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NeuroBusiness Conference

Bridging Neuroscience for Enhanced Business Performance

Book of Abstracts

University of Dubrovnik, Faculty of Economics and Business
18-19/09/2025, Dubrovnik, Croatia

UNIVERSITY OF DUBROVNIK
FACULTY OF ECONOMICS
AND BUSINESS

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Prof. Gideon Nave, University of Pennsylvania, Wharton School of Business

FROM THE EDITORS

Dear colleagues,

It is our great pleasure and honor to welcome you, on behalf of the editorial board, to the Book of Abstracts of the NeuroBusiness Conference, held in the inspiring setting of Dubrovnik, often referred to as the Pearl of the Adriatic. This conference is envisioned as a meeting point between academia and industry, bringing together the latest advances in neuroscience with creative approaches to business and management. It gathers leading experts who share their knowledge and research, fostering new ideas for innovation in business and strategy – always with the aim of applying neuroscientific insights to improve organizational effectiveness and decision-making.

This year, we are especially proud to host our distinguished keynote speakers: Professor Moran Cerf (Columbia Business School, Columbia University) and Professor Gideon Nave (Wharton School, University of Pennsylvania). Their groundbreaking work bridges the gap between neuroscience and business practice, opening up new ways of thinking about human behavior, market perception, and business interactions.

Within this Book of Abstracts, you will find unique contributions – from theoretical frameworks and empirical research to practical applications in real-world business settings. The abstracts span a wide range of topics, including consumer behavior, emotional marketing, decision-making in organizations, technological innovation, and more. Our aim is not only to showcase research findings but also to stimulate dialogue and collaboration between scholars, practitioners, and industry leaders.

We would like to extend our sincere gratitude to all authors who submitted their work. Our appreciation also goes to the members of the Scientific and Organizing Committees for their outstanding efforts in preparing this edition. Special thanks are due to the University of Dubrovnik – AXON Behavioural Science Lab, as well as our partners, whose support has made this conference possible.

We hope this Book of Abstracts will serve as a valuable resource for all participants, offering both inspiration and new directions for research and professional endeavors.

We wish you a fruitful, inspiring, and successful conference!

Sincerely,

The Editors

NeuroBusiness Conference 2025

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Brains, Brands, and Behavior: The Neuromarketing Link Between Personality and Attention

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JEL classification: M31, M37, D91, C91

Abstract

In the current digital age, consumers are inundated with an overwhelming volume of advertisements and brand messages. On average, a consumer is exposed to over 2,000 advertisements throughout their lifetime, and the modern adult can recognize thousands of brands. Moreover, approximately 700 new products are introduced into the marketplace daily, with an estimated two million brands competing globally for consumer attention. Even children, as early as 18 months old, can identify logos and are reportedly exposed to over 40,000 advertisements each year. In such a saturated advertising environment, understanding the psychological mechanisms that guide consumer attention and brand choice is critical for effective marketing strategies. Cognitive processes such as perception, attention, and memory play an important role in shaping how consumers interpret and respond to marketing stimuli. Emotions, which are closely linked to individual personality traits, can greatly influence consumer reactions to branding and advertisements. This study aims to examine the relationship between consumer personality traits, specifically extraversion, ambiversion, and introversion, and their effects on cognitive attention and brand preference, focusing on the comparison between local and international brands through a neuromarketing approach. The theoretical framework for this research is grounded in Social Cognitive Theory and Theories of Personality, which collectively posit that behavior is influenced by the interaction of personal traits, cognitive processes, and environmental factors. To investigate this complex interaction, the study was conducted in two parts, integrating psychological assessment and neuromarketing techniques. In the initial phase, the Extraversion Five Factor Non-Verbal Personality Questionnaire (E-FF-NPQ) was utilized to classify participants according to their personality traits. A sample of 30 individuals was recruited from Universiti Sains Malaysia for this screening procedure. The second phase involved eye tracking technology to capture and quantify consumer cognitive attention when exposed to visual stimuli. After personality classification, participants were shown a series of randomly selected product images from the high-involvement purchase category, specifically vehicles representing both local and international brands. Eye tracking metrics such as fixation duration time and gaze heatmaps were recorded to assess the attentional patterns of individuals based on their personality type. The third and final phase concentrated on conducting statistical analyses to examine the influence of individual personality traits on cognitive attention and subsequent brand choice. This stage aimed to investigate whether introverts, ambiverts, and extraverts exhibit significant differences in their processing and response patterns toward local versus international brands and whether such differences are evident in their eye attention data and brand preference outcomes. The results indicate that extraverts are more inclined to engage

with dynamic and interactive advertisements, referring to international brands that align with global trends and social status. In contrast, introverts tend to focus on simpler advertisements and exhibit a preference for local brands that resonate with familiarity and personal values. Ambiverts demonstrate a balanced response, displaying equal engagement with both vibrant and calm advertisements, depending on the context presented by the brand. The outcomes of this research have significant theoretical, practical, and methodological implications. Theoretically, it contributes to the integration of personality psychology and consumer behavior within the framework of neuromarketing. Practically, the findings may provide valuable insights for marketers seeking to tailor their branding strategies to resonate more effectively with target consumers based on personality-driven cognitive responses. Such insights are particularly beneficial for both local and international brands aiming to enhance consumer engagement and improve brand positioning in highly competitive markets. Additionally, the study contributes to the methodology by employing advanced neuromarketing techniques, such as eye tracking, to provide more accurate and real-time insights into consumer attention and brand choice.

Keywords: "personality trait", "high involvement", "brand", "eye tracking", "neuromarketing"

Gender Differences in Implicit Contempt toward Blatant and Subtle Empowerment Ads featuring Muscular Woman

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JEL classification: M37, M31, J16, C91

Abstract

This research explores gender differences in implicit and explicit emotional responses, particularly contempt, toward empowerment-themed advertisements (ETAs) featuring muscular women. Such ads challenge traditional gender norms and aim to create social change. However, reactions to these ads remain underexplored, particularly the unconscious biases they elicit. This study builds on Social Dominance Theory to investigate how implicit emotional responses vary between men and women across different ad formats – subtle (visual-only) and blatant (visual + text) – and the influence of empowerment message perception. Two studies were conducted. Study 1 (N=67, mixed design) examined how gender moderates the effect of different ad empowerment formats on Implicit contempt. Study 2 (N=142, between design) extended this by exploring whether gender moderates the relationship between empowerment ad formats and implicit contempt, contingent on how the empowerment message is perceived (strength vs. weakness). Affectiva AI software analyzed facial expressions through participants personal webcams to detect implicit contempt decoded by specific facial action units as Lip Corner Puller and Dimpler on one side of the face, while self-reported scales measured explicit emotions. In Study 1, include mixed regression analysis for controlling the random intercept of the participants, gender, and study conditions as acceptable in this research era. We also controlled for feminine-masculine self-image. The gender by ad condition interaction was significant. Further analysis of the conditions separately for each gender and the genders separately for each condition showed that men exhibited higher implicit contempt for subtle ads, while women showed higher contempt for blatant ads. In Study 2, we employed Hayes' PROCESS macro (Model 3) for a triple interaction analysis, we controlled for potential confounding factors, including cognitive dissonance, ad credibility, and feminine-masculine self-image. Gender by ads' conditions by women's empowerment message perception was significant in predicting implicit contempt. Further exploration of the effects, consistent with our approach in Study 1 revealed that Women had a differential contempt response when faced with the blatant message, dependent on their message empowerment perception. When the message was perceived as the ad reinforcing women's strength women expressed higher implicit contempt in the subtle condition than in the blatant While this trend was the opposite when they perceived the ad as reinforcing women's weakness, they showed higher implicit contempt in the blatant condition compared to the subtle. This showed the contempt responses of women are complex

and dependent on their interpretation of the message. Men had a significant effect, only when the message was perceived as the ad reinforcing women's strength, where they showed the same pattern as shown in study 1, higher implicit contempt in the subtle condition compared to the blatant condition. In conclusion, this study reveals critical insights into the complexities surrounding implicit emotional responses to empowerment-themed advertisements (ETAs) that challenge traditional gender norms. While previous research has focused primarily on explicit self-reported responses, our findings highlight the significant role of implicit contempt. By integrating Social Dominance Theory with existing literature on ETAs, we have demonstrated that men exhibit higher levels of implicit contempt toward subtle empowerment messaging, reflecting their resistance to shifts in the established gender hierarchy. In contrast, women's implicit responses varied based on their interpretations of empowerment, indicating a more complex landscape of emotional response toward these advertisements. The discrepancy we found between explicit and implicit reactions emphasizes the need for a more comprehensive approach to assessing the effectiveness of empowerment advertising. Ultimately, our study underscores the importance of understanding both explicit and implicit responses in the realm of marketing, paving the way for more effective and inclusive advertising strategies.

Keywords: “blatant and subtle empowerment-themed ads”, “implicit contempt gender differences”

Visual Attention and Choice: An Analysis of the Relationship between Fixation and Purchase Decisions in the Context of Sustainability

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JEL classification: M31, Q56, D91, D87, C91

Abstract

The growing awareness of environmental and social challenges is increasing the demand for sustainable products. However, the discrepancy between consumers' stated attitudes and their actual behavior - known as the "attitude-behavior gap" - remains large. One of the main reasons for this discrepancy is the perception that sustainable products are more expensive, which is a barrier for many consumers despite their environmental awareness. Traditional methods of consumer behavior research, such as surveys and focus groups, are often susceptible to socially desirable responses and often fail to reveal the true, often unconscious, drivers of decision making. Traditional methods are not inherently flawed - they retain their value and applicability in modern research, albeit with limited precision. The biggest limitation lies with the respondents themselves. Participants often have imperfect memory, and the very act of interviewing can influence their behavior. In addition, answers on sensitive topics can be misinterpreted or deliberately distorted. A particular challenge for researchers is that they cannot reliably assess whether participants are answering truthfully and whether the research questions are designed to provide accurate findings. For these reasons, this study uses a combination of traditional and neuromarketing research methods. The aim of this research is to analyze the cognitive and affective processes that influence the perception and choice between conventional and sustainable products, with a focus on the influence of price. For this purpose, the multimodal behavioral research platform iMotions is used, which integrates eye-tracking and facial expression analysis technologies. In addition to the iMotions platform and neuromarketing methods, participants will complete a questionnaire to assess their attitudes towards sustainable products. This mixed-methods approach enables the measurement of both implicit reactions - beyond conscious control or rationalization - and explicit attitudes. The study is conducted in three phases in which participants are exposed to visual stimuli: (1) comparison of images of conventional and sustainable products without additional information, (2) comparison of the same images with additional information, and (3) comparison of products with information about product and price information. This stepwise presentation of information makes it possible to determine exactly when and how different product attributes, especially price, influence visual attention and emotional arousal in relation to sustainable and conventional alternatives. The study will be conducted with a sample of 30 consumers in a controlled environment. Visual

attention will be measured using eye-tracking technology, while emotional responses will be analyzed using facial expression analysis software. In addition, participants will complete a short questionnaire on product perception and purchase intention after each visual stimulus. The results of this study will provide deeper insights into the decision-making mechanisms behind the choice between conventional and sustainable products, including influential variables such as brand and price. By identifying key moments for decision making - such as when price is the deciding factor or when sustainability-related information elicits certain emotional responses - the study contributes to a better understanding of the barriers to sustainable consumption. The findings have implications for developing more effective marketing strategies, communicating the value of sustainable products and designing public policies aimed at bridging the gap between attitudes and behavior. In addition, the results are expected to stimulate future research that addresses the issues raised in this study and contribute to the further development of methodological approaches in consumer behavior research, particularly through the integration of neuromarketing tools in the context of sustainable consumption. While neuromarketing methods provide valuable insights into unconscious decision-making processes, limitations such as the laboratory setting and small sample size may affect the generalizability of the results. Future research could conduct longitudinal studies or investigate the influence of actual purchasing decisions in real-world settings (e.g., online retail).

