JOURNAL OF INTERNATIONAL RESEARCH & MULTIDISCIPLINARY INNOVATION

Dopamine Loops and Cognitive Depletion: How Digital Marketing Architecture Erodes Consumer Decision Capacity

Author: Dr. Praveen rai

Affiliation: Allahabad University, Prayagraj

Email: praveenrai0059@gmail.com

Submitted to: Journal of International Research & Multidisciplinary Innovation (JIRMI)

Date: 21 March 2026

Abstract

Digital marketing is converging on neurobiological design principles, designed to systematically activate the mesolimbic dopamine reward pathway and keep consumers engaged and set off on the fast track to purchase. This paper investigates how the structural approach of dopamine-based marketing design, including variable reinforcement schedules, algorithmic personalisation, infinite scroll architecture, artificial scarcity cues and gamified incentive systems, relate to the progressive deterioration of consumer decision quality, called decision fatigue. Based on peer-reviewed data from the fields of consumer neuroscience, behavioural psychology and empirical e-commerce data, the paper proposes that these are part of a self-reinforcing cognitive depletion cycle wherein sustained stimulation of dopamine levels leads to higher frequency of decision demands, which depletes executive resources, leaving the consumer vulnerable to algorithmic direction and compliance to their impulses. It also discusses the ethical and regulatory

shortcomings of the current regulatory framework in comparison to the more 'neurochemically' based marketing practices and outlines the conceptual model and future research direction that is proposed.

Keywords: *digital dopamine, decision fatigue, ego depletion, mesolimbic reward system, algorithmic personalisation, choice overload, dark patterns, consumer neuroscience, impulse buying, variable reinforcement*

1. Introduction

The modern day digital marketplace is not a neutral exchange area. It is a behavioural system over which the architects will have control, made up of a set of principles that have been documented and codified in the area of neurobiological reward processing, and engineered to maintain engagement well beyond the level of rational preference satisfaction. The dopaminergic reward pathway—mesolimbic circuit from the Ventral Tegmental Area (VTA) to the Nucleus Accumbens (NAcc)—is the key instrument in this construction and digital platforms and e-commerce players have mastered how to activate it via interface design, algorithmic content curation, and structured marketing messages. In fact, this is what Chamath Palihapitiya, the former VP of User Growth at Facebook, has said for the engagement architectures of big platforms: "It is a short-term, dopamine-driven feedback system that is maximised for commerce and not for user cognitive sovereignty" (Turel et al., 2020). This design approach also relates to a second, empirically demonstrated effect, consumer decision fatigue. Decision fatigue, theorised by the ego depletion model of Baumeister and colleagues (1998), refers to a system that produces a decrease in the quality of the decisions made after extended cognitive effort. The conditions for quicker cognitive exhaustion are not coincidental in digital spaces where millions of product listings are available and where a constant stream of notifications are continuously pushed and where algorithmically designed stimuli constantly shape the space. The Baymard Institute's synthesis of 48 separate studies finds the average global rate of online cart abandonment to be 69.99%, and in 2023, SalesCycle reported 79.53% — the magnitude and persistence of these rates over years and across markets indicate that online cart abandonment is more a symptom of systematic decision fatigue than incidental consumer disengagement (Baymard Institute, 2025; EmailVendorSelection,

2025). The paper is divided into six substantive sections: a first section that examines the neuroscience of the dopaminergic mechanism of reward processing, the second one that explores the specific marketing mechanisms that trigger these pathways, the third that looks at the theoretical and empirical foundations of consumer decision fatigue, the fourth that searches the interaction between both phenomena in the context of digital commerce, the fifth that delves into the ethics and regulations, and the sixth that concludes with a synthetic section and a proposed research agenda.

