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Review

The anterior medial temporal lobes: Their role in food intake and body weight regulation

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HIGHLIGHTS

- The amygdala and hippocampus play a major role in food intake and weight regulation.
- These functions are far less known to cognitive and affective scientists.
- This review uniquely expands on the interactions between these two brain structures.

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ABSTRACT

The anterior medial temporal lobes are one of the most studied parts of the brain. Classically, their two main structures – the amygdalae and the hippocampi – have been linked to key cognitive and affective functions, related in particular to learning and memory. Based on abundant evidence, we will argue for an alternative but complementary point of view: they may also play a major role in food intake and body weight regulation. First, an overview is given of early clinical evidence in this line of thought. Subsequently, empirical evidence is presented on how food intake, including in the extreme case of obesity, may relate to amygdalian and hippocampal functioning. The focus is on the amygdala's role in processing the relevance of food stimuli, cue-induced feeding, and stress-induced eating and on the hippocampus' involvement in the use of interoceptive signals of hunger and satiety, as well as memory and inhibitory processes related to food intake. Additionally, an elaboration takes place on possible reciprocal links between food intake, body weight, and amygdala and hippocampus functioning. Finally, issues that seemed particularly critical for future research in the field are discussed.

Contents

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1. The anterior medial temporal lobes – classical role

The anterior medial temporal lobes are composed of two major structures – the amygdalae and the hippocampi. Both of them belong to the most widely studied areas of the brain, notably because of their involvement in key cognitive and affective functions.

It is classical neuroscience textbook knowledge that the amygdala is involved in emotion processing (e.g., [72,175]). In particular, its role in fear conditioning paradigms has often been underlined [89,114]. Recently, the idea that the amygdala acts as a “relevance detector”, rather than only being involved in the processing of fear-related stimuli, appears to have gained traction in the cognitive and affective sciences literature (see [119,125,140]). According to this idea, the amygdala is involved in the detection of any stimulus or event that can “significantly influence (positively or negatively) the attainment of [one's] goals, the satisfaction of [one's] needs, the maintenance of [one's] own well-being, and the well-being of [one's] species” [140]. This notion has become central in the study of emotion (see e.g., [6]).

As for the hippocampus, it has been related to various cognitive functions (see [108] for a review). It is mainly well-known for its contribution to spatial learning and memory (both in rats, e.g., [75], and in humans, e.g., [107]), in particular, explicit memory (e.g., [152]). Its role in inhibitory processes has also been emphasized (e.g., [28]).

However, based on abundant evidence, the anterior medial temporal lobes play a major role in functions that have not received sufficient attention in the literature and are far less known to cognitive and affective scientists: food intake and body weight regulation. In that light, an assumption of the selfish brain theory (according to this theory, the brain gives priority to its own energy needs; see [120]) will be shared in the present review, namely that the limbic system plays “a central role in the pathogenesis of diseases such as anorexia nervosa and obesity” (p. 143). In this framework, the limbic system's two core regions are defined as the amygdala and hippocampus. In the course of this review, we will endeavor to show that the limbic system's involvement in these functions is not incompatible with the aforementioned ideas and that it is rather complementary to these ideas.

It is worth noting that similar topics have been the object of several recent reviews (e.g., [5,56,78,98,109,117,139]). They include descriptions of studies linking food intake regulation to the amygdala [5] and the hippocampus Kanoski & Grill [78]; [117]) as well as studies showing the influence of memory on food reward processing [56] and obesity [98], and the impact of other factors such as environment and stress on obesity [109,139]. However, rather than reiterating the material covered by these scholarly works, the present review aims to integrate the literature on the functions of both the amygdala and the hippocampus in food intake and body weight regulation in two unique ways. First, this review thoroughly expands on the interactions between these two brain structures and on how important they are for food intake and body weight regulation, thereby filling a gap in the literature. Second, through the presentation of lesion studies in humans, the present work is uniquely ingrained in a neuropsychological and affective sciences perspective. Consequently, this review may benefit researchers in physiology, but also in psychology, cognitive and affective sciences, who may not be as familiar with this literature.

First, early clinical evidence pertaining to the involvement of the anterior medial temporal lobes in food intake will be presented, focusing on Klüver-Bucy syndrome, epileptic human patients, and amnesic patients who have a bilateral lesion of the medial temporal lobes. In a second part, experimental evidence will be discussed regarding the role of the amygdala in food intake, both in healthy-weight individuals as well as overweight and obese individuals. The third part of this review will be dedicated to the same purpose, but for the hippocampus. Subsequently, the reciprocal and dynamic links between food intake, affective and cognitive functioning, as well as amygdala and hippocampus functioning will be discussed. Finally, some of the current outstanding questions in this literature will be presented.

2. The involvement of the anterior temporal lobes in food intake regulation: early evidence

2.1. Klüver-Bucy syndrome

Klüver and Bucy [86] reported a syndrome that follows bitemporal dysfunction. Among other things, this syndrome is characterized by a hyperorality, bulimia, and the ingestion of non-food items (such as tea bags, feces or even shoe polish). These symptoms were reported both in rhesus monkeys and in humans (see for instance [91]). Thus, it appears that the dysfunction of both temporal lobes can lead to excessive intake of food as well as non-food items.

2.2. Psychomotor epileptic patients

Gastaut [42] has reported two types of hunger in patients with psychomotor epilepsy (i.e., epilepsy originating in the temporal lobe). The first of these is called “faim-valle”, which translates to “very intense hunger”. In patients with faim-valle, epileptic crises are often preceded by a violent hunger, and this rare but reliable sign of an impending epileptic crisis cannot be reduced by food intake. This often co-occurs with other symptoms such as olfactory and gustatory sensations, as well as chewing. The second type of hunger, called “faim postcritique”, or post-critical hunger, appears after the crisis and is much more common. It is even present in patients who have had a substantial meal 1 h before the crisis, however, this form of hunger can be reduced by food intake. In both cases, patients do not remember these episodes. Importantly, between epileptic crises, these patients do not display pathologic hunger. Thus, the dysfunction of the temporal lobes can also be associated with hunger dysregulation.