Keywords: "sustainable product purchase decision-making", "attitude-behaviour gap"

When Sadness Sparks Support: Female Role Models and Male Emotional-Motivational Responses to Women in Tech Entrepreneurship

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JEL classification: L26, J16, C91, G41

Abstract

Female underrepresentation in technological entrepreneurship continues despite targeted interventions such as exposure to successful women role models (Kovaleva et al., 2023; Byrne, Fattoum, & Garcia, 2019). However, implicit reactions - especially among male observers - have received little empirical attention. Gender bias literature suggests that men tend to have more negative responses toward women in masculine roles than women (Heilman & Okimoto, 2007; Ahl, 2006). Specifically, sadness is a negative emotion often associated with failure or loss of an unattainable goal (Lench et al., 2016), and disgust is a safeguarding emotion against a menacing entity and a response to a threat over valuable resources (Schnall, 2017). These emotions are particularly relevant in contexts where women challenge masculine norms, such as in the tech entrepreneurship domain. Gender bias is known to discourage positive behaviors toward women (Friedmann & Efrat-Treister, 2023) thus we would expect these negative emotions would lead for negative outcomes for women-led ventures (implicitly, more activation in avoidance region in the right prefrontal brain) and less self-reported investment. According to Gender Role Theory, women who enter traditionally male-dominated domains - such as technological entrepreneurship - violate prescriptive gender norms that define how women are "supposed" to behave (Eagly & Karau, 2002). Such norm violations often trigger social and emotional penalties, particularly among men, who tend to endorse traditional gender roles more strongly (Rudman & Glick, 2001). Cognitive dissonance theory further suggests that exposure to counter-stereotypical women may evoke internal conflict or discomfort, especially in contexts where masculine traits (e.g., assertiveness, competitiveness) are expected (Heilman & Okimoto, 2007). This discomfort can manifest as negative emotions such as disgust or sadness, which function as implicit indicators of social threat or value conflict. Building on this theoretical foundation, the present study examines whether exposure to female entrepreneurs paired with female role models elicits these negative implicit emotions - and whether such emotions, as predicted by gender bias literature, reduce motivational tendencies to support or invest in these ventures. We conducted a within-between experimental study with 180 participants who participated in an EEG and FEA study. Participants were exposed to crowdfunding pages representing technological ventures led by either male or female

entrepreneurs. Participants were randomly assigned to one of three role model conditions (female, male, or control) via vertical banner images. Emotional responses were measured both explicitly (via self-report) and implicitly through Affectiva AI, focusing on disgust and sadness. Motivation to invest was measured both explicitly (self-reported investment) and implicitly through Frontal Alpha Asymmetry (FAA) using EEG, where higher FAA reflects approach orientation and lower FAA reflects avoidance (Schmidt & Trainor, 2001; Leeuwis et al., 2021). Findings reveal that among men, female-led ventures evoked significantly higher implicit sadness - especially when they exposed to a female role model - compared to male-led ventures. This negative emotion was associated with reduced motivation to invest, both implicitly (FAA) and explicitly. Among women, emotional reactions were less consistent and largely unaffected by the role model manipulation. Mediation analyses confirmed that implicit sadness mediated the link between the gender of the venture leader and higher reported investment as well as higher approach activation in right prefrontal regions, among men. Contrary to initial assumptions that sadness would result in withdrawal and less investment, this pattern may reflect a compassion-driven response, where emotional discomfort toward perceived inequality or vulnerability motivates supportive behavior. A significant moderated indirect effect was found for the path: Entrepreneur gender → implicit sadness → investment (self-report), with the effect being stronger among men than women. For men: indirect effect= 4.085 se= 3.211 CI95 [0.034, 13.665], p= 0.047. For women: indirect effect= -1.522 se=1.830 CI95 [-7.952, 0.455], p= 0.140. The difference between the paths were significant: difference in indirect effects=-5.607 se=3.680 CI95 [-15.642, 0.398], p=0.032. Another significant moderated indirect effect was found for the path: Entrepreneur gender → implicit sadness → FAA, with the effect being stronger among men than women. For men: indirect effect= 0.071 se= 0.055 CI95 [0.001, 0.234], p= 0.044. For women: indirect effect= -0.009 se=0.021 CI95 [-.090, .015], p= 0.335. The difference between the paths were significant: difference in indirect effects= -0.079 se= 0.058 CI95 [-0.247, -0.001], p=0.048. No significant mediation effects were found for implicit disgust, although the observed trends were consistent with theoretical predictions. Furthermore, explicit sadness did not show the same pattern of results as implicit sadness, pointing to the divergence between implicit and explicit emotions in socially sensitive gender-related topics. This study reveals that implicit emotional reactions to gendered role models are more complex than previously assumed. Rather than deterring support, implicit sadness - especially among men - may enhance motivation to invest, potentially due to empathetic or moral considerations. These insights call for more emotionally attuned design of role model interventions, with considering implicit measurement of emotions to reveal complex phenomenon.

Keywords: "implicit emotional responses to gendered role models"

Who Do We Trust? A Biometric Method to Community vs. Platform-Driven Misinformation Warnings

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JEL classification: M37, J24, D91, L96, O33, C91

Abstract

Social media platforms use various warning messages to curb "fake news," but their effects on trust and engagement are unclear. These messages manifest in two different forms: platform-driven moderation and community-driven moderation. Platform-driven moderation operates as the authoritative voice of the platform, determining what content will be flagged or left unmarked. Conversely, community-driven moderation is based on user input and discourse, allowing the platform's community to audit and share concerns about content credibility. While these warning messages are designed to alter user behavior and shift trust away from flagged content (Seo et al., 2019), their effects, particularly on users' conscious and subconscious responses, remain largely unexplored. Thus, combining methods would offer a more complete and less biased view of real-time engagement and emotional reactions, capturing subconscious responses that complement self-reported data (Bačić and Gilstrap, 2023). To address this gap, and based on existing literature, we developed a series of hypotheses centered on expectations of a more positive impact of community-driven (compared to platform-based) misinformation moderation on trust, visual attention, emotional engagement, valence, and arousal (Silic et al., 2017; Seering, 2020; Simoiu et al., 2019). The study was conducted using 39 participants (28% male, 64% female, 8% non-binary), who ranged in age from 19 to 23 years, with the majority (43.6%) being 21 years old. This study used a within-subject experimental design; all participants were exposed to three misinformation moderation conditions (no alert, platform-driven message, community-driven message) using two content topics (healthcare and politics) in a counterbalanced order. Data types collected include eye-tracking (for visual attention – revisits, dwell time, fixation duration, and rate), galvanic skin response (GSR peaks per minute), facial expression analysis (FEA) (for engagement time %), and self-reported engagement (willingness to like, comment, share, report) and trust perceptions (in content and content author). All data was collected using the iMotions (v.10) platform and biometric equipment and respective software: Smart Eye AI-X (eye tracking), iMotions AFFDEX (FEA), and Shimmer 3 EDA/GSR (GSR).

A demographic survey was used to account for pre-existing biases, including social media habits and political affiliation, for post-hoc analysis. Our analysis of conscious survey responses indicates that participants found misinformation warnings from community moderation (M=4.692, SD=1.573) more trustworthy (p <0.001) than those from platforms (M=3.718, S=1.562) and that community messages (M = 4.718, SD = 1.337) were perceived to influence content accuracy more than platform messages (M = 4.231, SD = 1.53) with weak support (p=0.086). There was no difference in engagement (likelihood of liking, commenting, sharing, or reporting of the content). For visual attention, our data indicates that community-driven moderation was more effective at capturing users' visual attention and diverting it away from the flagged content compared to platform-based moderation (Dwell time: M=49.32% vs. M=23.4%, p<0.001; Revisit count: M=1.43 vs. M=1.07, p<0.001; Fixation Duration: M=377.43 vs. M=326.67, p<0.001; Fixation count per sec: M=1.23 vs. M=0.67, p<0.001). In terms of facial expression analysis, platform-driven moderation elicited greater emotional engagement from users than community-driven moderation (M=13.42% vs M=9.95%), driven mainly by facial expression associated with negative emotions. Lastly, platform-driven warning (M=3.39) elicited slightly higher arousal rates (Peaks per minute) on average than the community (M=2.85) condition (weak support). Our findings reveal that misinformation moderation intervention types do impact users' trust, visual attention, and physiological responses, while underscoring a critical need to be skeptical of moderation's unintended impacts, such as censorship and the erosion of trust in platforms. Our research contributes to the conversation of how misinformation moderation should focus on equipping users to be skeptical and autonomously discern content for truth or falsehoods. We find support that transparency and crowd-sourced warning messages (community-driven moderation) encourage more autonomous decision-making and resilient user behavior against misinformation.

Keywords: "misinformation moderation", "trust on social media"

It's all about the Context: Congruence between Implicit and Explicit Responses to Expected vs. Unexpected Ads featuring Males and Females

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Abstract

Expected ads are advertisements that feature idealized models – typically showcasing unrealistic standards of beauty that audiences have come to anticipate as the norm in advertising (Pounders, 2018). In contrast, unexpected ads are more recent and less traditional, these are advertisements that break away from conventional norms or audience expectations – often by featuring models that challenge traditional beauty standards, subverting typical advertising conventions (Bue & Harrison, 2019). Most advertising research have used explicit self-report to assesses consumer responses to both types of ads (Friedmann & Brueller, 2018) as understanding responses are crucial for impacting decision-making and behavior (Khatoon & Rehman, 2021). Responses to ads in this context, can be measured in two wats: 1) explicitly (using Self-reported attention, engagement, emotions), explicit responses require conscious awareness, influenced by cultural norms and expectations (Gross & John, 2003). 2) Implicitly (using Facial expression analyses of attention, engagement, emotions). Implicit responses are triggered automatically without conscious awareness (Greenwald & Krieger, 2006). These authentic responses assumed to bypass social desirability bias (Friedmann et al., 2024). The correlation between these responses is debated. Some scholars argue that they are generally aligned (Baldo et al., 2022; He et al., 2021), while others suggest they often diverge (Friedmann et al., 2024; Steiner et al., 2018). However, it is not clear in which specific situations this misalignment occurs (Morris & Kurdi, 2023). Thus, the research goal is identifying the contexts in which implicit and explicit responses tend to diverge or align. For this, we ran a mini meta-analysis of five studies using a multi- Level SEM (Random intercept per study and emotion) with "Metafor" R package to model both fixed effects and random effects. We found that implicit and explicit responses are generally not correlated but the context matters. Supporting the social role theory we found that expected ads generated positive and significant correlation. (rexpected

