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Review

Controversies in fat perception

Jaana M. Heinze [a,b,c,d], Hubert Preissl [b,c,d,*], Andreas Fritsche [b,c,d], Sabine Frank [a]

[a] Institute of Medical Psychology and Behavioral Neurobiology/fMEG Center, University of Tübingen, Otfried Müller Str. 47, 72076 Tübingen, Germany
[b] Department of Internal Medicine IV, University Hospital Tübingen, Otfried Müller Str. 10, 72076 Tübingen, Germany
[c] Institute for Diabetes Research and Metabolic Diseases of the Helmholtz Center Munich at the University of Tübingen, Otfried Müller Str. 47, 72076 Tübingen, Germany
[d] German Center for Diabetes Research, Otfried Müller Str. 47, 72076 Tübingen, Germany

HIGHLIGHTS

- Knowledge gap between differing fat perception and associated brain processes
- Impaired fat perception might be a driver for obesity.
- Sensory, genetic and neuroscientific approaches of fat perception are discussed.
- Fat perception is modifiable.
- Fat perception could be included in new therapy tools for obesity.

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ABSTRACT

Nutritional fat is one of the most controversial topics in nutritional research, particularly against the background of obesity. Studies investigating fat taste perception have revealed several associations with sensory, genetic, and personal factors (e.g. BMI). However, neuronal activation patterns, which are known to be highly sensitive to different tastes as well as to BMI differences, have not yet been included in the scheme of fat taste perception. We will therefore provide a comprehensive survey of the sensory, genetic, and personal factors associated with fat taste perception and highlight the benefits of applying neuroimaging research. We will also give a critical overview of studies investigating sensory fat perception and the challenges resulting from multifaceted methodological approaches. In conclusion, we will discuss a multifactorial approach to fat perception to gain a better understanding of the underlying mechanisms that cause varying fat sensitivity which could be responsible for overeating. Such knowledge might be beneficial in new treatment strategies for obesity and overweight.

Contents

* Corresponding author at: Institute for Diabetes Research and Metabolic Diseases (IDM) of the Helmholtz Center Munich at the University of Tübingen, Otfried Müller Straße 47, D-72076 Tübingen, Germany.
E-mail address: hubert.preissl@helmholtz-muenchen.de (H. Preissl).

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1. Introduction

Since 1980, the prevalence of obesity has more than doubled. The problem is no longer confined to developed countries but has become a worldwide phenomenon [1,2]. Therefore, nutritional research is very much spurred by an existing obesity epidemic. One important control component of eating behavior, and therefore a major topic of nutritional research, is taste processing; in particular the primary taste qualities salty, sweet, bitter, sour and umami, their interactions, and possible reasons for resulting food preferences [3,4]. Besides these five primary taste qualities, humans are also reported to be able to taste fat [5]. As the supplier of energy in its densest form, fat is also an important target of eating behavioral weight-loss interventions. Low-fat diets, often paired with low-fat products, are becoming more and more popular. However, the benefits and ill effects of fat-reduced products are a matter of controversy [6]. In the following paper, we will show that a comprehensive discussion of nutritional fat cannot be held without addressing the actual perception of fat. We therefore summarize the sensory and genetic factors as well as the personal characteristics affecting fat perception. We also outline brain research that has already dealt with fat stimuli. We would, however, like to point out that there is still a lack of knowledge on the neuronal mechanisms associated with differences in fat processing and fat taste perception.

