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Research review

Cold pleasure. Why we like ice drinks, ice-lollies and ice cream

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ABSTRACT

This review discusses how the ingestion of cold foods and drinks may be perceived as pleasant because of the effects of cooling of the mouth. The case is made that man has originated from a tropical environment and that cold stimuli applied to the external skin may initiate thermal discomfort and reflexes such as shivering and vasoconstriction that defend body temperature, whereas cold stimuli applied to the mouth are perceived as pleasant because of pleasure associated with satiation of thirst and a refreshing effect. Cold water is preferred to warm water as a thirst quencher and cold products such as ice cream may also be perceived as pleasant because oral cooling satiates thirst. The case is made that cold stimuli may be perceived differently in the skin and oral mucosa, leading to different effects on temperature regulation, and perception of pleasure or displeasure, depending on the body temperature and the temperature of the external environment.

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Introduction

Eating and drinking evokes pleasure and satisfaction, as the intake of food and drink stimulates a range of sensory inputs such as taste and smell and stomach distension that are programmed to cause pleasure and satiety (Breer, 2008; Cummings & Overduin, 2007; Cupples, 2005). Man has developed means of warming and cooling food and drink and the temperature of the food and drink may also contribute to the pleasure of eating and drinking (Engelen et al., 2002). Warming food and drink enhances the taste and smell by increasing the gustatory and olfactory stimuli, and many foods and drinks are ingested at temperatures well above body temperature. Cold food and drinks are also popular, especially in hot weather, but it is not clear why the cold temperature should influence the pleasure associated with food and drink, as cooling will tend to reduce the sensory impact of the food and drink on taste and smell.

Ice drinks, ice-lollies and ice cream are by definition ingested ‘ice cold’, and the cold temperature is an important component of the pleasure associated with ingestion of these products. Cold drinks and food are popular during warm weather when there may be a tendency for overheating of the body. Cold stimuli applied to the external surface of the body (skin) will cause reflexes

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such as skin vasoconstriction and shivering that will neutralise any tendency to body cooling and a reduction of body temperature (Clark & Edholm, 1985b), but cold stimuli applied to the mouth (internal surface of the body) do not appear to impact on body temperature and are not reported to cause any reflex shivering or skin vasoconstriction that influence body temperature.

This review will discuss the physiology and psychology of ingestion of cold products such as cold foods and drinks.

Control of body temperature

Humans are homeotherms and maintain core body temperature close to 37 °C (Davies, Blakeley, & Kidd, 2001). It is outside the scope of this review to discuss control of body temperature in man but the sensation of cold and how it influences temperature regulation is relevant. Disturbances to body temperature are usually due to some change in the external environment, apart from fever that is initiated in response to infection. Cold receptors are more numerous than warm receptors on the skin with the greatest cold receptor density occurring on the face (Davies et al., 2001). The preponderance of cold receptors may relate to the body having more risk of exposure to cooling than heating in most environments, and this agrees with the idea that "man is a tropical animal' that originated from a tropical environment (Clark & Edholm, 1985a). If man were to live naked and maintain a body temperature of 37 °C he must have a climate of 28–30 °C (Clark & Edholm, 1985a). Clothing, buildings and heating and cooling devices ensure that man can survive and even flourish in all the different climate regions of earth but the underlying temperature control system of man is that of an animal that originated in a tropical environment.

The reflex control of body temperature is mainly controlled by responses to changes in skin temperature as core temperature changes too slowly for it to be the primary thermal signal (Schlader, Simmons, Stannard, & Mundel, 2011). Thermal discomfort, where the skin is perceived to be too cold or too hot for comfort is a major controller of behavioural and reflex responses that tend to maintain a constant body temperature. So cold stimuli applied to the skin may cause reflex constriction of blood vessels in the skin, nose and throat and reflex shivering that will tend to defend body temperature against cooling.