2. Neurobiological Foundations of Dopaminergic Reward Processing

2.1 The Mesolimbic Pathway and Reward Anticipation

Dopamine is a monoamine neurotransmitter that is synthesized mainly in the VTA and SN, and that projects via the mesolimbic pathway to the NAcc, amygdala, hippocampus and prefrontal cortex. It does not encode pleasure itself, but rather the anticipation of that pleasure, its main role in the context of marketing. Wolfram Schultz's basic electrophysiology work has shown that dopaminergic neurons respond to reward-predictive events, but not to the actual delivery of the reward; that is, the larger the uncertainty of the reward, the greater the dopamine response that is elicited by the reward-predictive events (Schultz et al., 1993; Mirenowicz & Schultz, 1996). This is a neurobiological fact that uncertainty produces maximum dopamine activity, and the mechanistic basis for variable reinforcement based digital design.

Knutson and colleagues (2001) were able to show by using fMRI that the nucleus accumbens is specifically recruited during the anticipation of monetary reward, functioning in the same way as the anticipation of addictive substances. Later neuroimaging studies in a consumer setting confirmed that marketing cues—liked brand logos, price discounts, or appealing product pictures—engage the NAcc and VST.Marketing stimuli (favorite brand cues, discount price cues or attractive product pictures) have been found to engage the NAcc and the VST in later neuroimaging studies done in consumer settings (Karmarkar & Plassmann, 2019). More importantly, exposure to high reward salience leads to a dampening of prefrontal cortical activity, which is implicated in deliberative evaluation and the inhibition of impulses, suggesting a

neurobiological mechanism through which rational evaluation is suppressed during high reward salience exposure.

2.2 Variable Reinforcement and Behavioural Conditioning

B.F. Skinner's operant conditioning studies have shown that variable ratio reinforcement schedules (those that give rewards after an unpredictable number of responses) yield the highest rates of responding and the most persistent responding (and the greatest resistance to extinction). This schedule is then implemented on digital platforms with algorithmic content curation that delivers unexpected content that is rewarding (high engagement posts, relevant products, personalised products and offers). Infinite scrolling and personalised recommendations are specifically cited by Clark and Zack (2023) for being activates of dopamine in the form of dopaminergic prediction error, defined as when outcomes are greater than expectation, a positive prediction error reinforces the behavioural tendency, but when they are less, a negative prediction error provides incentive to continue. In a peer-reviewed public health setting, Sharpe and Spooner (2025) state that this is a "attention engineering" design pattern, which involves the systematic usage of psychological triggers in order to keep people engaged by creating an artificial sense of uncertainty.

3. Digital Marketing as Structured Dopaminergic Stimulation

3.1 Infinite Scroll and the Suppression of Stopping Cues

Temporary or permanent removal of the stopping cues, known as Infinite Scroll.Temporary or permanent suppression of stopping cues (Infinite Scroll). The infinite scroll interface doesn't create natural stopping points as would the paging, keeping the user in a constant state of reward anticipation. It's psychological effectiveness is based on two principles: the Zeigarnik Effect keeping the mind focused on unfinished task chunks and dopaminergic anticipation of next content unit that is likely to provide a reward. Infinite scrolling has been identified as one of five main types of dark patterns by Roffarello and De Russis (2022), which includes auto-play, pull-to-refresh, suggestions and social investment mechanisms, all of which take advantage of

psychological vulnerabilities to prolong platform time. Sharpe and Spooner (2025) cite the example of more than one billion users spending an average of 3 hours each day in dopamine scrolling, which the authors say should be the focus of urgent regulatory action to address public health concerns. The direct commercial impact of this attentional grab is the purchase exposure that can happen at scale: If a consumer spends three hours each day in an algorithmically curated product environment, he or she is exposed to a lot more purchase stimuli than all the other previous marketing mediums could satisfy.

3.2 Algorithmic Personalisation and Hyper-Relevant Targeting

The algorithms that Amazon, Netflix, TikTok and ecommerce giants use to make recommendations create behavioural profiles of people and then play stimuli that are finely tuned to meet each person's reward threshold. TikTok's 'For You' page features about 95% algorithmically-curated content (Hartman, 2025). Amazon's recommendation system is believed to generate about 35% of their revenue from the platform, and Netflix's algorithm is responsible for the viewings of about 80% of the content (Davenport et al., 2020) – a testament not only to satisfaction-based preference alignment, but to the influence of algorithmically driven reward prediction. The moral component of this accuracy is expressed by Taddeo and Floridi (2018), who warn that if the ethical design principles are not included, then the use of AI in marketing can exploit the vulnerability of the cognitive state and violate the autonomy of the consumer. The structural dominance of the commercial interest to increase personalisation over consumer welfare concerns is clearly manifested in consumer backlash over over-personalisation on the basis of inferred or sensitive data (Li & Park, 2024).

