Feeding your selfish brain

Prof Kerstin Oltmanns and colleagues at the University of Lubeck in Germany have further developed the 'selfish brain' model of energy metabolism. Showing that there is a link between energy metabolism in the brain and obesity, the team are now advancing their research in an attempt to finally address the issues of psychological overeating.

Energy metabolism in the brain has long been thought to have an important function in bodyweight regulation. As far back as 2004, the then Dr Oltmanns collaborated with colleagues to develop the so-called 'selfish brain' model to describe how energy metabolism and consumption are managed. This posited the theory that the brain would take precedence when inducing hunger or satiety: if the brain was therefore not processing energy inputs as efficiently as the rest of the body, it would continue to demand food consumption to the point of obesity.

THE EVER-HUNGRY BRAIN

More recent studies by Prof Oltmanns have further expanded the evidence, proving an inverse correlation between body mass index (BMI, a measure of obesity) and the presence of high-energy phosphates, such as adenosine triphosphate (ATP), in the brain. This suggests a close relationship between energy supply to the brain and bodyweight regulation, even in healthy individuals.

Because sensations which regulate food intake (such as appetite and satiety) are processed in the hypothalamus area of the brain, a disruption in nutrient sensing in this region can contribute to obesity. Prof Oltmanns and her team have shown that the brain's own energy supply may be involved in regulating the organism's body weight through this mechanism.

THE BODY-SHAPING BRAIN

High-energy phosphates, including ATP, are synthesised within neurons by glucose-derived biochemical processes, which, in turn, stimulates glucose uptake into the brain from peripheral blood circulation – without the need for insulin. However, in obese individuals, this quantity of glucose (supplied from the peripheral blood circulation) is insufficient to satisfy their needs. Prof Oltmanns and her team are investigating why this is the case, hypothesising that it could be due to defects in underlying chronically-activated appetite centres.

Taking the research one step further, Prof Oltmanns and her group identified a technique used to treat neuropsychological disorders as a potential method of regulating brain energy homeostasis (maintaining a consistent balance of energy supply and availability). Transcranial direct current stimulation (tDCS), delivering a constant, low-current electrical charge to the brain area of interest, reduced calorie

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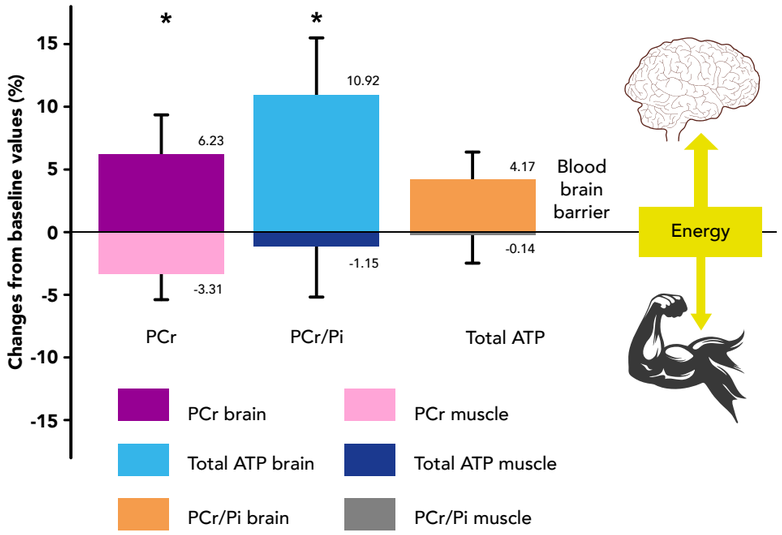
intake by 14%, mainly through a reduction in carbohydrate consumption (energy dense food sources). The prize-winning research was widely reported as a possible breakthrough in the treatment of obesity. The reduction in blood glucose precipitated by repeated tDCS also has implications for diabetes mellitus, which is so entwined with glucose regulation in the body and obesity.



THE EMOTIONAL BRAIN

The neuropsychological knife cuts both ways. Treatments may cross over from one realm to the other, but the underlying causes of obesity are just as tangled. The group have continued to research how psycho-social stress has a strong detrimental effect on food intake, whilst at the same time enhancing the brain's energy status. Recognising that food intake in industrialised nations is no longer regulated by feelings of physiological hunger and satiety, but rather a complex interplay of emotional states directly or indirectly related to diet, the group identify a range of ways in which this system can become unbalanced.

Studies have repeatedly shown that eating reduces and appeases stress in individuals, a process commonly known as 'emotional eating' or 'comfort feeding'. This process is completely divorced from physiological regulation of appetite and is purely centred in the brain of the individual, leading to overeating and obesity. The global research and social drive to combat this through nutrition and dieting only compounds the problem, providing further stress which is overcome or managed through additional, unregulated food intake.

THE HABITUAL BRAIN

Prof Oltmanns has developed a novel approach which uses an interactive learning programme to change eating behaviours and help individuals lose weight. Employing proven behavioural and therapeutic concepts, the award-winning tactic has now been turned into a consumer product through the development of a mobile application, called Nupp, which helps people to initiate and embed healthy eating behaviours. For this, the NUPP app has been specifically developed by a start-up company where Oltmanns is a partner.

