blue spaces" (eg: rivers, sea), Vitale et al (2022) found that "[B]uilding familiarity with and confidence in and around blue spaces in childhood may stimulate a joy of, and greater propensity to spend recreational time in, nature in adulthood, with positive consequences for adult subjective well-being" (p1). The data came from the "BlueHealth International Survey" 2017-18, which covered over 18 000 adults in fourteen European countries. The key measures were childhood exposure to blue spaces, adult exposure, and adult subjective well-being. Childhood exposure (ie: before sixteen years old) was measured by three items - "as a child, there was easily accessible blue space near my home(s)", "as a child, my parents/guardians were comfortable with me playing in and around blue spaces", and "as a child, I often visited blue spaces" (p4). Five items were used for well-being in the last two weeks (eg: "I have felt cheerful and in good spirits"). Frequency of visits to seventeen categories of blue spaces and twelve types of green spaces in the last month were recorded (table 10).

Blue Spaces (17)	Green Spaces (12)
Fountains	Local parks/pocket parks
Urban rivers or canals	Large urban parks
Swimming pools or outdoor spas	Community gardens or allotments
Ponds/streams/small water bodies	Playgrounds or playing fields
Lakes	Cemeteries or churchyards
Rural rivers or canals	Botanical gardens or zoos
Waterfalls	Woodlands
Wetlands	Forests
Outdoor ice rinks	Meadow
Esplanades/promenades	Grasslands
Piers	Moorland
Harbours of marinas	Heathland
Sandy beaches	
Rocky shores	
Cliffs and headlands	
Lagoons	
Open sea	

Table 10 - Categories of blue and green spaces.

[14] One issue is "whether increased biodiversity equates to increased mental health benefits for urban dwellers" (Douglas 2021 p39).

Overall, the main finding was that "greater exposure to blue spaces during "childhood predicted better subjective well-being in adulthood. This association remained after adjustment for other known risk factors of poor mental well-being, including population density and socio-economic factors, suggesting that childhood blue space exposure is a robust and independent predictor of adult well-being. Moreover, despite evidence that the way people relate to nature varies across cultures..., the positive relationship between childhood exposure to blue spaces and adult subjective well-being was upheld after accounting for country/region effects and was largely consistent across countries/regions" (Vitale et al 2022 pp7-8) [15].

Childhood exposure appeared to create a "higher intrinsic motivation to visit natural spaces in adulthood" (Vitale et al 2022 p8). However, the exact mechanism of this relationship was beyond this study.

Note that the data were collected at one point in time (ie: a cross-sectional design), which precluded causal inferences, and "reverse causality cannot be ruled out. For instance, adults already exhibiting better subjective well-being may choose to spend more time in natural spaces and therefore recall greater intrinsic motivation and more childhood exposure to blue spaces" (Vitale et al 2022 p10).

The measures were self-reports, and included recall of childhood experiences with no independent verification. Also there may have been uncontrolled variables (eg: dog ownership) (Vitale et al 2022).

Mental Health and Birdsong

As well as the growing evidence that contact with nature is beneficial for mental health, contact with wildlife also, including birds (Hammound et al 2022).

Ratcliffe et al (2013), for example, found that hearing birdsong was reported as restorative from psychological stress, while Ratcliffe et al (2020) found that "specific qualities of bird sounds such as perceived familiarity, complexity and patterns are predictive of perceived restorative potential" (Hammound et al 2022 p1). Past research, however, tends to use surveys (requiring recall of experiences and emotions), or

[15] Living near blue spaces can buffer against socio-economic inequalities in health. It has been "shown that people with low incomes who live by the sea are mentally and physically healthier than would be expected given their greater exposure to major drivers of decreased well-being, such as unemployment" (de Lange 2022 p40).

artificial set-ups with participants sitting in a laboratory (Hammound et al 2022).

Hammound et al (2022) used a different method of ecological momentary assessment (EMA) via a smartphone-based application ("Urban Mind"). Over fourteen days (between April 2018 and October 2021), around 1300 participants were contacted 42 times. Each time the question, "Can you see or hear birds right now?" was asked, along with others, including about mental health.