3.3 Artificial Scarcity, FOMO, and Loss-Aversion Exploitation

Loss-aversion amplifiers include scarcity notifications ('Only 2 left in stock') and countdown timers and flash sale architectures. Kahneman and Tversky (1979) introduced the neuropsychological asymmetry, which holds that similar gains trigger less urgency for purchase than similar losses do, and that this urgency stems from the dopaminergic and stress-hormonal response to the loss. Consumer autonomy research points to promotions that are time-limited, scarcity alerts that exploit the concept of FOMO, and personalised urgency notifications as

examples of a systematic exploitation of this asymmetry (Arbaiza et al., 2024; Spais et al., 2024). The structural dishonesty of artificial scarcity (where inventory scarcity is not a real condition but a manufactured one) exacerbates the ethical dimension, but the neurobiological effect on purchase urgency is the same whether the scarcity signal is accurate or not.

4. Consumer Decision Fatigue: Theory and Evidence

4.1 The Ego Depletion Framework

A basic theoretical framework for decision fatigue is the strength model of self-control (Baumeister et al., 1998). It suggests that there is a limited internal resource for deliberate decision making, impulse control and active evaluation that is the same. Ego depletion occurs as a result of a sequence of such depletions, when remaining resources are not enough to provide high-quality evaluative processing during sustained decision-making episodes. Two typical behavioural patterns in consumer situations that have been observed in the context of ego depletion were described by Baumeister and Tierney (2012) as decision avoidance (i.e. avoidance or indefinite delay of decision making) and impulsive compliance (i.e., selection of default options or first available option to reduce the evaluative cost). The two signatures can be directly seen in digital commerce behaviour. However, the replicability problems of the ego depletion literature have been noted, especially the large-scale multi-laboratory study by Hagger and colleagues (2016) which showed no significant effect of ego depletion via standardised protocols. In their rejoinder the authors acknowledged that there is a real phenomenon called 'ego depletion' that is similar to cognitive fatigue, and they explained that the failure of replication was due to the fact that the depleting tasks were not sufficiently prolonged or demanding (Hagger & Chatzisarantis, 2016). Baumeister's later theoretical developments have focused on the conservation rather than the depletion of resources as the mechanism, and have expanded the model to the workplace and chronic depletion conditions like burnout (Baumeister et al., 2024). The findings of the research in the literature are unanimous that decisions under high cognitive demand for a long duration lead to measurable deterioration in the quality of decision.Results of the literature studies show that the longer the decision-making process under high cognitive demand, the greater the measurable

degradation of decision quality, especially in the context of extended digital commerce engagement.

4.2 Choice Overload and Digital Commerce

This complement of the concept of ego depletion, choice overload, as described by Iyengar and Lepper (2000) in their seminal jam experiment that showed people were more likely to purchase jam when it was offered in six varieties than in 24, has been unprecedented in the digital commerce realm. A Google search for just 'running shoes' yields more than 50,000 results on Amazon; Netflix has more than 6,000 titles in its U.S. library; the average supermarket carries more than 30,000 products, a significant percentage of which are available digitally (Shaw, 2025). In 2024, Forrester surveyed consumers in the United States and found that around 40% of consumers said they would abandon an online shopping cart due to the overwhelming amount of products (Shaw, 2025). The Study of Major Chinese e-commerce Platforms on e-commerce checkout architecture, referenced by Dan Jian et al (2023), found choice overload as one of the major factors to cart abandonment in e-commerce. Research suggests that conversion rates are highest when there are 4 to 6 options per page, but drop significantly beyond that, (Shaw, 2025).