Sensation of cold and response to cold stimuli

The sensation of cold is mainly mediated by thermoreceptors that are distributed on the external skin surface of the body. The sensory receptors that mediate the sensation of cold are usually referred to as 'exteroreceptors' (Sircar, 2008). Body temperature control mechanisms can be activated by cooling of skin temperature receptors, and a cold stimulus to the skin that does not cause any change in body temperature, may cause reflex responses such as skin vasoconstriction, tensing of muscles and shivering that will help to conserve body heat as an anticipatory response to any body cooling (Clark & Edholm, 1985b). Cold stimuli to the skin are generally perceived as unpleasant as they may threaten a change in body temperature, however if the environment is warm and the skin is warm, a cold stimulus may be perceived as pleasant. This is why a dip in a cold river is pleasant on a warm summer day, but may be decidedly unpleasant on a cold winter day (Cabanac, 1971).

The oral mucosa is well supplied with sensory nerves by the trigeminal nerve and has similar sensations to facial skin – touch, pressure, hot and cold temperatures and pain (Ferguson, 1999). There is no evidence that the temperature receptors in the mouth are involved in the regulation of body temperature and their role appears to be mainly to sense the temperature of foods and fluids. The warm receptors may have a protective role in preventing thermal damage to the mouth but there is very little information available about oral sensory receptors apart from those involved in taste.

Cold temperature receptors and physiology of cold sensation

Research in sensory physiology has undergone a revolution with the discovery that all senses depend on the activation of Transient Receptor Potential cation channels (TRP) (Montell, 2011). TRP ion channels mediate, vision, taste, smell, hearing, touch and temperature. The sensation of cold has been shown to be mediated by Transient Receptor Potential Melastatin 8 (TRPM8), which is also stimulated by menthol to give a cool sensation (Patel, Ishiuji, & Yosipovitch, 2007). The TRPM8 cation channel is sensitive to temperatures below 25–28 °C (Fisher, 2011) which fits in with its role in detecting skin and oral cooling. Menthol has been described in the literature for many years as producing a sensation of cold but it is only recently that the molecular site of action has been discovered. TRPM8 is the site of action of menthol, and TRPM8 is the cation channel that responds to cold stimuli applied to sensory nerves mediating the sensation of cold (Fisher, 2011). Cooling the TRPM8 ion channel causes an opening of the ion gate channel and an influx of calcium ions that trigger activation of the sensory nerve ending and the firing of action potentials to cause a sensation of cold and reflexes associated with temperature regulation (Gavva et al., 2012).

Physiological effects of ingestion of cold products

Application of an ice-lolly to the skin will induce temperature regulation reflexes such as shivering and skin vasoconstriction (Clark & Edholm, 1985b), but there is no evidence that application of the same cold stimulus to the mouth has any influence on temperature regulation (Drettner, 1964). This may be because the skin cold receptors are involved in temperature regulation as exteroreceptors whereas the cold receptors in the mouth are involved in the appreciation of food and drink rather than temperature regulation. The peripheral cold receptors in skin and the mouth are likely to have the same structure but differ in the way they are connected to central control mechanisms in the brain.

As well as any reflex effects of the cold stimulus caused by ingestion of products such as ice cream there is a physical cooling effect due to the negative heat load associated with ingestion of the cold product. The magnitude of the negative heat load is due to the heat required to warm the cold product up to body temperature 37 °C.

A normal size portion of ice cream is in the region of 50 g. However, experimental ingestion of 500 g of ice cream within 10 min has been reported to cause a negative heat load of approximately −45 kcal (Nadel & Horvath, 1969). The ingestion of 500 g ice cream in young adults caused a fall in core body temperature of around 0.8 °C as measured by tympanic membrane temperature but did not cause any change in skin temperature. Within the first min after ingestion an increase in tympanic temperature of around 0.2 °C was observed and this was related to the metabolic effect of eating. After the initial rise in tympanic temperature the temperature fell at a rate of about 0.1 °C/min persisting for around 10 min without any change in skin temperature (Nadel & Horvath, 1969). The lack of effect of ingestion of ice cream on skin temperature agrees with other studies on the effects of ingestion of hot and cold fluids (Clark & Edholm, 1985c; Drettner, 1961).

Studies on healthy adults demonstrated that the blood flow in the finger and also the nasal mucosa decreased transiently when water was, held in the mouth, administered through a gastric tube,