The Plant-Based Penalty? A Neurophysiological Investigation of Vegan vs. Plant-Based Claims Across Vegetable, Functional, and Hedonic Food Categories.

The transition to more plant-based protein is a great challenge for policy-makers, producers and consumers – and for advertisers. Plant-based food suffers from consumers' perception that they are less tasty. Surveys found that the plant-based claim may be more tasty than the vegan claim, but no evidence existed on a neurophysiological level or between various product categories. In the current study, we compared the effects of Vegan and Plant-based claims in three product categories (vegetables, functional and hedonic products) on EEG and Eye Tracking. There was no difference in attention towards Vegan or Plant-Based claims in any of the product categories. On a neurophysiological level, claims were not effective on the obvious products (vegetables) and on functional products. Hedonic products, however, suffered from these claims; both vegan and plant-based claims reduced frontal alpha asymmetry compared to products without a claim, with neither being significantly more impactful than the other.

Keywords: front-of-packaging claims, neuromarketing, sustainability

Introduction

Sustainability has become increasingly more important, and promoting more sustainable consumption is therefore a challenge for policy-makers, producers and consumers – and for advertisers. Although more people report identifying as vegetarian or vegan in the Netherlands,

the gap between stated preferences and actual choices remains substantial (Hielkema, 2025). This attitude-behavior gap underlines the importance of effective communication strategies to promote sustainable behavior and emphasizes the relevance of neuroscientific testing.

To meet the demand for more plant-based foods, supermarkets have expanded their assortments, consequently increasing the number of claims on product packaging, such as vegan and plant-based. These claims aim to simplify consumer choices by quickly signaling product attributes. However, consumer perception of these claims may differ depending on how consumers interpret them.

Explicitly labeling a dish as “for vegans” can actually be counterproductive; both Krpan and Houtsma (2020) and Hielkema and Lund (2022) found that framing dishes with vegan or plant-based claims discouraged customers from choosing vegetarian options. Thus, in some contexts, these claims may act as a barrier to consumption. This barrier is largely driven by expectations; Stremmel et al. (2022) show that for products that were vegan, the claims increased perceived healthiness and sustainability, but decreased expected taste perception. This indicates that the effect of sustainability claims is significantly depending on the product category and the consumer’s underlying purchase motives.

Moreover, the type of claim may vary in effects as well. Ruby et al. (2024) found that a plant-based claim is more attractive than a vegan or vegetarian claim and leads to higher purchase likelihood. While Sleboda et al. (2023) and Macdonald (2023) found that the

plant-based claim is preferred, Hielkema and Lund (2022) found no difference between the different claims.

However, most of these studies relied on explicit survey methods. Self-reported purchase intentions may not always be a good indicator of actual behavior (Sheeran, 2002) or accurately relate to population behavior (Berkman & Falk, 2013). In marketing, researchers may employ neuroscientific tools such as eye-tracking or electroencephalography (EEG) to explore the effects of advertising (Meyerding & Mehlhose, 2020; Ohme et al., 2010; Venkatraman et al., 2015). There is a growing call for the application of neuroscience to uncover the neuropsychological mechanisms underlying environmental attitudes and behavior (Doell et al., 2023; Leeuwis et al., 2022).

Most prominently in neuromarketing literature is the EEG-index of Frontal Alpha Asymmetry (FAA), which refers to the lateralization of alpha-band activity in frontal regions of the brain. FAA is interpreted as a marker of approach/avoidance motivation and thereby an indicator for emotional valence (Coan & Allen, 2004). FAA positively correlated to tastiness and purchase intention for plant-based foods during visual-olfactory presentation (Inguscio et al., 2025).

A lot of research has investigated the attention to front-of-packaging (FOP) claims and found that different types of FOP claims do receive differential visual attention. For instance, Loo et al. (2020) found substantial variation in attention across claim types on granola bars: sweetener content and genetic modification claims received the most attention, followed by

sustainability claims. Applegate et al. (2025) found that protein content claims received the least attention despite being most influential on selection likelihood. To our knowledge, no studies directly compare vegan versus plant-based claims specifically.