4.3 Mobile Commerce and Amplified Depletion

Structural properties of the mobile commerce context amplify dopaminergic stimulation and cognitive resource depletion. There are more decision events per unit time on mobile devices, which are based on touch, versus desktop.Mobile devices are touch-based, and there are more decision events per unit time than there are on desktop. This shows in the comparative cart abandonment figures that XP2 (2025) reports mobile users had 75.45% cart abandonment rates, compared to 66.74% for desktop users, and some studies even put the mobile abandonment rate at 85.65% (EmailVendorSelection, 2025). The continuous connectivity of the mobile device extends the temporal range of the dopaminergic stimulation into different settings beyond shopping – meals, commutes, social interactions – and effectively colonizes attentional capacity during waking hours, building up cognitive depletion at a rate unattainable by any previous commerce. According to the dataset in Statista 2024, over 50 % of ecommerce traffic comes from mobile devices, even though they have lower average transaction values than desktop – which aligns with

the ego-depletion theory prediction of the reduction of decision quality under high-depletion conditions.

5. The Cognitive Depletion Cycle: Convergence and Consequences

There is no accident that digital dopamine marketing and consumer decision fatigue go hand in hand, but they are a positive feedback loop. This paper suggests a cognitive depletion dynamic, called the cognitive depletion cycle. Rewards anticipation during the initiation phase is produced by dopaminergic cues of marketing, such as personalisation, scarcity and variable reward events, and maintains the engagement with the platform by devouring attentional and evaluative resources. In the depletion phase, the consumer's prefrontal inhibitory capacity is diminished just when it is needed most, and this ultimately results in a decrease in the ability to resist further dopaminergic stimulation. During compliance, the fatigued consumer is unable to regulate his/her prefrontal system and it is now easier for him/her to comply with the algorithmically presented options with less evaluative resistance, just as platform recommendation systems are designed to do. Turel and colleagues (2020) specifically describe this dual effect: digital dopaminergic design has the effect of providing short-term satisfaction but also contributes to decision fatigue, falling attention spans and impulsive purchases. The evidences of behaviour for this cycle are considerable. Platform algorithms push the most prominent alternatives to consumers, such as default options, 'best-seller' labels, and top-ranked recommendations, and Makori (2023) documents that when consumers are tired, they are more likely to use them. The persistent rates of cart abandonment at more than 70% on a variety of independent measurement tools (Baymard Institute, 2025; SalesCycle, 2023; Dynamic Yield, 2024) represent an aggregate response of the cognitively depleted consumers that have abandoned purchase journeys because the evaluative cost to complete the cart exceeds their available cognitive resources. Higher rates of abandonment were seen in the luxury and jewellery sector (82.84%), the beauty and personal care sector (80.92%) and the fashion, accessories and apparel sector (78.53%), all of which had high option dimensionality and complex attribute evaluation requirements which lead to faster resource depletion. The cycle also implies that people's cognitive performance should be depleted on tasks that follow exposure to social media, which Dhir et al. (2021) also found to be highly associated. Another effect of the cycle is that following purchase regret occurs. Choices made under depleted conditions are less indicative of

preferences that are stable and have been aggressively endorsed and more indicative of algorithmic salience. What this preference misalignment leads to are post-purchase dissatisfactions, returns and loss of consumer trust in the brand, commercial costs that, unlike the short-term conversion benefits of a dopaminergic design, do not get passed on to the consumer and the market.

6. Ethical Analysis and Regulatory Implications

The ethical dilemma of digital dopamine marketing hinges on the difference between persuasion and manipulation. Persuasion involves getting the rational parts of the consumers to think about the relevant and correct information presented in an interesting way. When manipulation involves a psychological vulnerability, it takes advantage of that vulnerability without the involvement of rational evaluation because if the subject knew how it was happening he would reject it. Digital dopamine marketing, which leverages subliminal neurochemicals, opaque algorithmic systems and fabricated cognitive states, is in systematic violation of this. The consumer is not misled by the products' features, but rather the decision context is designed to de-fuse the consumer's own ordering of the products by reducing deliberative capacity and strengthening impulsive compliance. This type of harm differs in structure from the deception conveyed in information that is already dealt with by the current consumer protection laws and existing regulatory instruments are not sufficient to it. The General Data Protection Regulation (GDPR), in effect since 2018, is a European Union regulation that deals with the infrastructure of data that support personalised targeting, but not the neuropsychological effects of personalised stimulation. The EU AI Act (2024) brings in a new paradigm of risk-based regulation of AI systems, while its 'marketing' provisions are concerned with transparency of automated decision-making, not with the cognitive impact of algorithmically maintained interaction. The dopaminergic exploitation of interfaces described in this paper is not a surface-level deception, such as the types of deceptive interfaces the Federal Trade Commission has addressed through its enforcement actions. Although the EU AI Act and international privacy regulations have led companies to reconsider data management, the practical implementation of these laws is still poorly equipped to consider manipulation mechanisms that are grounded in neuroscience, as noted by Zhang and Thompson (2025). In addition to their capacity to meet these harms, frameworks would require to include neuroethical

