

## Original Article

# L-theanine, a natural constituent in tea, and its effect on mental state

Anna C Nobre PhD<sup>2</sup>, Anling Rao PhD<sup>2</sup> and Gail N Owen PhD<sup>1</sup><sup>1</sup>Unilever Food and Health Research Institute, Vlaardingen, The Netherlands<sup>2</sup>Department of Experimental Psychology, Oxford University, UK

Tea is the most widely consumed beverage in the world after water. Tea is known to be a rich source of flavonoid antioxidants. However tea also contains a unique amino acid, L-theanine that may modulate aspects of brain function in humans. Evidence from human electroencephalograph (EEG) studies show that it has a direct effect on the brain (Juneja et al. Trends in Food Science & Tech 1999;10:199-204). L-theanine significantly increases activity in the alpha frequency band which indicates that it relaxes the mind without inducing drowsiness. However, this effect has only been established at higher doses than that typically found in a cup of black tea (~20mg). The aim of the current research was to establish this effect at more realistic dietary levels. EEG was measured in healthy, young participants at baseline and 45, 60, 75, 90 and 105 minutes after ingestion of 50mg L-theanine (n=16) or placebo (n=19). Participants were resting with their eyes closed during EEG recording. There was a greater increase in alpha activity across time in the L-theanine condition (relative to placebo ( $p<0.05$ )). A second study replicated this effect in participants engaged in passive activity. These data indicate that L-theanine, at realistic dietary levels, has a significant effect on the general state of mental alertness or arousal. Furthermore, alpha activity is known to play an important role in critical aspects of attention, and further research is therefore focussed on understanding the effect of L-theanine on attentional processes.

**Key Words:** L-theanine, tea, alpha, EEG, attention

## INTRODUCTION

Theanine, ( $\gamma$ -glutamylethylamide) is a non-protein amino acid found in species of *Camellia*<sup>3,4</sup> and in the edible bay boletes mushroom *Xerocomus badius*<sup>4</sup> but is otherwise rare in nature. It is the major amino acid in tea and is thought to be a flavourous constituent of tea leaves. It constitutes between 1 and 2% of the dry weight of tea<sup>3</sup> which corresponds to 25-60mg per 200ml serving. Within tea the predominant form of theanine is the L isomer.

L-theanine is thought to cross the blood-brain barrier to exert its effects directly on the brain within 30 minutes.<sup>11</sup> Its central effects were first reported in humans following a randomised, placebo-controlled, crossover study comparing placebo, 50 and 200mg L-theanine. The study was originally published in Japanese<sup>7</sup> and later reviewed in English.<sup>8</sup> Relative to placebo, the higher dose of L-theanine increased power in the alpha frequency band (8-13Hz) of the electroencephalogram (EEG) across parietal and occipital sites after approximately 40min.

However, L-theanine was effective only in participants classified as highly anxious using a manifest anxiety scale. A more recent study has since confirmed that L-theanine is most effective in individuals who generally have high levels of anxiety.<sup>9</sup>

In the current study, the effect of L-theanine on the resting brain activity in young healthy human volunteers was investigated. The aim of was to measure changes in brain activity within the alpha frequency band of the EEG at different doses, in order to replicate and extend the findings

from previous examination of the effects of L-theanine upon brain activity.

