Multisensory control of ingestive movements and the myth of food addiction in obesity. Comment on Nazim Keven and Kathleen Akins, Neonatal imitation in context: sensory-motor development in the perinatal period

Article (Accepted Version)

Booth, David A (2017) Multisensory control of ingestive movements and the myth of food addiction in obesity. Comment on Nazim Keven and Kathleen Akins, Neonatal imitation in context: sensory-motor development in the perinatal period. Behavioral and Brain Sciences, 40. e381. ISSN 0140-525X

Author’s submitted manuscript
accepted for publication in *Behavioral and Brain Sciences* on 5 October 2016

Target for Commentary, BBS (in press):-
Nazim Keven and Kathleen Akins, Neonatal imitation in context: sensory-motor development in the perinatal period

Comment invited from David Booth:-
[Abstract: 54 words. Main text: 951 words. References: 613 words. Total text: 1701 words.]

Title

Multisensory Control of Ingestive Movements and the Myth of Food Addiction in Obesity

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Abstract

Some individuals have a neurogenetic vulnerability to developing strong facilitation of ingestive movements by learned configurations of biosocial stimuli. Condemning food as addictive is mere polemic, ignoring the contextualised sensory control of the mastication of each mouthful. To beat obesity, the least fattening of widely recognised eating patterns need to be measured and supported.

Main Text

Keven and Akins use recent evidence on the development of respiratory and ingestive movements to criticise claims that mimicry of tongue protrusion plays a role in attachment to carers. This comment applies their criticisms to the notion that addiction to ingestion makes people unhealthily fat. Both sets of ideas are symptomatic of a syndrome of ‘multisensory neglect’ in research. Ignorance of the configured biological and societal stimuli to each mouthful of food or drink largely accounts for the continued failure to reduce the contribution of excess energy intake to obesity and the resulting disease, disability and distress.

Ingestion of mouthfuls is shaped and contextualised by diverse interactions among the external and internal senses (Booth, 1985; Booth, Sharp, Freeman *et al*., 2011b). As K&A describe, using just the senses within the mouth, movements of the tongue rapidly become efficient at drawing the nipple along the upper lip to the hard palate. It should be noted that a few sessions of suckling are sufficient to change the full stretch of the tongue out of the mouth (K&A Figure 2(a)) to a slight protrusion between the lips and side-to-side movements (Steiner *et al*., 2001). These sights of the tongue in the absence of the nipple show vacuum ingestive activity, anticipatory to the tactile context of the breast between the lips and the nipple protruding into the mouth. Without independent evidence from emotional behaviour and autonomic physiology, there is no warrant for attributing sensual pleasure to the neonate from the taste of sugar on the tongue (Booth *et al*., 2010; Booth, 2016).

K&A could have written more about the changing multisensory contexts of movement patterns as they mature. For example, in their opening paragraph, they imply that stepping disappears because of relative lack of leg muscle. The fuller account is that learned integration of gravity into the control of stepping CPG can only begin when the legs are strong enough. To walk or run, the stepping CPGs have to be contextualised by learned coordination of proprioception with balance, touch and sight. K&A recognise a supportive role for gravity in swallowing but could assert its necessity for locomotion.

In another of K&A's examples, the infant's orientation to a face, gaze is potently drawn and held by the iris, eyelashes and eyebrow of each eye (sometimes plus spectacles!) by center-surround connections in the retina and V1 on which all visual recognition depends. Talk of attractiveness, reward value or pleasure in the eyes is otiose. We don't accuse extreme extroverts of addiction to socialising.

Consumption of drinks and foods requires vastly more complex sensory control of the movements holding in the hand(s), sipping, biting, masticating and swallowing. K&A cite re-setting of the swallowing CPG by the sight of food (Leopold & Daniels, 2009). That word "food" hides the variety of shapes, sizes and compressibilities of the solid and semi-solid items that the eater ingested previously, plus unique mixtures of soluble and volatile compounds (flavourings), different temperatures, and haptic microstructures, i.e., oral textures -- both tactile (Booth, 2005) and auditory (Mobini *et al*., 2011). When the infant begins to select mouthfuls, the hands, vocal tract and whole body become coordinated with the jaw, lips, tongue and pharynx following visual anticipation of the item's multisensory identity. The appearance of an item of food is configured in memory with the levels of all its other distinguishing physical characteristics and cultural attributes (Booth & Freeman 1993; Booth *et al*., 2011b).

Hence, an ingestive mechanism can be identified only when the social and physiological influences are specified. In research on ingestive behaviour, however, mere licking of the lips, curling of the tongue, amounts eaten, or ratings of eating, are given empirically empty labels such as regulation, motivation, pleasure, hunger, satiety, and even assigned generic functions like reward, working memory, attention and expectation. This systematic over-interpretation diverts thought and effort from measuring the multitude of highly specific interactions across and within sensory modalities that determine ingestion.

Investigators may implicate a sensory modality, and even a category of transduction (such as yellow color or sweet taste), but that is not enough, as K&A point out in conclusion. Action towards each sort of food or drink (or any other object) requires each afferent and efferent channel to be at a particular level of activity (e.g., Booth *et al*., 2011a). The information content which each channel transmits is combined into a limited number of types of quantitative comparison between present and past output-input relationships (Booth, 2013a). Notional cognitive-affective functions dissolve into actual causal processes within the individual's mind.

Until multisensory integration is specified, its neural basis must remain obscure. The medial edge of the subthalamic striatum, *Nucleus accumbens*, organises sequencing of ingestive movements via inhibitory interneurons on CPG systems. In the part involved in tongue protrusions, some cells are inhibited by tasting sucrose and excited by taste of quinine (Roitman *et al*., 2005). However, such isolated tastes, smells and textures cannot elucidate the contextualised use of combinations of specific levels of gustatory, olfactory, tactile, auditory and proprioceptive stimuli, let alone of equally crucial signals from the viscera and the visual field (Booth, 2013b, 2015).

Parents' various ratings of their infants' eating measure a single trait of responsiveness to foods, which relates to at least one of the many genes associated with obesity (Wardle & Carnell, 2009). After the age of 30, dopaminergic hyperactivity is associated with higher body mass index (Dang *et al*., 2016). Dopaminergic synapses lower thresholds and raise gain in the striatum, increasing the precision of processing of sensory characteristics (Warren *et al*., 2016). That is, dopamine activity reflects responsiveness to food stimuli, as part of arousal, not the reward of learning (Benton & Young, 2016; Kroemer & Small, 2016).

To combat obesity, we need activities under multisensory control to be described in eaters' terms, not in terms only of nutrients (Booth *et al*., 2004; Booth & Laguna-Camacho, 2015). Evidence on which sustained changes do most for keeping slim can then be collected and disseminated (Booth & Booth, 2011).

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