There was a positive association between seeing or hearing birds and mental well-being (after controlling for variables like age, gender, and occupation). The benefit of birdlife was "above and beyond the well-established effect of green spaces" (Hammound et al 2022 p5).

The mental health benefit existed for a short period after the experience of birdlife (ie: the subsequent measurement point). For example, an individual who reported birdlife experiences in the morning and positive mental health, also reported positive mental health in the afternoon (even without further birdlife experiences), but not at the evening data collection point without further birdlife experiences. "Perhaps unsurprisingly, the beneficial effect of seeing or hearing birds on mental well-being does wane over time" (Hammound et al 2022 p6).

Mental health benefits were found for individuals with a formal diagnosis of depression (around one-fifth of the sample), and for individuals without any formal mental health diagnosis.

In terms of methodology, the use of EMA allowed the researchers, Hammound et al (2022) explained, "to capture dynamic changes in the participants' whereabouts and mental well-being in real-time and in real-world contexts. In particular we used smartphone-based EMAs, which provide more accurate and complete measurements when compared to the traditional method of paper diaries and stand-alone electronic devices" (p7). Many variables were controlled for in the statistical analysis, but causality could not be directly established. The sample was self-selected volunteers. The study partly took place "during the covid-19 pandemic, which may have changed people's stress levels and response to birdlife" (Hammound et al 2022 p7).

Hammoud et al outlined some of the other methodological issues including that "participants were asked to self-report whether they had ever been diagnosed with a mental health condition, and to indicate their diagnosis. Furthermore, while participants were allowed

to select multiple diagnoses, the potential effects of co-morbid diagnoses were not taken into account in the statistical analysis. Future studies would benefit from the use of validated clinical instruments to assess current symptoms and diagnosis, and the exploration of possible effects of co-morbidity on findings. Finally, since we asked participants if they could see or hear birds, we were unable to dissociate between the potential mental health benefits of 'seeing' and 'hearing' birdlife. Nevertheless, in our encounters with birdlife, we do not perceive images and sounds of birds in a vacuum but as part of our multi-sensory experience. Therefore, it may be reductive to focus on visual and auditory aspects when assessing the mental health benefits of birdlife in real-time and real-world contexts" (p8).

APPENDIX D - MICRO-BREAKS

Albulescu et al (2022) began: "In an 'always-on' culture encouraged by the Fourth Industrial Revolution [Schwab 2016], it is essential to find a balance between being effective at work and having optimal well-being. Recent reports highlight the 'human energy crisis' many employees face today. Heavy workloads and long hours impede their capacity and energy renewal" (p1).

One possibility is the inclusion of short breaks ("micro-breaks"), defined as "short discontinuities in one's tasks of no longer than 10 minutes" (Albulescu et al 2022 p2). Note that other definitions cover periods up to one hour (Albulescu et al 2022).

The theoretical basis to micro-breaks includes the "Conservation of Resources theory" (COR) (Hobfoll 1989). "The general assumption is that employees have a particular supply of personal resources, such as directed attention or mental resilience instrumental for achieving work goals. Recovery
is thus necessary, achievable when no demands similar to those related to the task at hand are put on the person, or when new resources are built up" (Albulescu et al 2022 pp2-3).

Albulescu et al (2022) undertook a systematic review and meta-analysis of studies on the efficacy of micro-breaks to enhance performance. Nineteen relevant published articles were found (which included 22 studies).

There were small statistically significant benefits of micro-breaks on vigour, and fatigue, but not on

performance of the task. In terms of moderators, break duration (ie: longer), and type of task (eg: micro-breaks better for creative tasks) were the only significant ones found. "However, when it comes to cognitively demanding tasks, taking short breaks does not seem to affect subsequent performance" (Albulescu et al 2022 p17).

The researchers admitted that "we could not address one of the most important questions for practice about which specific activity is most efficient for recovering lost resources during work: 'What to do in these breaks to feel and perform better?'. However, while we still need a clear explanation for the performance outcome, at least for well-being, the answer seems to be 'any type of decoupling activity'" (Albulescu et al 2022 p19).