ads=0.064, SE=0.02, p=0.003; runexpected ads =-0.018, SE=0.03, p=0.56). Aligned with sociological literature of unequal power structure (Brown et al., 2015; Gaunt, 2013), we found less correlation when viewing female models, especially when exposed to the unexpected vs. expected ads (bad type x model gender=- 0.1081, p=0.01). Furthermore, we found gender differences in the unexpected ad condition, where women were less correlated than men (bad type x gender =- 0.0949, p=0.03)., supporting women's tendency to social desirability bias. Moreover, we challenge assumptions about women's expressiveness as we men showed greater implicit emotional expressiveness (p=0.006). We also found no evidence for a distinct gender bias from men toward female models. We have three contributions: (1) we advance the understanding of implicit–explicit response dynamics. Our study provides a resolution to a long-lasting debate in the literature by demonstrating that implicit and explicit responses are not uniformly aligned. Instead, their alignment is highly context-dependent – especially relevant when examining expected ads. (2) we extend the Social Role Theory to implicit responses beyond explicit as we found expected ads elicited greater alignment than unexpected ads. This divergence was especially pronounced among women when viewing unexpected ads than expected, suggesting that social desirability pressures may more strongly constrain women's responses in norm-violating contexts. While both men and women exhibited lower alignment when viewing female models in unexpected ads, men did not display a distinct gender bias. This pattern implies that the divergence reflects internalized societal expectations for both genders rather than direct prejudice of men. (3) we reframe gendered assumptions about emotional expressiveness, as men exhibited stronger implicit expressiveness than women. This finding complicates traditional gender stereotypes and contributes to theories of gender and emotional responses. This research highlights the need for marketers, educators, activists, and policymakers to use implicit measures in socially sensitive campaigns, as traditional methods like surveys may miss hidden misalignments in responses. Notably, findings on men's higher implicit responsiveness could help reduce stigma around women's emotional expression.

Keywords: "expected and expected ads", "implicit vs. explicit responses"

Generalizable Neuroforecasting of Aggregate Consumer Behavior

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JEL classification: M31, C91, D87, C88

Abstract

Forecasting aggregate behavior is essential in economics, marketing, and public policy. Traditional models rely on behavioral data from representative samples, assuming individual-level behavior generalizes accurately to larger populations. Research on neuroforecasting has demonstrated that in some contexts, neural responses - especially those reflecting early affective processes - can forecast aggregate choice better than self-report measures or choice itself. However, questions remain regarding the mechanisms driving this predictive power and the generalizability of neural signals across varied populations. This study investigates how early neural responses improve forecasting accuracy of aggregate consumer behavior. Building upon the Affect Integration Motivation (AIM) framework, which divides decision-making into early affective, integrative, and motivational stages, we propose that early activity associated with early affective process (e.g., nucleus accumbens, NAcc) provide a more generalizable index of shared preference than downstream deliberative processes (e.g., medial prefrontal cortex, MPFC) or observed behavior. Using two fMRI experiments, we evaluate how neural versus behavioral data forecast aggregate preferences in demographically varied internet markets. We further examine how forecasting accuracy changes with sample representativeness and size, offering theoretical and practical insights into when and why neural data outperform traditional measures. Two independent studies compared neural and behavioral forecasts. In Experiment 1, 37 fMRI participants and 2,956 internet users evaluated 36 crowdfunding campaigns. Lab participants decided whether to fund each campaign; online users made paired preference choices. In Experiment 2, 40 fMRI participants and 992 internet users made decisions regarding viewing preferences for 32 YouTube videos. Analyses explored how sample representativeness to the market impacted forecasts based on behavioral and neural predictors. We further examined the minimum sample size for stable neural forecasts. In both experiments, NAcc activity significantly predicted aggregate market preferences (Exp 1: p < .004; Exp 2: p < .001), outperforming behavioral forecasts. In Experiment 1, lab behavior was only marginally associated with internet preferences ($p = .062$). In Experiment 2, lab behavior failed to predict market behavior ($p = .661$). In contrast, neural forecasts remained significant in both. Behavioral forecast accuracy declined with decreasing demographic match ($t = –2.57$, $p = .012$). Neural forecasts did not vary with representativeness ($t = –0.587$, $p = .558$), suggesting broader generalizability. Interclass correlation revealed significantly shared NAcc responses (ICC = .441, $p = .004$ in Exp 1; ICC = .408, $p = .009$ in Exp 2), while MPFC responses were

not significantly correlated. These findings support the hypothesis that affective neural responses are more broadly shared than downstream cognitive processes. Sample size analyses showed that neuroforecasting stabilized with as few as 25–30 participants. These findings highlight that early neural activity, particularly in affective circuits, can provide more accurate forecasts of aggregate behavior than behavioral choices, especially when samples lack demographic representativeness. By integrating the AIM framework with models of random utility, we suggest that generalizable neural value signals underpin forecasting success, while idiosyncratic deliberative responses and behaviors introduce noise. While behavior reflects individual preferences, affective neural signals offer shared insights into collective choice. Importantly, robust forecasts were achieved with relatively small samples, addressing concerns over fMRI cost and feasibility. While behavior reflects individual preferences, affective neural signals offer shared insights into collective choice. Overall, this work demonstrates the utility of neuroforecasting in identifying the shared affective components of choice. Neural signals, particularly those indexing early emotional responses, may reveal generalizable drivers of market behavior and forecast aggregate outcomes - even where behavioral data cannot.

Keywords: "neuroforecasting", "decision neuroscience"

Annotations, Images, and Attention: Visual Design Choices that Change Climate Perceptions

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JEL classification: Q54, D87, C91, D91

Abstract

Aim Despite the exponential growth in accessible and scientifically credible climate change data, public engagement and perceived urgency regarding the climate crisis remain inconsistent and often insufficient. Prior studies have emphasized the communicative power of visualizations in shaping risk perception and fostering emotional engagement (Harold et al., 2016; Schneider & Nocke, 2008; Mahyar, 2024). However, less is known about how specific design elements within visualizations influence user attention and affective response. This study aims to bridge that gap by empirically investigating how annotated insights and accompanying imagery alter viewers' visual engagement and their perceived urgency about climate change. Grounded in Gestalt visual principles and cognitive load theory, and extending work by Courtney (2019) and Gulhan et al. (2025), we ask: (R1) how different placements of a key insight affect visual attention and perceived urgency, and (R2) whether the presence of an adjacent image enhances/detracts from urgency and engagement. Method We employed a within-subjects experimental design using biometric eye-tracking (SmartEye AI-X, 60Hz) with iMotions software to measure gaze behavior, dwell time, and fixation metrics across six visualization conditions. A total of 33 undergraduate participants (aged 18–23) viewed visualizations representing climate metrics (e.g., global sea levels), with variations in insight placement (3 experimental conditions: annotation, subtitle, footnote) and image presence (2 experimental conditions, with and without image). Each stimulus was displayed for 30 seconds, followed by brief survey measures (3 questions per stimuli) capturing perceived urgency and data importance. Areas of Interest (AOIs) were predefined to include the data points, title, and insight location, allowing for precise analysis of visual attention patterns. Pairwise t-tests were applied to compare fixation count, duration, dwell percentages, and survey responses across conditions. Results The most significant finding emerged for R1: placing the insight as a footnote led to a statistically significant increase in participants' perceived urgency regarding climate change, compared to the subtitle condition (M=8.22 vs. M=7.88, p < .05). This counterintuitive outcome is supported by eye-tracking metrics showing that footnote placement encourages viewers to spend more time on the actual data points (M=16.97% dwell time), compared to when the insight appears as a subtitle (M=12.28%). Conversely, when the insight is placed as an annotation, viewers direct more visual attention to the insight itself (M=29.10% dwell on annotation vs. 16.23% on footnote),

drawing focus away from the AOI containing the data. These results suggest that footnote placement may subtly support comprehension without overshadowing the core data, allowing for more sustained cognitive processing of environmental trends. For R2, the introduction of an image adjacent to the visualization reduced visual attention on the data. Both fixation count and dwell percentage on the data AOI were significantly lower in the image-present condition (Fixation Count: M=70.3 vs. M=84; Dwell %: M=69.0 vs. M=97.7; both p < .01). However, survey responses showed no statistically significant increase in perceived urgency or emotional connection when an image was present (p > .10 across measures), partially contradicting the hypothesis that imagery would enhance affective impact. Conclusion This study demonstrates that minor alterations in visualization design can meaningfully influence how viewers process and interpret climate data. Notably, placing an insight as a footnote can increase perceived urgency, potentially because this subtle placement allows viewers to maintain focus on the data itself, rather than being distracted by prominently placed textual cues. These findings raise important implications for policymakers, media outlets, and visualization designers seeking to balance narrative clarity with data integrity. Additionally, the reduction in visual attention caused by adjacent imagery suggests a trade-off between aesthetic appeal and analytical engagement: while images may draw initial attention, they may dilute cognitive focus on critical data features. Given the high stakes of climate communication, we recommend deliberate, evidence-based placement of narrative insights to maximize impact. Future research should expand beyond GenZ samples.

Keywords: data visualization design, eye-tracking

Visual and Physiological Insights into Human Deepfake Detection: An Eye-Tracking and GSR Study

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Abstract

Deepfakes have been prevalent in digital media for at least over 5 years, but their effectiveness at deceiving the audience has not been fully researched. Researchers are well aware that deepfakes mislead a percentage of viewers, but it is still unclear what makes some deepfakes more realistic and other comically obvious. Both the quality and manipulated features of deepfakes have been described as key indicators to expose deepfake media's authenticity. Regarding manipulated features, extensive studies have documented detection rates of specific features, but have led to conflicting results. Furthermore, detection with differentiating deepfake quality has yet to be tested for significance. This study analyzes which variables lead deepfakes to mislead the audiences' to believe them as real. Before developing our experiment, we crafted 4 questions that aimed to guide our research: RQ1: How well are people able to detect a deepfake? RQ2: How fast are people able to detect a deepfake? RQ3: What are the features of deepfake media that expose its inauthenticity? RQ4: Is there a biometric response when a subject has detected deepfake content? Using the iMotions software, paired with a 60Hz eye-tracker and GSR device, 32 participants viewed a randomized series of 10 videos. The eye-tracking metrics collected were average fixation count, average fixation per second, average time to first fixation, and average dwell count. The GSR metrics collected were peak occurrence and average peak per second. The study consisted of a demographic survey, two experimental sections, and a debrief. In Section 1, participants viewed 4 videos (low quality deepfake, medium quality deepfake, high quality deepfake, and one authentic) and answered whether the video used deepfake technology, their confidence level, and if they have seen the video before. Section 2 included 6 videos (2 facial deepfakes, 2 audio deepfakes, and 2 authentic). Participants were told to skip ahead if they detected a deepfake and answered whether the video used deepfake technology, the feature that indicates its inauthenticity, and if they have seen the video before. The debrief asked the level of concern of deepfakes, as well as demonstrating which videos were

deepfakes for misinformation purposes. For Experiment 1, the medium quality deepfake led to the highest detection accuracy, however, nearly a quarter of participants had noted seeing the video before. The high quality deepfake tied for the lowest detection accuracy (87.50%), supporting its categorization as high quality. The authentic video had a detection rate of 87.5% and low quality deepfake achieved 90.62%. For the 3 other videos outside of the medium quality deepfake, the average rate of previous viewing was under 10%, determined as insignificant. Regarding the eye-tracking metrics collected, there was not substantial significance identified between the varying quality videos and the authentic with the average dwell count being the only metric to demonstrate significance. In the GSR data, no significance was found between any of the quality deepfakes and the authentic baseline. In Experiment 2, the audio deepfake detection accuracy varied by a margin of 53.13% and facial deepfakes varied by a margin of 15.63%, with both authentic videos achieving a 96.80% detection accuracy. On average, facial deepfakes had a lower detection accuracy than audio deepfakes. Nevertheless, the varying quality of the audio deepfakes utilized could be the cause. Regarding eye-tracking metrics, there was significance identified between facial deepfakes and audio deepfakes, however, no significance was found between authentic videos and varying feature deepfakes. Regarding GSR metrics, no significance was determined between any of the deepfake or authentic videos. This study demonstrates that 18-24 year old college educated individuals are able to detect deepfakes with varying levels of accuracy. The detection rates between a high quality deepfake and a low quality deepfake do vary, but not significantly. Therefore, we are unable to conclude that the quality of a deepfake has any impact on human detection accuracy. Audio deepfakes varied significantly from facial deepfakes and audio deepfakes varied significantly from each other, but facial deepfakes did not. It can be concluded that facial deepfakes are a larger threat than audio, showcased by their lower detection accuracy. Audio deepfakes may possibly be harder to create due to the more complex manipulation involved with the generation process. Biometric data showcases that fixations serve as a significant indicator for how humans interact with deepfake content compared to authentic media, however, GSR data does not.