considerations about how the interface design itself can be manipulated, the need for disclosure of personalisation mechanisms by algorithms, the need for regulatory frameworks regarding the cognitive friction features (stopping cues, option reduction architectures, cooling-off prompts before completion of purchase), and independent assessment of the cognitive load profile of commercial digital environments. There are some elements of these frameworks provided by the OECD AI Principles (2023) and India's NITI Aayog Responsible AI Strategy (2024), which focus on human oversight, transparency and accountability, but have been little more than scaffolding when applied to marketing and are not binding. Both Sharma and Patel (2023) and Zhang and Thompson (2025) argue for a minimum standard of institutionalised algorithmic ethics audits and a ‘privacy by design' principle; the evidence presented in this paper indicates that the minimum standards will need to be supplemented by additional elements to ensure that consumers are adequately protected.

7. Conclusion and Research Agenda

This paper has combined evidence from consumer neuroscience, behavioural psychology and empirical e-commerce analytics to demonstrate the existence, mechanisms and implications of a dopamine marketing-consumer decision fatigue double loop.This paper brings together a synthesis of evidence from consumer neuroscience, behavioural psychology and empirical e-commerce analytics to establish the existence, mechanisms and implications of a dopamine marketing-consumer decision fatigue double loop. Variable reinforcement schedules, algorithmic personalisation, artificial scarcity and infinite scroll architectures exploit the mesolimbic dopaminergic system, which evolved to encode reward anticipation and to guide adaptive behaviour, to ensure commercial engagement. Such cognitive engagement is then sustained, draining executive resources needed for autonomous decision-making, producing a consumer population that exhibits a growing and more algorithmic kind of purchase behaviour, and more of a preference shift towards algorithmic salience. The conceptual framework outlined here (initiation, depletion and compliance) provides a framework for empirical research at various levels. Future studies should take an individualistic approach and use a longitudinal ecological design while observing the association between digital engagement duration, dopaminergic

measurements and consumer decision quality in real world conditions. Experimentally test the effectiveness of specific interface modifications (required stopping cues, options set size constraints, etc.) to reduce the feeling of decision fatigue without a commensurate commercial burden, at the platform level. It is a critical time for interdisciplinary collaboration between consumer neuroscience and public policy in order to create neuroethically informed regulatory standards for commercial interface design.

References

1. Arbaiza, F., et al. (2024). Anthropomorphism of chatbots and consumer vulnerability: Ethical considerations in AI-mediated marketing. Journal of Consumer Behaviour, 23(2), 415–429.
2. Baumeister, R. F., Bratslavsky, E., Muraven, M., & Tice, D. M. (1998). Ego depletion: Is the active self a limited resource? Journal of Personality and Social Psychology, 74(5), 1252–1265.
3. Baumeister, R. F., André, N., Southwick, D. A., & Tice, D. M. (2024). Self-control and limited willpower: Current status of ego depletion theory and research. Current Opinion in Psychology, 59, Article 101849.
4. Baumeister, R. F., & Tierney, J. (2012). Willpower: Rediscovering the greatest human strength. Penguin Press.
5. Baymard Institute. (2025). 50 cart abandonment rate statistics 2025. https://baymard.com/lists/cart-abandonment-rate
6. Clark, L., & Zack, M. (2023). Reward variability and variable reinforcement schedules in digital products. Annual Review of Clinical Psychology, 19, 211–238.
7. Davenport, T. H., Guha, A., & Grewal, D. (2020). How AI is transforming the marketing landscape. Harvard Business Review, 98(1), 42–51.
8. DataReportal. (2024). Digital 2024: Global overview report. https://datareportal.com/reports/digital-2024-global-overview-report

9. Dhir, A., et al. (2021). Antecedents and consequences of social media fatigue. International Journal of Information Management, 56, Article 102006.

