Hitting the right nerve: effects of transcutaneous vagus nerve stimulation on symptoms of anxiety

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Part III

Working Mechanisms

Chapter 7

Transcutaneous nerve stimulation via the tragus: are we really stimulating the vagus nerve?

Burger AM, Verkuil B (2018). *Brain Stimulation, 11,* 945-946.

Dear Editor,

Research on transcutaneous vagus nerve stimulation (tVNS) is accumulating. Several studies now assessed whether stimulating the auricular branch of the vagus nerve (ABVN) affects cognitive, emotional and neurological processes, similarly to the invasive stimulation of the vagus nerve at the cervix. Currently, the main areas that are targeted during auricular stimulation are the cymba concha and the tragus [270]. Recently, Badran et al. [296] published an important study on the brain activation patterns associated with tragus stimulation, showing that tragus stimulation was associated with stronger activation in afferent vagal cerebral areas compared to sham stimulation. Crucial to our interpretation of the findings on tragus stimulation as a method to stimulate the vagal nerve is anatomical evidence that the human tragus is indeed innervated by the auricular branch of the vagus nerve. Yet, we here describe inconsistencies in the reporting of this innervation pattern in the sole, but often cited cornerstone publication. These inconsistencies imply that interpreting tragus stimulation as a method to stimulate the vagus nerve is still too premature, and that it plausible that the tragus is innervated only by the great auricular nerve and the auriculotemporal nerve.

In 2002, Peuker and Filler published an article titled “The Nerve Supply of the Human Auricle” (Clinical Anatomy 15: 35-37), in which they described an anatomical study where the nerve supplies of the ears of seven cadavers was exposed. To this date, this article remains the only detailed description of the nerve distribution of different innervation areas of the lateral surface of the human auricle.

Although older studies provide some anatomical basis for a vagal innervation of the cymba concha [297,298], vagal innervation of the tragus is based solely on this article by Peuker and Filler [25].

Unfortunately, the article contains several inconsistencies, which limit the interpretability of their findings. Specifically, the main text in the results section does not correspond with their results presented in their Table 1. Below this text, we added a table summarizing the claims from both the first table as well as the main text from the original article. Importantly, there are contradictions between the text and the table regarding the innervation of the antihelix, the tragus and the cavity of the concha (bold and underlined in the table). According to the original Table 1, the tragus is innervated by the ABVN in 45% of the exposed auricles. However, in the main text, the authors mention that the tragus is innervated either by the great auricular nerve (45% of all exposed auricles) or by the auriculotemporal nerve (9%), or by both of these nerves (46%). They do not mention that the tragus is innervated by the ABVN, and this is inconsistent with their Table 1.

We have been in contact with professor Filler, who acknowledged the inconsistency and regretfully was unable to assess which of the assertions from the manuscript was correct. Given the current inconsistency in the original article, we would like to emphasize the clear need for a replication of this study to assess the nerve supply of the human auricle. As of yet, it is not possible to conclude that the tragus of the auricle is innervated by the ABVN and this impacts the interpretation of studies using this type of auricular stimulation.

Table 1. Inconsistencies in the innervation patterns between Table 1 and the main text by Peuker & Filler (2002).

	Table 1 by Peuker & Filler (2002)			Alternative Percentages in Main Text			
	ABVN	GAN	ATN	ABVN	GAN	ATN	Double Innervation
Crus of helix	20%		80%				
Spine of helix		9%	91%				
Tail of helix		100%					
Scapha		100%					
Crura of antihelix	9%	91%					
Antihelix	73%	9%	18%	73%	18%		9% (ABVN & GAN)
Antitragus		100%					
Tragus	45%	46%	9%		45%	9%	46% (GAN & ATN)
Cymba conchae	100%						
Cavity of concha	45%	55%		45%			55% (ABVN & GAN)
Lobule of auricle		100%					

Note: ABVN = auricular branch of the vagus nerve; GAN = great auricular nerve; ATN = auriculotemporal nerve. NB. Percentages reported here suggest that 11 auricles were reported on- although the paper mentions that 14 auricles were exposed. In the case of 14 auricles, one auricle would constitute 7% of the sample, yet, the smallest percentage reported here is 9%, suggesting that 11 auricles were examined.