Keywords: deepfakes, deepfake detection, eye tracking, galvanic skin response

Pings, Placement and Performance: Rethinking Workplace Notifications Using Biometrics

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Abstract

This study investigates the cognitive and physiological effects of digital notifications in simulated office environments, focusing on how modality (visual, auditory) and placement (e.g., bottom-right, top-left) influence user attention, task performance, and emotional arousal. As tools like Microsoft Teams and Slack become pervasive, users face increasingly frequent and often disruptive alerts that may compromise productivity and well-being. Prior research shows that interruptions degrade cognitive performance and elevate stress, especially when notifications violate expectations or require rapid modality switching. However, limited research has systematically examined how location and modality together shape visual attention and recall accuracy. Drawing on prior work on attention disruption, visual salience, and cognitive load (Duchowski, 2007; Iqbal & Horvitz, 2007; Bačić, 2018), this study uses biometric data (eye-tracking and galvanic skin response) to evaluate (RQ1) how notifications affect task accuracy, (RQ2) how notification sound (chime), and (RQ3) how unexpected placements impact influences performance, visual attention and arousal. A within-subjects experimental design was used with 34 undergraduate participants (ages 18–24), each completing six structured email-response tasks involving inventory and pricing synthesis under time constraints. Each task introduced a notification variable: no notification (control), or a Microsoft Teams-style alert in one of four screen positions without sound (top-left, top-right, bottom-left, bottom-right), and one bottom-right alert with a chime. Eye movements were recorded using the SmartEye AI-X (0.5° accuracy, 60Hz), and skin conductance was measured with the Shimmer3 GSR+ unit. The study was administered via the iMotions 10.1 platform. Task accuracy was evaluated through post-task recall quizzes, and biometric data (fixation count, fixation duration, revisit count, dwell time, and GSR peaks per minute) were compared across conditions using paired-sample t-tests. Findings revealed the effects of notification presence and placement, particularly in the bottom-right corner with sound - the default Microsoft Teams configuration - compared to the no-notification baseline (p < .001). Additionally (RQ2), the presence of sound alone significantly boosted accuracy compared to silent conditions (p = .009), suggesting that auditory cues may enhance memory encoding by reinforcing alert salience. Regarding visual attention (RQ3), the bottom-

left notification location yielded significantly higher fixation counts than the bottom-right-with-sound baseline ($p = .039$), indicating that alerts placed in unexpected areas draw greater visual attention. However, top-left notifications - also non-standard - elicited significantly shorter fixation durations compared to bottom-right notifications ($p = .018$), suggesting that while these alerts captured attention, they were quickly dismissed (lower dwell time and revisits), potentially due to their perceived irrelevance or visual novelty. Fixation duration analyses revealed marginal or no significant effects for other positions. Contrary to expectations, no significant differences were found in GSR levels across conditions, indicating that variations in notification placement or modality did not elicit measurable physiological arousal under the task conditions. Similarly, revisit count and dwell time did not vary significantly by location, although marginal trends suggested possible learning effects. This study provides empirical evidence that notification placement and auditory characteristics influence user performance and visual attention, particularly fixation count and duration during cognitively demanding tasks. Unexpected placements like the bottom-left corner attract more initial attention and glance revisits but may not support sustained processing, while standard placements with sound (e.g., bottom-right with chime) enhance recall performance. These findings challenge the view that notifications are inherently disruptive, suggesting that specific configurations may aid task execution by reinforcing key cues without overwhelming cognitive resources. Notably, the bottom left draws more frequent glances, while the top left may prompt faster, more reflexive responses. For workplaces prioritizing focus and productivity, keeping notifications in the bottom right - the default for many systems - appears optimal.

Keywords: "digital notifications", "work disruption", "visual attention", "task performance", "eye-tracking", "galvanic skin response"

Mapping the Attention-Conversion Funnel from Exposure to Memory of Instagram In-Feed Advertising

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Abstract

Native in-feed advertising now dominates mobile social platforms, yet little is known about how exposures lasting only a few hundred milliseconds are translated into persuasive impact. Industry metrics such as impressions, reach, click-throughs, and likes capture behavior that occurs after a sequence of covert perceptual and mnemonic events. To illuminate these hidden operations, we introduce and empirically test the Attention-Conversion Funnel consisting of (1) Exposure, (2) Attention Capture, (3) Engagement, and (4) Impact and examine whether sponsored Instagram posts progress through these stages as efficiently as visually comparable organic posts. We used a mixed method approach combining eye tracking followed by a questionnaire. Specifically, a within subject's design exposed each participant (N = 152; (46.1% female, 53.9% male, mean age = 25.10 years, SD = 6.24) to an Instagram mock up feed of 29 uniformly formatted posts (8 sponsored, 21 organic). The post order was randomized to eliminate order effects. Participants scrolled autonomously for a maximum 110 s, close to the 164 s average Instagram session yet short enough to match fast scroll norms. This semi constrained procedure preserves agency while standardizing exposure length across individuals. Stimuli comprised real advertisements active during data collection, selected to span common Instagram themes (fashion, travel, food, media, music, fitness). Gaze was recorded at 60 Hz with a Smart Eye AI-X system and processed in iMotions. Funnel metrics were computed per post as defined above. Funnel stages were operationalized for every post: Exposure (onscreen), Attention Capture (time-to-first-fixation), Engagement (dwell-time ≥ global mean), and Impact (immediate recall). Stage one, Exposure, mirrors impression thereby answering how many participants scrolled to the post. In other words, the amount of participants the post was actually visible to. Because this creates the necessary opportunity for processing; without reach, no downstream effects can arise. In line with this, stage two, Attention Capture, answers how many participants showed immediate attention which was measured via short time (under average) TTFF to the post from onset to the screen (being visible). In other words, the immediate noticing, so the participant fixated the post rapidly after it entered view. Stage three, Engagement, is defined as the number of participants who had an above-average dwell time per post. So, the participant's dwell time on the post

exceeds the above-average dwell across all 29 posts. Stage four, Impact, is defined as the memory recall of the post, and for sponsored posts the brand or product advertised. Demonstrates successful memory encoding, linking attention to eventual behavior. Measured by an aided recall (Likert scale with amount of ads recalled seeing) and an unaided recall (number of ads (specifically the brand or product able to name). Exposure was uniformly high (sponsored 95.4 %, organic 96.1 %; p = .47). Attention Capture disadvantaged sponsored content: average TTFF was 241 ms versus 223 ms and the odds of meeting the rapid-capture criterion were 29 % lower (p = .009). Engagement followed a similar pattern: sponsored posts were 38 % less likely to attract above-mean dwell time (p = .021). Once Engagement occurred, however, Impact converged. 82.9 % of engaged viewers recognized at least one sponsored brand compared with 84.6 % for organic posts, and unaided recall was likewise equivalent. Our findings nuance ad-avoidance debates and provide granular benchmarks for campaign optimization under genuine mobile browsing speeds. Crucially, the funnel adds a neuroscientific layer to effectiveness measurement: it exposes covert stages of visual attention and pre-decisional memory that standard metrics such as impressions, reach, click-throughs, or “likes” inherently miss, thus offering a fuller picture of how ads work before any behavioral trace appears. The current analysis opens up avenues for further research as there may be temporal stages of ad memory forming. For example, does a quick glance enable the same, less or qual (detailed) brand recall as a sustained gaze.

Keywords: "attention-memory funnel of native Instagram ads", "eye-tracking of ads within scrollable mobile feeds"

I've seen it on the Radio: Visual Transfer Effects in Cross-Media Advertising

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JEL classification: M31, M37, D87, C91, D91

Abstract

When TV and radio campaigns for a brand share consistent messaging, the radio version benefits from enhanced perception due to visual recall (Edell & Keller, 1989). High-imagery radio ads can engage visual cognitive resources, competing with concurrent visual tasks for attention (Bolls, 2002). This implies that listeners mentally visualize the content of radio ads, despite their auditory nature, drawing upon the brain's capacity for mental imagery. Strategic media sequencing - where TV ads precede radio - could thereby create a visal transfer effect, which boosts brand recall, message processing, and engagement. Neuromarketing evidence indicates that advertisements with strong visual or auditory components activate brain regions involved in memory, emotion, and decision-making (Beard et al., 2024; Chan et al., 2024; Venkatraman et al., 2015). These findings suggest that the visual transfer effect leverages shared neural circuits. Beta-band power (13–25 Hz) is associated with visual imagery and high-level visual processing (Kilmarx et al., 2024; Villena-González et al., 2018), supporting the idea that prior visual exposure enhances encoding and recall of multimodal brand representations. Additionally, Russo et al. (2020) showed that prior exposure to a radio ad increased visual attention to the brand, engagement and approach motivation - measured by Frontal Alpha Asymmetry (Davidson, 2004) - when the same ad was later seen on TV. This cross-modal effect demonstrates that prior media exposure changes how the brain processes subsequent advertising, although it does not confirm the visual activation during auditory processing. We aim to validate the visual transfer effect on a neurophysiological level by measuring activity in the occipital lobe (linked to visual processing) and frontal alpha asymmetry (FAA) in a between-subject design. We hypothesized that prior visual exposure to a TV commercial would lead to increased occipital activation during subsequent auditory processing of the same brand's radio ad and that successful visual transfer would correlate with more positive FAA, reflecting approach motivation toward the brand. 40 Dutch and right-handed participants (25 Female, 15 Male, Age M = 36.6, SD = 15.6) were recruited to the Unravel lab. Participants first watched 21 TV commercials, and then listened to 20 radio commercials. In the visual transfer condition (n=20), participants watched TV ads of the same brands later featured in the radio block. The control group (n=20) viewed unrelated TV ads. Both groups listened to the same radio commercials, featuring 14 brands (7 FMCG, 7 non-FMCG). Other brands in the TV block were similar in size and awareness but distinct in product category. Participants rated how easy it was to imagine each product (1 = very hard; 5 = very easy), capturing an explicit measure of the visual transfer effect. EEG was recorded using the Enobio 8 system at F3, F4, C3, Cz, C4, P3, P4, and Oz electrodes. Data were processed using iMotions 10, calculating beta power (13–25 Hz) at Oz and frontal alpha asymmetry (8–12 Hz at F3, F4) as markers for mental imagery and

motivational direction, respectively. Paired t-tests or Wilcoxon Signed-Rank tests (based on Shapiro-Wilk normality results) were used to compare conditions. Explicit ratings showed a trend toward greater ease in imagining the product in the visual transfer group (M = 3.718) than the control group (M = 3.557), particularly for FMCG ads (Mtransfer = 3.857, Mcontrol = 3.636), though this did not reach significance (V (13) = 23.5, p = .074). EEG analysis revealed significantly higher beta power in Oz for the visual transfer group (M = -0.385) than the control group (M = -0.699), indicating increased mental imagery (t (13) = -2.482, p = .028). FAA was significantly lower (indicating less approach motivation) in the visual transfer condition (M = -0.125) than the control (M = -0.025), (t (13) = 6.862, p < .001). This study is the first to demonstrate a visual transfer effect at the neurophysiological level. While prior research has only shown effects on explicit recall and perception, our findings confirm that visual exposure through TV advertising can reactivate occipital regions during subsequent auditory processing, and is associated with more favorable affective responses. These results support a strategic combination of TV and radio campaigns to enhance brand impact via cross-modal memory activation.