Based on this literature, the present research explores how different claims influence consumer perception by using neuroscientific tools. Specifically, it examines whether products benefit from displaying vegan or plant-based claims and the way consumers cognitively respond to such cues. Multiple product categories were included to explore the influence of claims across these different categories. We especially focused on products that are inherently plant-based (i.e., vegetables and fruits), where labeling may simply state the obvious, as well as hedonic and functional product categories. Based on prior studies, we hypothesized that plant-based claims elicit higher FAA than vegan claims. Additionally, we expected a lower FAA score within the hedonic product category, because vegan claims often reduce expected taste – a key hedonic driver. Regarding visual attention, we hypothesized that the distinct visual properties of the vegan claim would result in a higher fixation ratio than the plant-based claim, though we expect no significant differences in fixation ratio across product categories.

Methods

Participants

Participants were recruited through a participant panel agency and received compensation for their participation. Participants were between 18 and 75 years old and right-handed. All participants signed informed consent prior to the experiment. Twenty-four participants, aged 19 to 73 years old (9 Females, 15 Males, M_{age} = 34.67, SD_{age} = 18.60), were recruited.

Stimuli

Product images were sourced from the Albert Heijn website (ah.nl). The study included three product categories: vegetables/fruits, hedonic, and functional products. The vegetables/fruits category comprised six products, the hedonic category comprised seven products, and the functional category comprised seven products.

The vegan claim was obtained from V-Label (V-Label, 2023). The plant-based claim was created based on the Albert Heijn "Bio" claim, using Google Gemini (Google, 2026). Adobe Illustrator (Adobe Inc., 2025) was used to digitally add these claims to the product images. All other claims were removed to prevent potential influence from additional on-pack information with Google Gemini (Google, 2026).

To prevent location bias, for each product various positions for the claims on the packaging were created (left or right, top or bottom). Therefore, 96 images in total were shown. Example stimuli for each product category are presented in Figure 1. **[insert fig 1. here]**

Procedure

At the start of the session, the participants provided informed consent and were fitted with the EEG headset and afterwards, the eye tracker was calibrated. During the task, each product was shown without a claim, with a vegan claim and with a plant-based claim. All stimuli were shown in random order, separated by a white screen for 1 to 1.5 seconds. Each version of a product was presented twice, with each presentation lasting six seconds, resulting in 12 seconds of recorded data per stimulus. Following the task, the EEG equipment was removed and participants were debriefed. The study was designed and recorded using iMotions (11.0.3, 2025).

Eye tracking

Eye movements were recorded using the screen-based Tobii Pro X3-120 eye tracker (Tobii AB, 2019), with a sampling rate of 120 Hz. The distance between the eye tracker and the participant's eyes was generally 60–65 cm. At the beginning of the session, each participant followed a 9-point calibration procedure to ensure good accuracy. This calibration was poor for one participant, who was therefore excluded from the eye tracking analysis.

Fixations are calculated using I-VT Filter in iMotions, with a window-length of 20 ms, velocity threshold of 30deg/s. Fixations <60 ms were discarded and gaps were interpolated for a maximum of 75 ms. Adjacent fixations were merged for a maximum of 75 ms and 0.5 degrees. The eye-tracking is quantified as a fixation within specified areas of interest (AOIs) on the vegan or plant-based claims during the exposure to a stimulus in a binomial way.

EEG recording and processing

Brain activity was recorded using the wireless B-Alert X10 EEG system, which includes nine channels positioned according to the International 10/20 electrode placement standard (F3, Fz, F4, C3, Cz, C4, P3, POz, and P4). Reference electrodes were positioned on the mastoid bones behind each ear. Conductive gel was applied between the scalp and the electrodes to maintain impedance below 40 kΩ. The EEG signals were recorded continuously throughout the experiment at a sampling rate of 256 Hz.

Preprocessing of EEG data is performed within iMotions. Raw EEG data was Notch filtered at 50 Hz and a band-pass filter was added ranging from 0.5 to 100 Hz. Artifacts were automatically removed when the signal amplitude exceeded 120 μV.