In terms of the methodological issues, half the studies had student samples and half employees, and many of the studies used an experimental design in a laboratory or workplace setting. "In most studies, participants in the control group were engaged in some break or free time between work tasks (n = 12). In contrast, in a slightly smaller number of studies, these participants continued working without respite (*n* = 10)" (Albulescu et al 2022 p8). Different tasks were used (eg: work simulation; generate new ideas), and the time on task varied between two minutes and four hours before a break (table 11). The overall methodological quality of studies was rated as medium.

There was a limited of studies available to include.

- Length of break duration
- Activity during break (or not) (eg: relaxation; different task)
- Type of study design (eg: experiment)
- Sample (eg: students)
- Study setting (eg: laboratory)
- Task type (eg: office; nursing; brainstorming)
- Control group activity
- Measurement of task performance (eg: Utrecht Work Engagement Scale; self-reports)
- Country of study (eg: 8 in USA; 4 in Germany)

Table 11 - Key methodological differences in the studies in Albulescu et al's (2022).

APPENDIX E - WEAR DISCOMFORT

Raccuglia et al (2018) observed that comfort is "often considered in relation to a single factor causing discomfort", when "in a real life situation it is rare

that only one single factor entirely influences how comfortable an individual feels" (p33). Clothing is a good example.

"The clothing system can be considered as a combination of various interacting components that ultimately affect overall clothing functionality and wear comfort sensation" (Raccuglia et al 2018 p33). This is even more so with physical activity, and the perception of skin wetness, for instance. So, "wear discomfort during exercise" has been studied.

Raccuglia et al (2018) recruited eight active males at Loughborough University in England to try three short sleeved 100% polyester T-shirts made from three fabrics that varied in the percentage of surface area in contact with the skin. This was done by the inclusion of hole areas in the garments. The participants performed various sweat-producing exercises in thirty-minute sessions in each T-shirt. At five-minute intervals, they rated wetness perception (0-30; "extremely dry" to "extremely wet (soaked)"), stickiness sensation (0-12; "not-sticky" to "extremely sticky"), texture sensation (-9 to +9; "very smooth" to "very rough"), thermal sensation (-10 to +20; "cool" to "hot"), and wear discomfort (1-7; "comfortable" to "very uncomfortable").

There were three significant differences between the High and Low skin contact T-shirts, namely wear discomfort (ie: higher for Low contact), stickiness sensation (ie: higher in the Low contact garment), and textile sensation (ie: Low contact felt rougher) (table 12).

Measure	Low skin contact		High skin contact	
Time	Baseline	30-mins	Baseline	30-mins
STICKINESS SENSATION (0-12)	"Not sticky" (0)	"Sticky" (6)	"Not sticky" (0)	"Slightly sticky" (3)
TEXTURE SENSATION (-9 to +9)	"Slightly rough" (3)	"Slightly rough" (3)	"Smooth" (-6)	"Slightly smooth" (-3)
WEAR DISCOMFORT (1-7)	"Slightly uncomfortable" (3)	"Uncomfortable" (5)	"Comfortable" (1)	"Slightly uncomfortable" (3)

(Data from figure 6 p39 Raccuglia et al 2018)

Table 12 - Approximate overall ratings for three measures with significant differences between Low and High skin contact T-shirts.

Wetness perception and thermal sensation did not vary between the T-shirts. Many of the ratings varied between baseline and during the exercise (ie: as the individual sweated). Texture and stickiness sensations were the best predictors of wear discomfort.

APPENDIX F - RHYTHM

Musical behaviours, like dancing and singing, create social cohesion. "When we engage in musical activities with others, our movements become temporally aligned with our group members as each individual entrains to the underlying beat of the music. This type of interpersonal synchrony encourages pro-social behaviour among those involved, even in infants" (Cirelli et al 2014 p1).

Cirelli et al (2014) showed this in an experiment with thirty 14-month olds. Infants either bounced with an adult stranger in synchrony to music or out of synchrony. Then the pro-social behaviour was measured by the stranger dropping an item and the child having the opportunity to pick it up. Helping was significantly greater in the synchrony than asynchrony conditions. But helping did not vary with a stranger who did not bounce.

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