Keywords: "cross-media effects", "visual transfer"

Latent Dimensions in Neural Representations Predict Choice Context Effects

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Abstract

Every decision we make in life requires us to compare between choice options that each has multiple attributes. Understanding multi-attribute choice behavior has been a major challenge in economics and psychology, with numerous models and theories developed over the years. This challenge further deepens as researchers do not have access to the entire set of attributes that people represent in their minds for the choice options in question. Furthermore, it is well-known that choices are influenced not only by the attributes of each individual option, but also by the interaction with the attributes of other available options, a phenomenon known as choice context effects. One of the most well-known choice context effects is the decoy effect, which has been studied extensively over the past four decades and explained by various computational models. When studying choice context effects, researchers usually face two interacted problems. First, they try to understand the interactions between available choice options, their attributes, and their effect on participants' choices. Second, they cannot describe the full attribute space of each multi-attribute option since it potentially has multiple latent attributes that cannot be explicitly described. For example, a coffee cup could be described only by its volume size and price, but also has sensory attributes such as taste, temperature, and color. The inaccessibility to these latent attributes leads researchers to describe the choice options using only explicit and numeric attributes in a two-dimensional attribute space such as a product's price and quality. Accordingly, almost all theories and models developed require the options to have two numerical attributes in order to explain the decoy effects. Hence, this two-dimensional view of choice options confines current research of the decoy effect. Current theories neglect important aspects of human perception such as object representations and categorization, which are relevant for representing every object, whether it is in a choice scenario or not. In the current study, instead of relying on the researchers' traditional two-dimensional view, we propose to rely on the decision-makers' view. To do so, we estimate the choice options' representations as they are represented in the human brain in a data-driven way, with fewer assumptions regarding the structure of the underlying attribute space. We propose that by using neural representations we could gain access to both the well-studied explicit two-dimensional attribute space, and to other latent attributes in the high-dimensional neural space, thus explaining choice context effects better. To test this, we first estimated the decoy context effects in a behavioral sample,

where participants performed a choice task between two (binary group) or three (trinary group) lottery options, described each by a probability to win an amount of money (e.g., 40% of winning $20, otherwise zero). The decoy effects were calculated as the difference in the propensity of choosing the target option between the two groups. Then, to estimate the neural representations of each lottery, we recruited two additional independent samples in a preregistered design. These participants completed a functional magnetic resonance imaging (fMRI) scan while viewing individual lottery stimuli one by one without the context of multi-alternative choice. We then extracted participants' high-dimensional neural representations for each lottery and calculated the similarity between all lotteries in the neural representation space. Based only on the neural representational similarity of the individual lotteries, we successfully predicted the magnitude of decoy effects as measured from the behavioral sample. We show that both our out-of-sample predictions and data-fitting procedures surpass the performance of models relying on the lotteries' traditional two-dimensional representations (amount and probability). Moreover, we show that the neural representations that predict the choice context effects encode latent dimensions which go beyond the two-dimensional attribute space. Finally, we estimated the number of dimensions encoded in each brain region. In general, our goal is to provide a method which could be generalized to any high-dimensional choice option by incorporating concepts from object representations and representational geometry with high-dimensional neural representations into models of decision-making.

Keywords: "fMRI", "choice context effects"

Art 2.0: How Fear of Missing out drives Consumers' NFT Artwork Investments

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Abstract

This study explores how fear-of-missing-out (FOMO) appeals influence consumer investment intentions in NFT artwork. Drawing on blockchain's impact on digital ownership, NFTs provide verifiable proofs of authenticity and ownership, reshaping digital art markets through scarcity and exclusivity. Theoretical Background FOMO appeals have emerged as an effective means of communication in digital environments, largely fueled by the real-time, emotionally charged nature of social media platforms (Kapoor et al., 2022). They trigger a psychological urgency to act, rooted in consumers' desire to avoid loss or exclusion. Research highlights that FOMO elevates not only the intention to purchase but also the intensity of emotional arousal and the speed of decision-making (Friederich et al., 2024). The NFT context is particularly susceptible to FOMO dynamics due to its inherent features, such as highly visible social proof through online engagement metrics. NFTs often carry signals of exclusivity and community membership, which can activate status-driven behavior and reinforce peer-driven investment cycles. This aligns with findings that FOMO not only fosters impulsivity but also reshapes perceived value by emphasizing time-sensitive opportunities (Friederich et al., 2024). Social media acts as an amplifier of FOMO cues by spreading user-generated excitement and urgency at scale. Studies show that NFT-related FOMO conversations spike investment activity and boost sentiment-driven demand (Horky et al., 2023). Preliminary Study A explored the connection between NFT-FOMO mentions and NFT purchases, analyzing 28000 posts from social media. Time series analysis revealed that NFT-FOMO reach and positive sentiment significantly boosted the number of unique NFT buyers. Additionally, both current and previous-month NFT-FOMO mentions increased transaction volume. Study 1: Study 1A tested FOMO's causal impact on investment intentions through a between-subjects experiment. Results showed that FOMO messaging significantly increased investment intentions. Study 1B specifically examined the neurobiological effects of FOMO-driven investment intentions. In a controlled lab setting, participants were exposed to FOMO-based versus neutral NFT posts, while neuro-measures, EEG (electroencephalography) and GSR (galvanic skin response), captured real-time cognitive and emotional reactions. EEG measured cognitive load and approach motivation, and GSR

assessed physiological arousal. Results replicated Study 1A, with neuro-measures revealing heightened approach motivation and increased emotional arousal. Mediation analysis confirmed that emotional arousal influenced investment decisions, indicating that FOMO cues activate both cognitive and affective pathways. These findings illustrate that FOMO appeals can have measurable impact on consumer´s emotional state, both in terms of valence and arousal. Study 2 extended the analysis by exploring perceived rewards as a mediator and the need for uniqueness as a moderator. Findings revealed that FOMO increases perceived rewards and in turn enhances purchase intentions, while the effect of FOMO appeals is reduced for consumers with a higher need for uniqueness, as they do not want to form part of a group who acts in a similar way. Study 3 compared NFTs with traditional art, showing that FOMO appeals significantly boosts investment intentions for NFTs, but not for traditional art. This shows the relevance of FOMO appeals in digital and social media-driven environments. FOMO appeals intensify cognitive and affective states, driving impulsive NFT investments. Neurobiological evidence from Study 1B highlights emotional arousal and neural engagement as key mechanisms. This underscores how FOMO-based marketing taps into subconscious processes to influence financial behavior effectively.

Keywords: "fear of missing out (FOMO)", "neurobiological correlates"

It's not Only What is Said, but How: How User-Expressed Emotions Predict Satisfaction with Voice Assistants in Different Contexts

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JEL classification: M31, M37, L86, C93, O33

Abstract

This research explores how emotions expressed during interactions with multimodal (MM) and voice-only (VO) voice assistants (VAs) influence user satisfaction across different contexts. Based on cognitive appraisal theory (Watson & Spence, 2007), it investigates how emotional responses arise depending on task characteristics and device anthropomorphism. Advanced methodologies are introduced, integrating speech content analysis with voice tone assessment to address the limitations of traditional self-reported measures (Schindler et al., 2023). Voice-based interactions with technology are a novel field of research. It has been shown that voice-based communication inherently evokes more emotions than text or tactile communication (Hoffmann et al., 2019). Negative emotions tend to reduce satisfaction, while positive emotions enhance it (Phillips & Baumgartner, 2002). To capture user emotions, the study employs a dual method of capturing user-expressed emotions based on speech content and tone. Combining speech content analysis with voice tone evaluation allows for a richer understanding of user emotions. This multimodal approach captures both linguistic cues and vocal subtleties, to assess objective user emotions in order to predict satisfaction (Fan et al., 2021). For speech content we used the LIWC15 software, and for voice tone, we used the devAIce® model integrated into iMotions. These tools enable real-time emotional tracking during VA interactions. Study 1: Task Pleasantness; The first study explores the impact of task pleasantness on emotional responses with MM and VO devices. The between-subjects experiment involved 97 participants. Findings indicate that MMs significantly enhance positive emotions during pleasant tasks through interactive visual feedback. In contrast, VOs reduce emotional strain during unpleasant tasks, aligning with preferences for simplicity during negative experiences (Jokinen, 2015). Study 2: Task Complexity; The second study examines how task complexity affects user emotions. Conducted with 97 participants, it found that MMs are more effective for complex tasks due to graphical support, while VOs excel in simple tasks by reducing cognitive load (Hoffmann et al., 2019). The study also observed that VOs induced more negative emotions during complex tasks, emphasizing the role of visual support in reducing strain. Study 3: Device Anthropomorphism; The third study investigates the role of anthropomorphic design in VAs and included 109 participants. It found that anthropomorphized MMs foster stronger positive emotions and

empathy, enhancing user satisfaction. In contrast, non-humanized VOs were more effective for task-focused interactions. These findings suggest that human-like design elements influence user perception and emotional engagement (Schindler et al., 2023). All three studies highlight the importance of tracking user-expressed emotions during a VA interaction, to predict user satisfaction. Furthermore, the findings underscore the need to align VA type, task complexity, and anthropomorphic design to optimize user satisfaction. By combining speech content and voice tone analysis, the study provides insights that contribute to more empathetic, user-focused VA designs.