EEG signals were analyzed in the frequency domain by estimating the distribution of spectral power across frequency components. Power spectral density (PSD) was computed using Welch's method with 50% overlap and a window length of 0.5 s. The data was decomposed into the alpha frequency band (8–12 Hz). Frontal Alpha Asymmetry (FAA), was calculated in iMotions, using the following equation:

$$ln(PSDF4) - ln(PSDF3)$$

For each participant and claim, the FAA was averaged per product to rule out the effect of location of the claims.

Statistical Analysis

The models were tested with Bayesian hierarchical models, a method suggested by the field to estimate the probability or direction of the effect (Kiers & Tendeiro, 2025). Models were fitted using the *brms* package in R (R Core Team, 2025) with chains = 4, iter = 2000, cores = 4. We used weakly informative priors following recommendations for hierarchical models, so $N(0,0.5)$ was set as prior for the fixed effects. Sensitivity checks with small ($N(0,0.25)$) and wide priors ($N(0,1)$) for the model coefficients yielded similar results. All models converged successfully (all $\hat{R}$ values < 1.01; bulk and tail effective sample sizes > 1000). Visual inspection of trace plots indicated good mixing and no evidence of non-convergence.

The Bayes Factor and Leave-One-Out (LOO) were calculated by comparing the model of interest to the null model that assumes no effect of Claim or Product Category (i.e., only random factors included). Additionally, the contrasts of claims were examined by looking at the posterior probability of the coefficients. The HPD 95% credible interval was calculated with the *emmeans*

package. When the interval excluded zero, or when the posterior probability of a coefficient (*pd*) exceeds 95%, this could be an indication of an effect (Kruschke & Liddell, 2018).

For the eye tracking, models with Bernoulli distribution were created where the fact that a participant fixated on the claim during an exposure of one of the stimuli (0 or 1) served as DV. Since this includes an unequal distribution of exposures to some products compared to others (because of the location variations), a random factor for product was included in the model. The model was defined as Fixated (0|1) ~ Claim * Product Category + (1|Product) + (1|Participant). Intercept prior was $N(0, 1)$, sd priors were exponential(1).

For the EEG, the model inputs were the average FAA per Product, Claim and Participant. Gaussian models were defined as FAA ~ Claim * Product Category + (1|Participant). The intercept prior was $N(0, 0.5)$, random-effect standard deviations (class *sd*) and the residual standard deviation sigma was exponential(2).

Results

Eye Tracking

The interaction model did not provide a significantly better fit than the intercept-only model ($\Delta elpd$ = -1.3, SE = 1.3, $BF10$ = 0.068). Analysis of the posterior distributions revealed no meaningful differences between Vegan and Plant-based claims across any product category (Figure 2). In the functional category, the median difference was negligible (b = 0.222, HPD = [-0.085, 0.556], pd = 91.08). Similar patterns were observed for the fruit/vegetable category (pd = 50.16%) and the hedonic category (pd = 50.03%), where the probability of a directional effect was near chance levels. **[insert fig 2. here]**

Frontal Alpha Asymmetry

The interaction model did not provide a significantly better fit than the intercept-only model ($\Delta elpd$ = -3.3, *SE* = 3.6, *BF10* <.001). Posterior distributions were examined to identify the effect of claims in each product category (Figure 3). In the functional product category, there was no evidence that the FAA in response to the claims differed (Plant-based - Control: *pd* = 58.30%; Vegan - Control: *pd* = 74.45%; Vegan - Plant-based: *pd* = 80.33%). For vegetables and fruit, no difference was found as well (Plant-based - Control: *pd* = 66.47%; Vegan - Control: *pd* = 51.38%; Vegan - Plant-based: *pd* = 67.40%). In the hedonic product category, there was a negative effect of both claims on FAA (Vegan-Control: *b* = -0.064, *HPD* = [-0.118, -0.009], *pd* = 98.96%; Plant-based - Control: *b* = -0.065, *HPD* = [-0.118, -0.010], *pd* = 98.95%). This effect was not different between Plant-based or Vegan claims (*pd* = 50.34%). **[insert fig 3. here]**