2. Sensory, genetic, personal, and neuronal fat perception

Fat perception can be influenced by several sensory, genetic, personal, and neuronal factors. Within the last decade, our understanding of fat as a taste, above and beyond its textural properties, has increased. Humans are able to taste free fatty acids (FFAs) when olfactory, visual, and textural cues are masked, and individuals differ in their sensitivity to fat [5,7]. Nevertheless, when questioned about the fat content of their food, humans usually refer to its somatosensory properties. On the genetic front, several single nucleotide polymorphisms (SNPs) were reported to affect the outcome in fat perception trials. In addition, personal factors such as saliva composition, age, sex, body mass index (BMI), diet, and sensitivity for the bitter component 6-n-Propylthiouracil (PROP) have an influence on an individual's fat perception. On a neuronal level, several brain areas respond to oral fat presentation, including areas involved in homeostatic control, hedonic ratings, and reward. In the following paper, we will summarize the main sensory, genetic, and personal factors influencing fat perception and highlight the neuronal activation patterns known to be associated with fat intake. A proposed scheme of the contributing factors is presented in Fig. 1.

2.1. Sensory mechanisms of fat perception

The sense of taste has two major roles; it warns the body against toxic and possibly harmful substances, and helps the individual to recognize beneficial and nutritious compounds in consumed food. The five primary taste qualities sweet, salty, sour, bitter, and umami have already been identified. Each of these qualities provided an evolutionary advantage. Some tasting agents enhanced energy intake (sweet: carbohydrates) or intake of specific nutrients (umami: proteins, salty: electrolytes), whereas others served as a warning signal (bitter: toxic, sour: dangerous pH-exposure) [8,9].

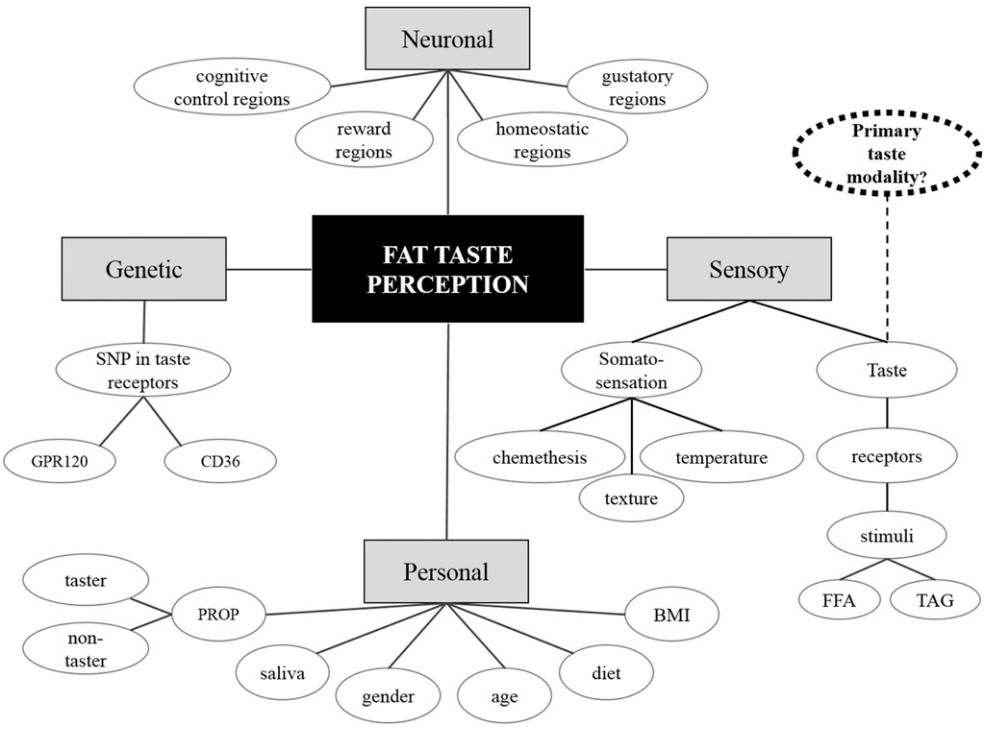

Fig. 1. Summary of the most prominent sensory, genetic, personal, and neuronal factors influencing fat taste perception. BMI: Body Mass Index, CD36: Cluster of Differentiation 36, GPR120: G-Protein coupled Receptor 120, FFA: free fatty acid, PROP: 6-n-Propylthiouracil, SNP: single nucleotide polymorphism, TAG: triacylglycerol.