Keywords: "user-expressed emotions", "voice analysis"

Green Gaze: A Neuromarketing Study on Eco-Tourism Purchase Decisions

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Abstract

In response to growing environmental awareness, eco-tourism has gained prominence as a preferred travel choice among consumers. However, the complexity of sustainable purchasing decisions in this context requires deeper insights into how marketing elements influence consumer behavior. This study explores the impact of eco-labels, eco-brands, price cues, and social media on eco-tourism purchase intentions through a neuromarketing approach, aiming to uncover subconscious drivers of consumer choices. The study adopted the Stimulus-Organism-Response (SOR) model to understand the interaction between external marketing stimuli and internal cognitive-emotional processes leading to purchase decisions. A sample of 30 participants from University Sains Malaysia was selected through convenience sampling. Participants were exposed to modified eco-tourism visuals that incorporated variations of eco-labels, eco-branding elements, pricing information, and social media content. Using SMI Eye Tracking Glasses 2 Wireless and Be Gaze software, we recorded gaze behavior, including fixation durations and Areas of Interest (AOIs), to capture real-time attention patterns. SPSS was used for data analysis, with paired sample t-tests and one-way ANOVA applied to evaluate attention differences across stimuli. The results revealed that eco-labels significantly influenced attention and purchase intentions. AOIs containing eco-labels attracted higher fixation durations (t (29) = 6.55, p < 0.001), indicating their effectiveness in drawing consumer focus and enhancing trust. Similarly, eco-brands were shown to positively affect purchase decisions, with significant differences observed across related AOIs (F (3) = 8.07, p < 0.001). These findings confirm that branding sustainability efforts can enhance credibility and consumer engagement. Price cues also played a critical role. Participants exhibited varied attention patterns based on price positioning, highlighting the importance of perceived price fairness in the decision-making process (F (3) = 29.09, p < 0.001). Despite eco-conscious values, pricing remained a decisive factor in shaping intent to purchase. Additionally, the influence of social media on green purchase behavior was confirmed. Social media-driven content not only captured visual attention but also positively influenced emotional engagement and decision-making. This supports existing literature suggesting that digital platforms amplify consumer awareness and trust in sustainable offerings. Overall, the study demonstrates that neuromarketing tools, particularly eye-tracking, provide valuable insights into unconscious consumer responses that traditional survey methods may overlook. Eco-labels and eco-brands emerged as key attention drivers, while price and social media were shown to modulate how sustainability messages are received and processed. These findings have both theoretical and practical implications. Theoretically, the integration of the SOR model with neuromarketing provides a robust framework for examining eco-tourism consumer behavior. Practically, the insights gained can

inform marketing strategies that align with environmental values and enhance the effectiveness of eco-tourism promotions. Future research should explore cross-cultural comparisons, long-term behavioral impacts, and the differential effects of third-party versus self-declared eco-certifications. The integration of neuromarketing with sustainability research enriches our understanding of how consumers make eco-conscious decisions beyond self-reported attitudes.

Keywords: "neuromarketing", "consumer decision making"

Compulsive Buying from the Perspective of Eye-Tracking Research

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JEL classification: D12, D87, M31, M37, C91

Abstract

Compulsive buying is a significant and growing phenomenon in consumer behavior, associated with negative financial, psychological, and social outcomes. As digital commerce becomes increasingly pervasive, understanding the psychological and behavioral mechanisms underlying impulsive consumer decisions is essential. This research aims to explore the socio-demographic and environmental factors contributing to compulsive buying and to examine the role of visual attention in online shopping behavior. The study builds upon a theoretical overview of existing research, focusing on key predictors of compulsive buying, such as age, gender, and exposure to persuasive environments - particularly in the fashion industry, the sustainability-driven green industry, and e-commerce platforms. These industries often employ targeted visual and emotional stimuli that may increase consumers' susceptibility to compulsive purchasing. In addition to this literature review, the article presents findings from an experimental laboratory study using eye-tracking technology. The method was designed to observe and analyze how visual attention is distributed while individuals navigate online shopping environments. Respondents participated in simulated shopping tasks across various e-commerce websites, representing different product categories (e.g., electronics, cosmetics, sportswear). During the tasks, behavioral metrics such as the number of products viewed, time spent on product images, descriptions, and prices (Dwell Time), as well as the number of eye fixations, were recorded for different Areas of Interest (AOIs). Additional behavioral indicators included the speed of navigation, the number of products added to the cart, and whether the respondent read product reviews. The results reveal that individuals with higher levels of compulsive buying tendencies demonstrate distinct visual behavior patterns. Specifically, these respondents exhibited: Shorter but more intense visual engagement with product stimuli (i.e., concentrated Dwell Time and Fixation Count on product images); Faster screen navigation and higher number of product clicks; Less time spent reading product descriptions and reviews; A higher number of products added to the cart, even when price and details were not thoroughly examined. These findings suggest that visual stimuli in online shopping interfaces may act as triggers for impulsive decision-making, especially among consumers with higher materialistic values or susceptibility to emotional spending. The study confirms the potential of eye-tracking as a diagnostic tool in consumer research, offering deeper insights into unconscious behavioral patterns that traditional surveys may overlook. The conclusions highlight several implications: 1. For online retailers and UX designers, optimizing product presentation and reducing sensory overload could support more deliberate shopping behavior. 2. For marketing strategists, understanding the visual cues that drive impulsive actions may help create more ethical advertising strategies, particularly when targeting vulnerable consumer groups. 3. For consumer psychologists and behavioral researchers, the integration of biometric tools like eye-tracking opens new pathways for studying and mitigating compulsive consumption behaviors. In summary, this study

contributes to both theoretical understanding and practical applications by demonstrating how visual behavior in digital shopping environments reflects deeper psychological processes linked to compulsive buying. The research emphasizes the importance of interdisciplinary approaches - combining consumer psychology, marketing, and human-computer interaction - to foster responsible consumption in the digital age.

Keywords: "consumer behavior", "neuromarketing"

Low Level Visual and Auditory Features Predict Preferences of Commercials

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Abstract

In recent years the use of video content for marketing has become more prominent in digital marketing. This has increased the need to investigate what attributes and features makes a video more likable and therefore successful. Previous work has shown that low-level visual features extracted from pictures of products or ads are related to saliency and can affect the perception, preferences, and even choices of those stimuli. Other studies showed that low level auditory features are related to preferences of music clips. However, it is still unclear if and how low-level visual and auditory features influence the preferences of dynamic stimuli such as videos in general and commercials in particular. Moreover, the combined effect of both low-level visual and auditory features on preferences for commercials was never examined. Here, we examined if low-level visual and auditory features, extracted from video commercials for consumer products (such as colorfulness, scene frequency, loudness, zero crossing rate, etc.) are related to the subjective rankings of those commercials and the products advertised in them. First, participants (n=87) watched 100 commercials in a randomized order. After each commercial, participants stated their willingness to pay (WTP) for each of the products appearing in the commercial and indicated how much they liked the commercial. We then automatically extracted various low-level visual and auditory features from the video commercials. Next, we built models to predict either Liking or WTP, using three feature sets: models that only used visual features, models that only used auditory features, and models that used both. Using a leave-one-commercial-out Ridge regression, we found that both low-level visual and auditory features can predict the likability rankings of the commercials and the average WTP for the products appearing in them. Moreover, we showed that the combination of visual and auditory features had the strongest prediction success. Additionally, we calculated the average beta coefficient for each feature from all regressions to identify which ones contributed the most to each model. We found that in the models using only visual low-level features, the most important one was scene frequency, while in the models using only auditory features, the most important one was the variance of the zero-crossing rate. It is important to note, that the models that used both types of low-level features had consistent results, showing that scene frequency and the variance of zero crossing rate contributed the most to the models. Next, we tested if the relationship between low-level features and subjective preferences could be better explained by non-linear models. Therefore, we employed a support vector machine regression using different kernels. We found that these nonlinear models outperform our previous linear models. Consistent with our previous

results, the models with the strongest predictive power were those that combined both visual and auditory features. Moreover, models that included only low-level visual features tended to perform better than those that included only auditory features, highlighting the well-known visual system dominance and the stronger influence visual features have on perception and preferences. Lastly, using a Support Vector Machine (SVM), we classified subjective rankings into high and low values (based on a median split). These models achieved high accuracies, ranging from 64% to 91%. Again, we found that models using only visual features had higher prediction accuracies than models using only auditory features. For example, in predicting Liking, the visual-only model achieved 73% accuracy compared to 64% for the auditory-only model. The highest prediction accuracy, however, was achieved by models that combined both visual and auditory features (91% in predicting WTP). These results reveal that low-level visual and auditory features influence the likability of commercials, and the preference of the products advertised in them. This provides valuable insights into consumer behavior, highlighting the importance of multisensory integration in shaping consumer perceptions. Additionally, our findings could potentially guide marketers and creative teams during the development process of novel commercials.

Keywords: "visual and auditory low-level features", "consumer subjective preferences"

Improvement of Project-Based Learning (PBL) by Integrating Artificial Intelligence Personalization (AIP) and Biosensors

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Abstract

In everyday educational processes, our goal is to provide young people with skills that are in line with the needs of the labor market. Project-based learning (PBL) can help us prepare young people for the future by involving them in real-world problem solving activities. In the context of rapidly evolving educational paradigms, Project-Based Learning (PBL) has emerged as a powerful approach to foster critical thinking, collaboration, and real-world problem solving. However, optimizing individual and group performance within PBL remains a challenge, especially in terms of real-time feedback and personalized learning strategies. Using technology effectively during PBL is one of the best ways to help students solve real-world problems and prepare them for life after college. This paper explores the integration of Artificial Intelligence Personalization (AIP) and biosensors as tools for enhancing the effectiveness of the PBL process. The aim of this paper is to promote biosensors as a tool for providing objective physiological data reflecting students and respondents emotional and cognitive states, together with the AIP that can contribute to easier mastering of learning outcomes and can help with improving group dynamics and motivation among learners. This interdisciplinary approach offers a new framework for optimizing outcomes of PBL. The paper discusses potential applications, ethical considerations, and future directions for implementing biosensor in educational settings. In addition to assembling a theoretical framework, the paper is completed with a case study as a practical example of PBL as a basis for qualitative research and deep interview. During the period of one academic year, a group of 27 students aged from 15 to 17, participated in the PBL through a project called Yours digitally, Central Dalmatia. The project was an outcome of the initiative of Ministry of Tourism and Sports. The main goal of this initiative was to involve the education sector in promoting key activities of tourism in which students participate by designing new methods of preserving the space, nature, and culture of the local community while following the Strategy for Sustainable Tourism. Data were collected through semi-structured, in-depth interviews with 27 students who participated in project-based learning (PBL). The aim was to explore their perceptions of PBL and the motivational factors influencing their engagement in project-based activities. Along with the in-depth interview, the neuromarketing study was conducted within a group of 75 respondents to select the best visual and content-based solution as the outcome of the project activities. After conducting qualitative research by using behavioral and neurological methods to analyze the non-verbal reactions of respondents (neuromarketing

research using eye-tracking method and facial expression analysis) and the method of semi-structured interviews to assess the impact of PBL on motivation, it is concluded that PBL in a digital environment represents an effective model of connecting biosensors and AIP as useful tool for encouraging motivation and developing competences and skills. The results of this research, along with a practical contribution to the more effective implementation of PBL in schools and universities in order to improve skills and motivation could offer suggestions for further research.