## SUBJECTS AND METHODS

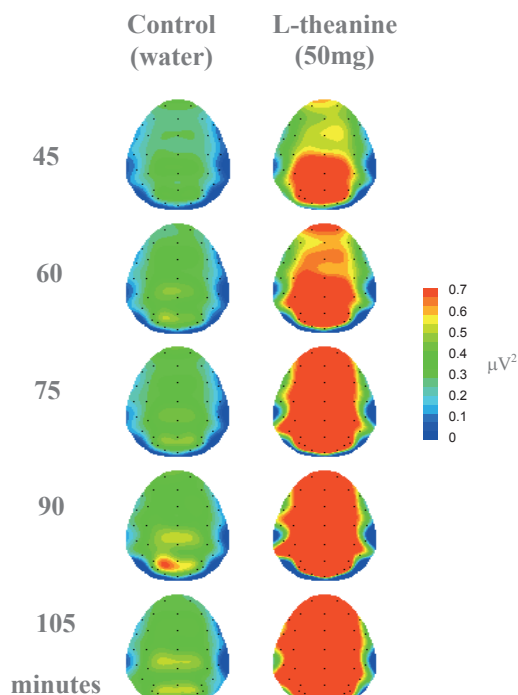
Sixteen participants (11F, 5M) were assigned to the *L-theanine* group and a further 19 (12F, 7M) to the *control* group. The *control* solution was 100 ml of cool potable water and the *L-theanine* solution was prepared by dissolving 0.5 mg powdered L-theanine (Taiyo Kaguka Co. Ltd., Yokkaichi, Japan) per Kg participant body weight in a tea infusion (total L-theanine 50mg/serving).

EEG activity was recorded using either Ag/AgCl electrodes mounted on an elastic cap (Electro-Cap Inc.) and positioned according to the 10-20 International system (AEEGS 1991).

The first EEG sample was collected 45 minutes after ingestion and measured subsequently every 15 minutes (45, 60, 75, 90, 105 minutes). Epochs of EEG containing 8,192 points of data for each electrode were saved from each 60-second measurement trial and analysed off line. Average power ( $\mu V^2$ ) was computed using a cosine transformation: alpha 1 (8-10Hz) and alpha 2 (11-13Hz).

**Corresponding Author:** Dr G.N. Owen, Unilever Food and Health Research Institute, Olivier van Noortlaan 120, Postbus 114, 3130 AC Vlaardingen, The Netherlands  
Tel: +31-10-4606486; Fax: +31-10-4605236  
Email: gail.owen@unilever.com  
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The ethics committee at the Department of Experimental Psychology, University of Oxford approved each of the studies and all participants provided written informed consent before taking part.



**Figure 1.** Average power plotted on a schematic top-view of the scalp for *L-theanine* and control at five successive times after ingestion. Activity was higher in the *L-theanine* group than in the control for alpha-1 ( $p < 0.05$ ).

## RESULTS

The alpha-1 band showed significant main effects of time [ $F(4,104) = 5.20, p < .05$ ] and condition [ $F(1,26) = 5.825, p < .05$ ]. Alpha activity increased over time and was greater in the *L-theanine* group (Figure 1). There was also a marginally significant interaction between the factors [ $F(4,104) = 2.42, p = .05$ ]. A significant linear contrast for the interaction between drink condition and time showed a greater increase of alpha activity over time in the *L-theanine* condition [ $F(1,26) = 4.51, p < .05$ ]. In the alpha-2 band, a linear contrast showed a main effect of time [ $F(1,26) = 6.56, p < .05$ ] but there was no effect of condition or an interaction of these factors.

## DISCUSSION

The current study demonstrated that *L-theanine* significantly modulates the resting state of brain activity. *L-theanine* enhanced the power in the alpha-1 frequency band, replicating previous reports.<sup>7,10</sup> In the current experiment, the power in the alpha band increased linearly with time and this linear increase was significantly enhanced by *L-theanine*. This increase in alpha-band activity supports a role for *L-theanine* in achieving a relaxed but alert mental state via a direct influence on the central nervous system.

These results have since been replicated under ecologically valid conditions in which participants passively watched television (unpublished). It was notable that *L-theanine* was able to elevate the level of alpha-1 even

under this situation in which participants are already highly relaxed and entertained.

Furthermore, activity in the alpha-band is also a key component in focused attentional processes.<sup>2,5</sup> Directed deployment of alpha appears to be critical to the ability to suppress distracting visual information during highly demanding tasks. Recently, *L-theanine* has also been shown to enhance this so-called alpha attention effect also.<sup>6</sup>

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## AUTHOR DISCLOSURES

Gail Owen is an employee of Unilever, which markets food products some of which contain *L-theanine* and caffeine.

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