Discussion

In the existing literature, there have been investigations into attention to FOP claims, but not comparing this attention between various product categories. Moreover, survey research established that the vegan or plant-based claims are experienced differently, but no evidence existed on a neurophysiological level. In the current study, we compared the effects of Vegan and Plant-based claims in three product categories on EEG and Eye Tracking. There was no difference in attention towards Vegan or Plant-Based claims in any of the product categories. On a neurophysiological level, claims were not effective on functional products and vegetables or fruits. Hedonic products, however, suffered from these claims; both vegan and plant-based claims reduced frontal alpha asymmetry, with neither being significantly more impactful than the other.

The decreasing effect of the claims on frontal alpha asymmetry indicates a decrease in approach motivation (Coan & Allen, 2004), and thereby possibly a decrease in liking, purchase-likelihood and tastiness of the product (Inguscio et al., 2025). The fact that this effect is only prevalent in hedonic products, could be expected based on the observations of Stremmel et al. (2022), who saw the expected taste declined with vegan products - which is the exact opposite of the goal of hedonic consumption.

For advertisers, this means they would be wary of adding claims to hedonic products. Additionally, retailers of plant-based foods (like vegetables or fruit) are not losing or gaining anything with any of the claims.

Limitations in the current study include: the lack of pre-testing the stimuli, or collecting any survey data that could help clarify the amount of meat the participants eat or the opinion they have about vegan or plant-based foods.

Future research could test a broader variety of claims, for example next to vegan and plant-based adding a claim like “without-animals” or “cruelty-free”. Also, more product categories (such as plant-based alternatives for animal-based food) could be incorporated to validate the effects. Additionally, adding measures that test the associations of sustainability, taste, purchase intent or likeability can help explain the results and better inform advertisers how to implement claims for their specific situations.