Keywords: "project-based learning (PBL)", "biosensors", "artificial intelligence personalization (AIP)"

Olfactory and Auditory Cues and Shopper Attention in the Cookie Category

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Abstract

In today's crowded retail environment, shoppers are overloaded with competing sensory stimuli, which affects how they allocate attention and highlights the importance of sensorial marketing to uncover strategies for guiding shopper focus and enhancing brand engagement – both consciously and unconsciously. This study focuses on the cookie category, naturally associated with sensory experience and emotional connections. Grounded in the Stimulus–Organism–Response (S–O–R) model (Mehrabian & Russell, 1974), the research explores whether olfactory and auditory cues (Stimulus) can shape shoppers' unconscious and conscious reactions (Organism) and influence their attention and brand associations (Response). Executed as a pilot with a limited sample, this study provides initial evidence and a reference point for larger-scale research. All stimuli (scent and sound) were developed with the brand owners (Brand X) to ensure relevance and authenticity. An experiment was conducted in a controlled lab with 32 participants randomly assigned to one of four scenarios. Each participant viewed the same sequence of four retail shelf images designed to test whether cookie-related scent and sound attract attention to the category overall or to specific brands. The image scenarios included: (1) Brand X vs. juices (testing unrelated category contrast), (2) Brand Y (category leader) vs. juices (testing category vs. unrelated), (3) Brand X vs. Brand Y (testing direct brand competition), and (4) salty snacks vs. juices (testing if the crunch sound could be attributed to another category and if scent acts as a control). Each sensory condition included either visual-only (control), cookie-breaking sound (auditory), cookie scent (olfactory), or both combined. Each image was shown for 30 seconds, with sound presented every 5 seconds and scent diffused continuously. After exposure, participants completed a questionnaire to capture conscious perceptions, category familiarity, and brand associations. Preliminary findings suggest that cookie-related scents and sounds influence unconscious attention, with scent having the stronger effect. The combined scent and sound condition showed the highest electrodermal activity (EDA) amplitude, strongest positive electroencephalography (EEG) asymmetry, and most frequent positive facial expressions, especially when Brand X was present. These implicit results consistently indicate that scent is the most impactful sensory element for enhancing non-conscious engagement. At the same time, participants' self-reported responses indicated they did not expect sound or scent to influence their attention consciously. Over half (56%) believed scent would have little or no influence on cookie purchases, and 47% said the same about sound. This gap highlights the value of combining implicit and explicit measures when studying consumer behavior. Eye-tracking results further confirmed increased visual fixation on Brand X - even when compared directly to the

category leader, Brand Y - suggesting that scent may have the potential to become part of the recognizable attributes of Brand X. While sound was less distinctive in its current form, it may still offer potential with refinement. In conclusion, this pilot research shows that multisensory marketing, especially scent, can influence unconscious shopper attention, even when shoppers are not consciously aware of it. However, these findings should be interpreted with caution due to several limitations. First, the small sample means results should be seen as exploratory and would benefit from larger-scale replication. Second, because the cookie category is widely recognized in Croatia, repeating the study in countries with a different category footprint could reveal cultural differences. Third, the auditory stimulus used was only a single cookie-cracking sound; the relatively low impact may reflect this choice rather than the full potential of sound cues. Testing different sounds could clarify this effect. Despite these limitations, this research offers practical implications for brand owners seeking new ways to attract attention in-store. Combining scent and sound in-store could help guide shopper focus toward the category and specific brands, building stronger emotional and sensory connections. Future research should explore whether scent alone can function as an independent brand cue, reinforcing the distinctiveness and memorability of Brand X even outside the store and across cultures.

Keywords: ”sensorial marketing”, “SOR model”, “Eye tracking (ET)”, “Electrodermal activity (EDA)”, “Facial Expression Analysis (FEA)”, “Electroencephalography (EEG)”, “in store strategy”

Hue Matters: How Color Shapes Women's Perceptions of STEM Advertising

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JEL classification: M31, M37, C91, J16

Abstract

The underrepresentation of women in the Science, Technology, Engineering, and Mathematics (STEM) fields is a persistent challenge with significant implications for diversity and innovation. This research investigates how advertising strategies leveraging color influence women's engagement with STEM-related ads. Integrating quantitative and qualitative approaches, it examines how hues and tones elicit emotional responses and perceptions of femininity and masculinity, aiming to challenge traditional gender stereotypes and foster inclusivity (Labrecque & Milne, 2012; Schroll et al., 2018). This study uses a mixed-methods approach to analyze advertising design preferences. A pretest (N=151, 55% female, M age=38.78) assessed visual elements like colors, fonts, and slogans. Affectiva AI measured emotional responses, while participants rated femininity/masculinity. Mann-Whitney U tests showed gender-based differences, e.g., orange increased anger in females, and red was less joyful for them. A main experiment, focused solely on testing the effects of color, between-subjects design: 3 (ad color: gray, light purple, dark blue) × 2 (participant gender: male, female). Participants were shown Python course ads in one of the three color conditions and rated their implicit attention, explicit attention, purchase intention, and ad attitudes. Demographics and feedback were also collected. We analyzed the qualitative data from participants (such describing ads, impressions, and suggestions for improvement) using MAXQDA, focusing on gendered differences in preferences. Using PROCESS Model 3, a three-way interaction model was conducted with ad's condition, implicit attention, and gender predicting purchase intention, controlling for explicit attention and age (n=282, 49.6% female, M age=45.17). The overall model was significant, F (9,272) =7.32, p < .001, R2 =.195. A significant three-way interaction was found between ads' condition, implicit attention, and gender, b=.0488, t (272)=2.36, p=.019. Follow-up analyses revealed that for females, implicit attention moderated the relationship between ads' condition and purchase intention, F (1,272)=6.91, p=.009, with significant conditional effects observed at higher levels of implicit attention. For males, the interaction was nonsignificant, F(1,272)=0.09, p=.768. Conditional effects showed that among females (and not for male), the light purple ad was associated with implicit attention that led to higher purchase intention. No significant effects were observed for the grey (control) or dark blue conditions. A parallel analysis was conducted with attitude as the outcome variable. The overall model was significant, F(9,272)=9.32, p<.001, R2=.236. A significant three-way interaction was also observed, b=.0369, t(272)=2.48, p=.014. Follow-up analyses indicated that implicit attention moderated the effect of ad's condition on attitudes for females, F(1,272)=5.80, p=.017, but not for males, F(1,272)=0.73, p=.393. Among females, higher implicit attention was associated with more favorable attitudes toward the light purple advertisement condition (b=.394, p=.002). Among

females, the light purple ad increased implicit attention, leading to a positive attitude toward the Python course ad, while gray and dark blue showed no effects. Light purple boosted purchase intentions when implicit attention was high. Qualitative findings showed women preferred vibrant, engaging designs, while men favored simplicity. Gray was seen as dull, light purple had mixed reactions, and dark blue was viewed as professional and clear. This study highlights color's role in creating inclusive, impactful STEM ads. By choosing colors that resonate emotionally and challenge gender norms, advertisers can foster inclusivity and capture attention effectively. Findings offer insights for educators, policymakers, and marketers bridging the STEM gender gap. Future research should explore the long-term impact of color-based ads on cultural norms and sustaining women's interest in STEM careers.

Keywords: "STEM advertising"

Men think Women's Sports are Boring – Their Bodies Disagree

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Abstract

This study examines whether the longstanding disparity in viewership, media attention, and perceived excitement between men's and women's sports is rooted in measurable physiological differences or is instead a product of entrenched societal bias. Despite recent surges in support for women's sports, such as record-breaking viewership for NCAA Women's Basketball and unprecedented attendance at collegiate volleyball events, mainstream sports culture continues to prioritize male athletics. Past literature suggests that such imbalances may stem from both explicit and implicit gender biases reinforced through underrepresentation and stereotypical media portrayals (Cooky et al., 2013; Gomez-Gonzalez et al., 2022; Sheadler & Wagstaff, 2018). However, little research has employed biometric methods to rigorously test whether actual viewer excitement differs by the gender of the athletes being observed. This study aims to address this gap by triangulating self-reported interest and biometric responses to men's and women's basketball footage using eye-tracking, facial expression analysis, and galvanic skin response (GSR) data. A within-subjects experimental design was conducted with 31 undergraduate participants (14 male, 17 female) from a private Midwestern university, of whom 26 yielded usable biometric data. Each subject viewed two short (<5 min) clips: one of a men's and one of a women's NCAA basketball game, with viewing order randomized. Both clips were closely matched in score differentials, gameplay intensity, and team recognizability. Physiological excitement and attention were measured through three biometric modalities: (1) SmartEye AI-X for fixation count and duration (visual attention), (2) iMotions AFFDEX software for facial engagement % time and attention % time (emotional engagement), and (3) Shimmer GSR+ for arousal peaks per minute (physiological excitement). Subjects also completed pre- and post-video surveys assessing self-reported interest in both men's and women's sports on a 1–9 scale. Metrics were aggregated and scaled for comparison, and paired-sample t-tests were used to evaluate hypotheses. Physiological data showed no significant difference in recorded excitement or attention when viewing men's vs. women's basketball, regardless of the participant's gender. For both male and female viewers, GSR peaks, fixation metrics, and facial engagement were statistically indistinguishable between video types (e.g., for males, GSR PPM: $p = 0.568$; engagement: $p = 0.463$; attention: $p = 0.316$). However, significant differences emerged in self-reported interest. Before watching, male viewers rated men's sports significantly

higher than women's (5.7 vs 3.2, p < 0.05). Notably, after exposure to both videos, male participants' self-reported interest in women's basketball increased markedly (from 3.2 to 5.3, p < 0.05), effectively eliminating the initial disparity. In contrast, female viewers exhibited no statistically significant preference before or after viewing. Additionally, while males continued to self-report a stronger preference for men's basketball overall, their biometric responses did not corroborate this preference, indicating a potential cognitive dissonance or internalized bias. Findings strongly suggest that the cultural disparity in attention and enthusiasm for women's versus men's sports is not biologically grounded in actual differences in viewer engagement or excitement. Physiological measures revealed no difference in emotional arousal or attentional engagement between genders of the athletes observed. The male viewers' self-reported bias against women's sports diminished after a brief viewing experience, underscoring the powerful role of exposure in shaping perceptions. These results call into question the media's long-standing narrative that men's sports are inherently more engaging and provide empirical support for broader representation and promotion of women's sports. Strategic increases in women's sports media exposure, especially during prime broadcast windows, could reshape public perceptions and help achieve gender equity in sports coverage. Future research should replicate this study across other sports contexts, age demographics, and international populations to confirm generalizability and explore longitudinal effects of sustained exposure.

