Want to keep cool on hot summer days? Here's how

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Abstract
Are neck, hand or forearm cooling, ice-cube sucking or cold showers effective ways to lose heat on those dog days of summer? Can sports clothing keep you cool by wicking away sweat? When the heat is on, some of us are prepared to entertain even snake-oil solutions for the sake of personal comfort, but do such cooling strategies really work?

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Are neck, hand or forearm cooling, ice-cube sucking or cold showers effective ways to lose heat on those dog days of summer? Can sports clothing keep you cool by wicking away sweat? When the heat is on, some of us are prepared to entertain even snake-oil solutions for the sake of personal comfort, but do such cooling strategies really work?

Let’s first consider heat loss from a physical perspective, putting aside physiological heat-loss mechanisms, such as sweating and skin blood flow. Cooling down is more easily understood when reduced to this level because the physical properties of heat exchange are well known.

Understanding heat loss

The first of these properties is the temperature gradient; the bigger the temperature difference between two things, the more rapidly heat (thermal energy) flows towards the cooler one.

Substances conduct heat at different rates (thermal conductivity). Water, for instance, is 24 times more conductive than air at the same temperature. Consider walking into the cold room of a bottle shop, which is usually a cool five degrees Celsius, versus swimming in water of the same temperature. The latter is excruciating, with death from hypothermia just around the
We also need to keep in mind the heat retained within various substances, which is known as mass-specific heat. This tells us how heat is required to increase the heat of two objects that weigh the same by one degree Celsius. Water has a specific heat four times that of air, for instance, so a kilogram of water can remove four times as much heat as the equivalent mass of air.

Density is important too, because it determines the mass of a substance that can be contained within a fixed space. Since water is 800 times denser than air, a bath filled with water is many times heavier than one that contains air.

Together, specific heat and mass define the volume-specific capacity of substances to store heat. Going back to our example with water: it has a heat capacity more than 3,000 times that of air because of the combined effects of its mass-specific heat and density.

An object’s mass and surface area are important as well, because heat is stored in its mass and lost through its surface. Spheres have the largest mass for a given surface area, while wafers have the opposite characteristic. In other words, an object’s surface-area-to-mass ratio dictates its heat-exchange potential, with flatter and thinner surfaces (such as hands and feet) losing heat more rapidly.

**Cooling solutions**

So, to cool an object, maximise the temperature gradient, choose a coolant with a high thermal conductivity and heat capacity (liquids), and modify the shape of your object to resemble a wafer. Without question, water is ideal for cooling non-living objects.

But does it work as well for living bodies? And how is it influenced by the physiological responses that we all experience when exposed to heat?

So far, we have only considered heat conduction, or heat exchanged between objects in direct contact – touching a hot stove for example. But conduction speed is influenced by the distance heat must travel.

Animals enhance cooling by delivering heat closer to the skin surface. This convective mechanism, which involves delivering hotter central-body blood to the cooler skin, shortens the conductive pathway and promotes heat loss.

![Natural selection has ensured that naked human skin is ideally suited for evaporative cooling. Obi/Flickr, CC BY](http://theconversation.com/want-to-keep-cool-on-hot-summer-days-her...)

But this mechanism relies on increasing and sustaining skin blood flow, which is dictated by the separate and combined effects of deep-body and local skin temperatures. Maximal skin blood flow occurs only when both the deep-body and local skin tissues are heated, but not if...
only one region is hot.

When a hot person is placed in very cold water (say of about five degrees Celsius), skin blood flow is dramatically reduced, so heat loss is compromised. Paradoxically, submerging that same person in temperate water (25 degrees Celsius) increases heat dissipation by preventing this blood-flow suppression.

**Clothing and comfort**

Natural selection has ensured that naked human skin is ideally suited for evaporative cooling, and anything placed on the skin interferes with that process.

The average person has some 110 sweat glands per square centimetre of skin (although this varies with location). When heated, these glands secrete sweat that wets the skin. The ensuing evaporation transfers heat to water molecules, which change from a liquid to a gas, leaving the sweating person cooler.

But, in still conditions, the characteristics of the air in direct contact with the skin change; it rapidly becomes warmer and more humid. This warmer air is less dense and spontaneously rises, taking with it heat (natural convection) and water vapour, and permitting the incoming air to be warmed and humidified.

When we move, or when air moves across the skin (forced convection), convective and evaporative cooling are magnified. Clothing reduces these benefits.

So these are the principles that dictate human heat loss. But we must now distinguish between thermal strain and comfort.

Strain is the physiological impact of heating the body, as quantified through deep-body and skin temperatures; comfort relates to the pleasure derived from different thermal states. We now need to consider whether we wish to feel more comfortable or to reduce thermal strain.

Since comfort follows reduced thermal strain, our energies should be directed accordingly. The first strategy should be to resist counter-evolutionary practices designed to minimise strain (heat avoidance, for instance, and air conditioning), and allow our bodies to adapt to seasonal variations.

So, use natural ventilation whenever possible, dress appropriately and experience the climate. With adaptation, you can improve both physiological heat loss and thermal comfort.

The second strategy is for desperate times, like those dog days of summer: water immersion. Showers help, but are very wasteful. Hand and forearm immersion are good, but time consuming. Neck cooling and ice-cube sucking suck!

Instead, bathe in enough temperate water to just cover yourself, and stay there until you feel cool-cold. Natural water sources are ideal. And as for sports clothing, there is no clothing that can improve the heat-loss capability of your skin; donate your money to a worthy charity!

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**Thermoregulation**