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Figures

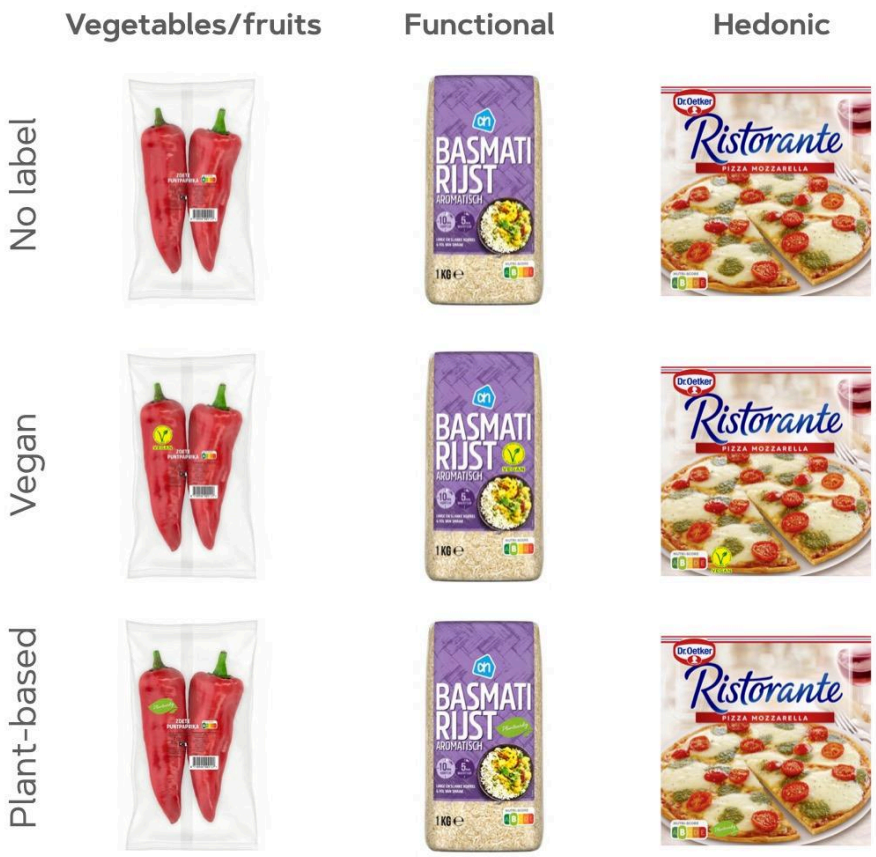
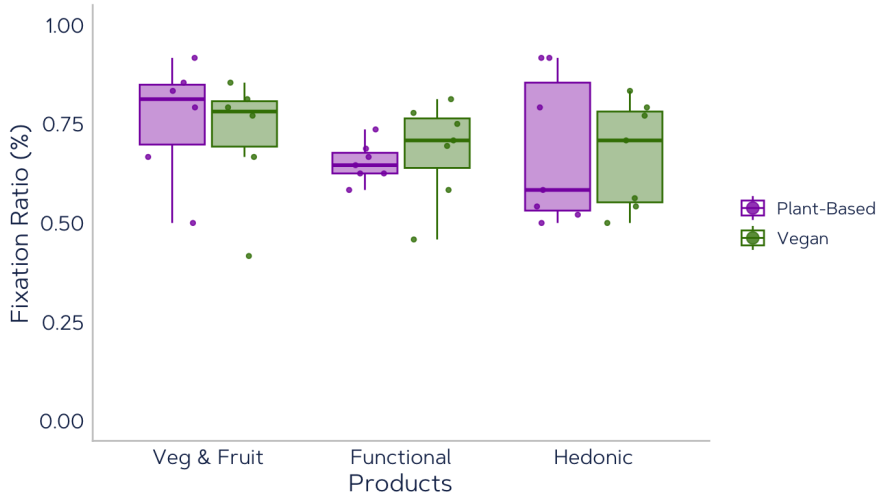
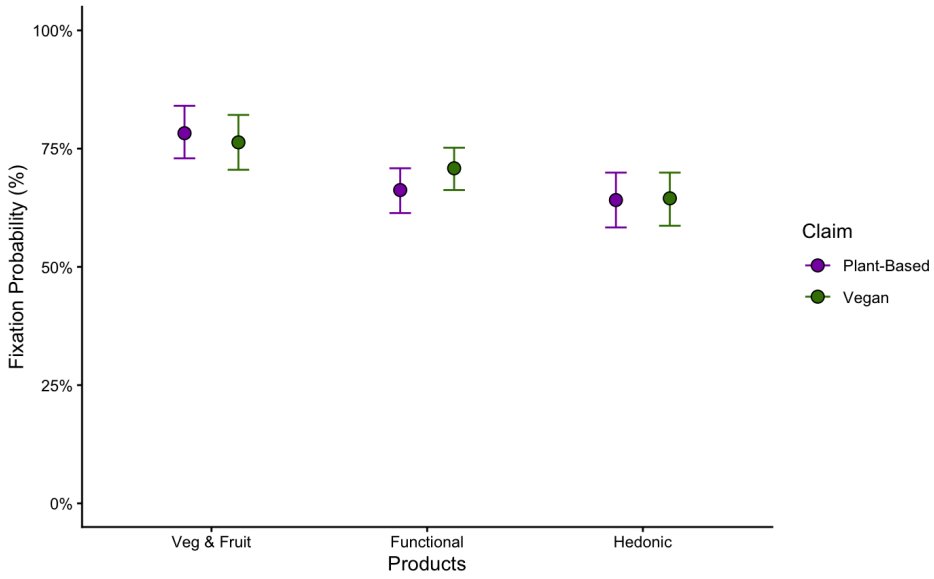


Figure 1. Example products from each category (vegetables/fruits, functional, and hedonic), shown with either a vegan claim, a plant-based claim, or no claim.