The group are currently engaged in a study to rigorously investigate the theory on which this approach is based. This will probe the definition of overeating as a neuropsychological condition alongside the basic physiological premise of a non-compensated increase in energy intake. Using psychotherapeutic concepts (such as conventionally applied treatments for addiction and methods of conditioning to disconnect feelings of stress and reward from eating behaviour), as well as teaching stress coping strategies, the group hope to change the perception of obesity as a purely physiological problem.

Neurobiological approaches which influence the signalling pathways involved in mood regulation, reward perception and addictive behaviour will also be considered. These may well identify pharmacological targets which can be used to treat chronic obesity in the future. By viewing obesity as a brain disease, one which is mediated by the interaction between energy homeostasis, hyperactivity of the stress systems, and activation of reward pathways, Prof Oltmanns is opening a new door on the development of strategies to tackle this growing problem.

THE LEARNING BRAIN

Having identified that the chronic consumption of 'comfort foods' is detrimental to body weight, and having determined that 'emotional eating' is disconnected from hunger perception, it is clearly time to 'retrain' obese individuals to perceive hunger and satiety more keenly.

According to Prof Oltmanns, these individuals have a 'starving brain', unable to distinguish between physiological and 'emotional' hunger. As such, it is vital to teach their brains to overcome this, doing so both physiologically – with consistent regular meals – and psychologically – through behavioural therapy and stress coping.

She and her team are leading the charge on this front, harnessing the knowledge and expertise in this field which may finally make a difference to the obesity epidemic of industrialised nations. Novel approaches such as their Nupp app show just how innovative they can be in addressing the challenges of 21st century healthcare.

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Q&A

Why might some people's brains be 'selfish brains'?

All human brains are "selfish brains": this is physiological. The brain is the control centre and thereby the hierarchically superordinate organ within the organism. It regulates all metabolic processes of the body and requires much more energy for its activity than other organs do. Therefore, intact brain functioning is indispensable for life. Against this background, it appears plausible that the brain in a "selfish" way ensures that its own energy requirements are covered, finally in favour of the survival of the whole body.

How do the physiological and psychological aspects of obesity interact?

A growing body of evidence including neurotransmitter regulation, neuronal pathways, clinical comorbidities, and behavioural studies imply that overeating and obesity are tightly linked to neurobiological and psychological aspects such as mood status, addictive behaviour, motivation and reward processing, as well as psychosocial stress coping. Particularly the involvement of neuronal pathways that include brain areas assigned to reward, motivation, learning, memory, and cortical inhibitory control render it obvious that concepts which exclusively focus on physiological aspects of obesity – either in a scientific or a therapeutic context – do not meet the requirements.

What are the long term psychological and neurobiological effects of overeating and obesity?

Indeed, overeating and obesity cause problems far beyond the known somatic consequences like cardiovascular disease, diabetes mellitus, and troubles with the musculoskeletal system. Persons concerned frequently suffer from psychological disturbances reaching from decreased self-esteem and impaired social integration to severe diseases such as depression or anxiety disorders. In turn, these factors foster additional weight gain leading to a vicious cycle. Moreover, recent neuroimaging studies make it clear that specific brain areas involved in appetite regulation are altered in obesity suggesting a neurobiological correlate. However, the cause-and-effect-chain is not clear, yet.

How does the Nupp app help people to lose weight?

Scientific studies have proven that conventional weight loss programmes such as diet and fitness programmes are ineffective in the long term and that the vast majority of individuals put the weight back on again. The only sustainable, long-term solution is an adjustment of one's dietary habits towards the natural regulation of the appetite, which is mostly lost in obesity.

The NUPP app is an interactive learning programme in both German and English, that aims to change people's eating behaviour. The NUPP app is based on proven behavioural and therapeutic concepts, but foregoes diet plans. Users practice – under the direction of the NUPP app – regular eating habits, train their sense of hunger and satiety, and learn how to stop linking their emotions to food.

What is your latest research programme hoping to achieve?

Of course, our latest research programme aims to broaden the knowledge about underlying mechanisms of disturbed body weight regulation and obesity development. But our recent project is much more than a scientific study. Beyond research, this is the translational attempt to find an efficient strategy, which helps people to lose weight and steadily sustain it in the long run.

The World Health Organization (WHO) estimates the number of overweight people worldwide as approx. 1 billion with a tendency to rise further. With regard to this huge number, a new therapeutic approach beyond diets and fitness programmes is urgently required.

Detail

RESEARCH OBJECTIVES

Prof Oltmanns' work focuses on experimental obesity research. This comprises underlying endocrine, psychological and neurobiological mechanisms of body weight regulation. Her current research focuses on the behaviour of food intake (i.e., the reasons behind comfort eating).

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BIO

Prof Kerstin Oltmanns is Head of the Psychoneurobiology Department at the University of Lübeck, Center of Brain, Behavior and Metabolism (CBBM). This professorship was specially financed by the Deutsche Forschungsgemeinschaft (DFG). An award-winning mobile phone app, developed from Prof Oltmanns' research is designed to help users develop healthy eating behaviours.

CONTACT

Prof Dr Kerstin Oltmanns
University of Lübeck
Center of Brain, Behavior and Metabolism (CBBM)
Psychoneurobiology Section
Ratzeburger Allee 160
23562 Lübeck
Germany

E: oltmanns@pnb.uni-luebeck.de
T: +49 451 31017531
W: https://www.pnb.uni-luebeck.de/