Keywords: "gender bias", "sports media", "biometrics", "women's athletics"

Real-World Impact of Brain-Based Mindset Technology in U.S. Workplaces

A Comparative Analysis from Jan-May 2024 vs. Jan-May 2025

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Abstract

Reulay is an AI-powered, neuroscience-based digital therapeutic platform designed to enhance emotional well-being, reduce stress, and support healthy longevity. Through personalized, short-form video interventions grounded in emotion regulation science and brain plasticity, Reulay aims to shift users from states of emotional distress - such as overload, distraction, discouragement, and uncertainty - toward adaptive emotional states like resilience, focus, optimism, and confidence. The platform leverages real-world usage data and user-selected emotional challenges to guide personalized mental resets, offering a scalable response to the growing psychological burden in modern workplaces. A pilot study at Mayo Clinic previously demonstrated measurable improvements in anxiety, distress, and attentional focus, underscoring Reulay's potential as a digital-first mental health intervention. As emotional strain, burnout, and cognitive overload rise - particularly in high-demand and remote work settings - scalable, neuroscience-informed tools are urgently needed. This study assessed year-over-year changes in psychological distress and digital engagement with Reulay among U.S.-based users. To control for seasonal confounders (e.g., holidays, weather), the same five-month period - January through May - was analyzed in both 2024 and 2025. The study aimed to evaluate changes in emotional burden and naturalistic use patterns in response to Reulay's mindset interventions. Platform analytics were collected from two cohorts: 1,569 users from January–May 2024 and 790 users from January–May 2025. Users selected from predefined psychological challenges and engaged in customized video interventions targeting specific mindset shifts (e.g., overload to calm, distraction to focus). Key metrics included frequency of sessions, minutes watched, and sessions marked "effective" for adaptive emotional states. Two-proportion z-tests and independent z-tests for means were used to compare data across years. In 2025, both psychological burden and user engagement increased significantly. Overload-related sessions rose from 121 to 1,070 - a 135.4% increase (Z = -24.56, p < 0.001), and distraction-related sessions increased from 115 to 379 (+48.0%; Z = -11.42, p < 0.001). Average sessions per user rose from 0.64 in 2024 to 12.7 in 2025 (+1,884%; Z = -26.35, p < 0.001). Average minutes watched per user increased from 0.51 to 8.23 (+1,515%; Z = -28.01, p < 0.001), indicating much deeper platform engagement. Sessions marked "effective" for adaptive emotional states also increased substantially: Optimism: 51 to 139 sessions (+172.5%; p < 0.001); Resilience: 37 to 196 sessions (+429.7%; p < 0.001); Confidence: 44 to 106 sessions (+140.9%; p < 0.001). These patterns indicate not only heightened emotional distress but also a shift in user preference toward future-oriented mindset goals,

suggesting a desire for inner clarity, motivation, and psychological resilience. This real-world, observational study revealed a significant rise in emotional strain - especially overload and distraction - and a concurrent, dramatic increase in engagement with Reulay's digital therapeutic interventions. The rise in sessions marked "effective" for optimism, resilience, and confidence suggests that users are actively seeking not just relief, but momentum and growth. These findings highlight the relevance of AI-powered, neuroscience-based tools as scalable complements to traditional mental health care. Future research should evaluate long-term clinical and organizational outcomes, including impacts on burnout, retention, and productivity.

Keywords: "neuroadaptive technology", "workplace stress", "AI-driven neurotechnology", "emotional resilience", "digital therapeutics", "cognitive overload"

Framed by Design: Eye-Tracking and Survey Insights into Visual Identity and Populism in Slovak Political Campaigns

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JEL classification: D87, M31, Z18, C91

Abstract

Visual identity plays a crucial, yet often underestimated, role in shaping the public's (voters') perception of political campaigns and their messages. The aim of this study was to clarify the impact of visual framing on the evaluation of identical political messages in ongoing political campaigns in Slovakia. The starting point of the research was the assumption that visual design is not merely an aesthetic component of a campaign but an active tool of cognitive framing that can alter the emotional tone, credibility, and perception of populism in campaigns, even when the textual content or message remains unchanged. The research was conducted on a sample of 50 respondents - citizens of the Slovak Republic with voting rights - while respecting demographic, geographic, and educational diversity across all levels. The visual stimuli consisted of eight political banners: four representing the concept of the strongest political party according to current public opinion polls, and four from the currently ruling party. The banners were presented in their original design styles, but the visual identity of one party was deliberately swapped onto the slogans of the other, and vice versa. The slogans, headlines, and key messages remained real and unchanged. No logos or actual party names were displayed, and the people shown in the visuals were generated using artificial intelligence. Each respondent viewed the banners on a screen while their eye movements were recorded using a Gazepoint eye-tracking device. In parallel, a quantitative survey was conducted, focused on the evaluation of campaign credibility. The eye-tracking results revealed that visual framing significantly influenced how respondents processed identical content. Slogans with strong contrast, clear typography, and prominent placement achieved the longest fixation durations and the highest number of revisits. Conversely, group compositions or visuals with dispersed visual hierarchies attracted significantly shorter attention spans. A particularly interesting observation was related to the banners with swapped visual identities: respondents often fixated quickly and repeatedly on the slogan but showed a higher number of revisits to key areas of interest (AOIs), suggesting cognitive dissonance or a need for reinterpretation of the message. The results of the concurrent

survey were generally neutral to mildly positive, but frequently polarized. Some banners combining a populist slogan with the minimalist visual identity of the opposing party received positive responses from respondents where such interest would not have been expected. This confirms that visual framing, or the framing of political party identities, has a significant influence on respondents. It also confirms the hypothesis that visual framing can affect the perceived credibility of a campaign as much as, if not more than, the textual content itself. The findings confirm the primary research hypothesis that visual identity significantly affects the perception of campaign credibility, emotional tone, and populist framing, even when textual messages remain unchanged. The secondary hypothesis - that swapping visual identities between ideologically opposed parties reduces respondent identification with campaign content - was particularly supported in cases with high revisit counts and polarized credibility ratings. This study contributes to a deeper understanding of how design and visual aesthetics operate as autonomous factors shaping the perception of political messages. In the context of growing personalization, aestheticization, and polarization of political discourse, understanding visual framing is essential not only for campaign creators but also for researchers studying the cognitive and behavioral aspects of political communication. The combination of eye-tracking and concurrent survey-based research enables a deeper insight into what people not only think, but also where they actually look and how this shapes their attitudes.

Keywords: "visual framing in political campaigns", "neuromarketing and political communication"

Mapping Consumer Attention: A Quantitative Study of Visual Perception of a Sale Flyer

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Abstract

This paper focuses on the analysis of visual perception of a print advertisement using eye tracking technology. The main aim of the study is to identify the elements of the advertisement within defined Areas of Interest (AOI) that attract participants' greatest and fastest attention. Based on these findings it is possible to optimize the visual hierarchy in the design of effective advertising materials. The research sample consisted of 49 volunteers from the student population of the university selected by convenience sampling. All participants met the criterion of normal vision and underwent a calibration process. Prior to exposure to the advertisement participants were not informed about its content. The experiment took place under controlled laboratory conditions where the advertisement was displayed on a 24-inch monitor for six seconds. Data collection and analysis were carried out using the iMotions software platform in conjunction with an AI X eye tracker. For each of the defined AOI we calculated key metrics such as Dwell Time (total fixation duration) Time To First Fixation (TTFF) and Fixation Index (number of individual fixations and their sequential arrangement). Collected data were processed using descriptive and correlation statistics to examine the relationships between individual AOI and observed metrics of visual attention. The findings confirm that the size and contrast of elements are closely correlated with both the speed of their detection and the duration of sustained attention. Primary messages such as information about a discount promotional call or validity date stood out most prominently whereas secondary explanatory texts and smaller graphic details received attention later and for a shorter period. This trend highlights the importance of a clear visual hierarchy in which dominant elements guide the viewer gaze and support engagement. It can be concluded that to maximize the effectiveness of a print advertisement it is crucial to apply bold high contrast and highly legible elements for primary information while secondary texts should be visually differentiated through graphic cues such as icons frames or color differentiation. These recommendations extend the theoretical framework of neuromarketing visual perception and behavioral marketing and offer practical guidance for creators of targeted visual campaigns to optimize the communication effectiveness of their advertising materials.

Keywords: "consumer", "consumer attention", "visual perception", "advertising"

Neural Evidence of the Language Effect in Cause-Related Marketing: An fMRI Study

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Abstract

Cause-related marketing (CRM) is a marketing strategy that ties fundraising for a cause to purchases of a firm's products. It can benefit the causes, the firms, and consumers. However, consumers often approach CRM with skepticism and scrutiny. To alleviate the unfavorable perceptions of impure altruism, we propose a theoretically grounded, managerially practical strategy: Present CRM messages to target audiences in their second (vs. native) languages. Second language (L2) use can prompt positivity biases and leave people more tolerant of moral wrongdoing than native language (L1), so we hypothesize that marketing messages in L2 facilitates higher purchase intention toward CRM campaigns. We conducted one behavioral study and one fMRI study for this proposition. In the behavioral study, we recruited 200 undergraduate students from a university, whose L1 is Cantonese and L2 is English. We asked the participants to read and evaluate a CRM campaign launched by a local brand, in Cantonese or English, at random. We measured participants' purchase intention. We also measured prior brand knowledge and attitude, perceived price, and cause proximity. The results affirm that using L2 (vs. L1) leads to increased purchase intention (4.95 vs. 5.63; $t(198) = 2.51$, $p = .013$), even after we control for prior brand knowledge and attitudes, perceived price, and cause proximity. The fMRI study aims to understand more about the underlying mechanism for the effect of marketing languages on consumers' purchase intentions towards CRM campaigns. The study employed a 2 (language: English as L2 vs. Chinese as L1) x 2 (ad type: CRM vs. non-CRM) within-subjects design with language as a within-subjects independent variable. Twenty-seven undergraduate and master students (20 female, 7 male; Mage = 22.48 years) participated in the current study. All participants were native Chinese speakers who had been screened to ensure English proficiency prior to the experiment. Participants were safety-screened carefully and placed inside a Siemens Prisma 3T MRI scanner. Inside the scanner, each participant was displayed with 96 advertisements of various non-gender, non-age-specific products, including food items, household objects, and toys. Each image consisted of a product

paired with a marketing slogan, either CRM or non-CRM in either Chinese or English. The numbers and product types were held constant across all condition (e.g., “Donate 10% to coffee bean farmers” vs “10% less calories than other coffee”). MRI data was collected using a 64-channel head coil. Functional T2-weighted echo-planar images were acquired with 60 interleaved slices (TR/TE = 1000/29ms, flip angle = 45°, field of view (FOV) = 100 mm, matrix = 90 × 90, slice thickness = 2.2 mm, voxel size = 2 × 2 × 2 mm^3, 750 volumes per run). Followed by acquiring high-resolution T1-weighted anatomical images using a 3D T1- weighted MPRAGE sequence (TR/TE = 2300/2.28 ms, flip angle = 8°, FOV = 100 mm, matrix = 256 × 256, slice thickness = 1 mm without gap). Whole-brain analysis revealed a significant cluster for the English (> Chinese) contrast using a cluster-defining threshold of t = 5.16, p < .05, with family-wise error (FWE) cluster correction applied. This cluster was located primarily in the left precentral gyrus (peak MNI coordinates: –42, 4, 32; peak t = 6.63; peak z = 5.84; cluster size = 90 voxels; cluster-level $PFWE$ = .000; peak-level $PFWE$ = .000). The left precentral gyrus was found to be related to visual language encoding, when individuals read silently and transduce visual information into phonological codes (Kaestner et al. 2021). This interesting finding may give us inspirations on the underlying reason for the marketing language effect on CRM purchase is the language transduce process. It is possible that when individuals read the visual information in their second language, the transduce process takes more cognitive load and the information processing stays on the face meaning, which is perceived positive and altruistic for cause-related marketing messages. On the contrary, read visual information in native language does not involve as much transduce process as with the second language and individuals would read behind the lines and see more egoistic and profit-seeking motives from the campaign. Our research contributes to the research on cause-related marketing and marketing communication language with insights from both behavioral and neuroscience data.

Keywords: "cause-related marketing effectiveness", "information process for different languages"