(A)

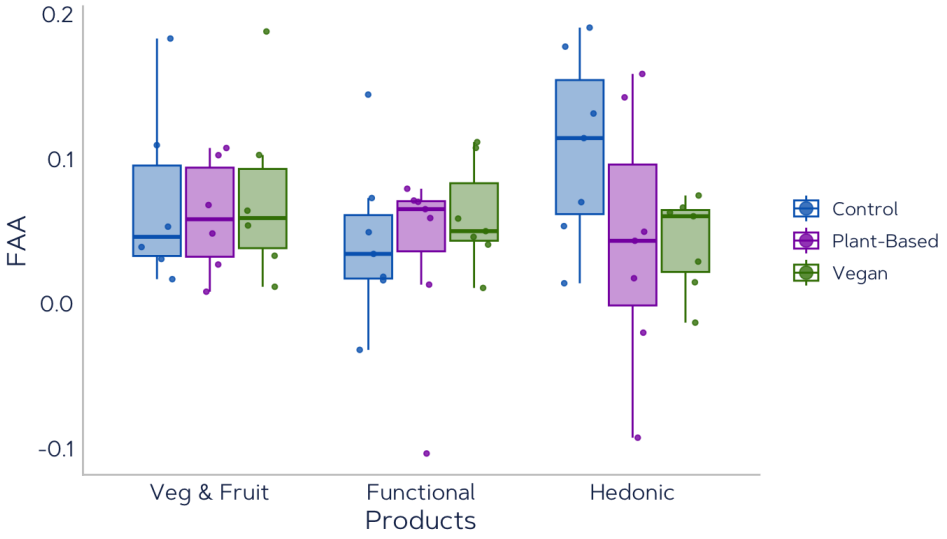


(B)

Figure 2:

(A) The average fixation ratio per product for each Product Category and Claim.

(B) Mean Fixation Probability by Claim and Product Category. The points represent the mean proportion of respondents who fixated on the claim (n = 23 respondents, k = 1,748 observations). Error bars indicate 95% bootstrapped confidence intervals. Data are categorized by Claim (Plant-Based vs. Vegan) across three Product Groups (Vegetables, Functional, Hedonic).



(A)

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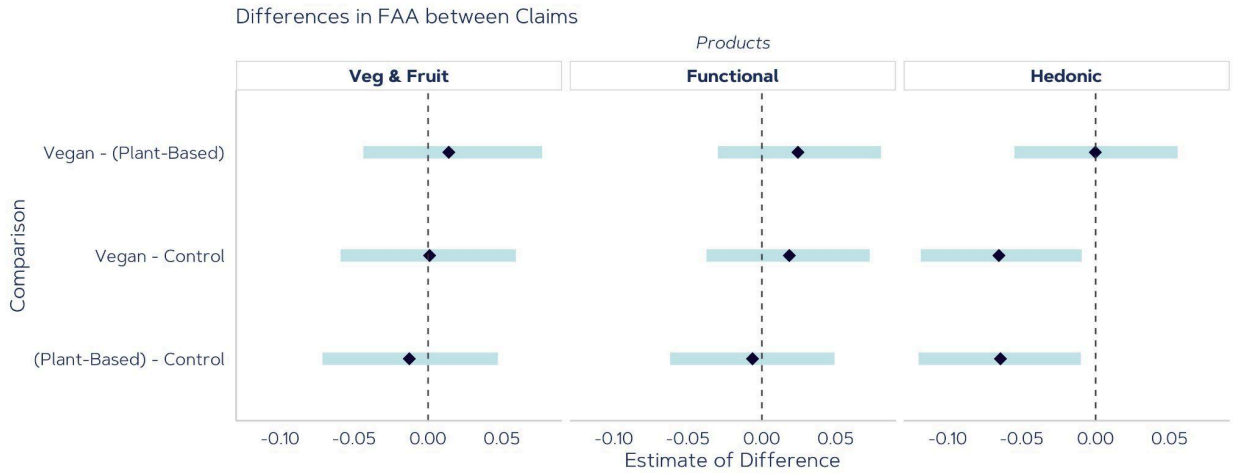

Figure 3:
(A) Average FAA per product for each Product Category and Claim.
(B) Posterior Estimates of the Difference in FAA between Claims. The points represent the median posterior difference in FAA between the claims, nested within each Product Category. Horizontal lines represent 95% Credible Intervals. The dashed vertical line at zero indicates the "null effect": intervals crossing this line suggest no consistent evidence for a difference in visibility between the two claims in that product category.