10. Dynamic Yield. (2024). Cart abandonment rate: 12-month global average. https://www.dynamicyield.com

11. EmailVendorSelection. (2025). 38+ cart abandonment rate statistics (2026 updated). https://www.emailvendorselection.com/cart-abandonment-rate-statistics/

12. Gupta, R., et al. (2025). Neural mechanisms and digital platform design: A neuromarketing synthesis. Journal of Marketing and Social Research, 4(1), 18–37.

13. Hagger, M. S., et al. (2016). A multi-lab preregistered replication of the ego depletion effect. Perspectives on Psychological Science, 11(4), 546–573.

14. Hagger, M. S., & Chatzisarantis, N. L. D. (2016). Reply to Baumeister's response to the preregistered replication. Perspectives on Psychological Science, 11(4), 585–591.

15. Hartman, A. (2025). The neuroscience of social media: How algorithms hijack your brain. Richmond Functional Medicine. https://richmondfunctionalmedicine.com/neuroscience-of-social-media/

16. Iyengar, S. S., & Lepper, M. R. (2000). When choice is demotivating: Can one desire too much of a good thing? Journal of Personality and Social Psychology, 79(6), 995–1006.

17. Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. Econometrica, 47(2), 263–291.

18. Karmarkar, U. R., & Plassmann, H. (2019). Consumer neuroscience: Past, present, and future. Organizational Research Methods, 22(1), 174–195.

19. Knutson, B., Adams, C. M., Fong, G. W., & Hommer, D. (2001). Anticipation of increasing monetary reward selectively recruits nucleus accumbens. Journal of Neuroscience, 21(16), RC159.

20. Li, S., & Park, J. (2023). Over-personalisation and consumer backlash: When algorithmic relevance becomes intrusiveness. Journal of Retailing and Consumer Services, 72, Article 103258.

21. Makori, A. (2023). Cognitive heuristics in fatigued consumer decision-making. Journal of Consumer Psychology, 33(4), 201–218.

22. Mirenowicz, J., & Schultz, W. (1996). Preferential activation of midbrain dopamine neurons by appetitive rather than aversive stimuli. Nature, 379(6564), 449–451.

23. NITI Aayog. (2024). Responsible AI strategy for India. Government of India.

24. Oberlo. (2024). Cart abandonment rate by industry. https://www.oberlo.com/statistics/cart-abandonment-rate-by-industry

25. OECD. (2023). OECD AI principles. Organisation for Economic Co-operation and Development. https://oecd.ai/en/ai-principles

26. Roffarello, A. M., & De Russis, L. (2022). Towards understanding the dark patterns that steal our attention. CHI Conference Extended Abstracts, 1–7.

27. SalesCycle. (2023). Ecommerce stats and trends report. https://www.salescycle.com

28. Schultz, W. (1998). Predictive reward signal of dopamine neurons. Journal of Neurophysiology, 80(1), 1–27.

29. Schultz, W., Dayan, P., & Montague, P. R. (1993). A neural substrate of prediction and reward. Science, 275(5306), 1593–1599.

30. Sharma, R., & Patel, A. (2023). Algorithmic accountability and ethical AI in consumer marketing. Journal of Marketing Ethics, 15(2), 88–109.

31. Sharpe, B. T., & Spooner, R. A. (2025). Dopamine-scrolling: A modern public health challenge requiring urgent attention. Journal of Public Health, 47(2), e215–e221.

32. Shaw, J. (2025). Choice overload: Why too many options are killing sales. Medium. https://medium.com/@jodiemshaw/choice-overload-6280f9b8bf29

33. Spais, G., Phau, I., & Jain, V. (2024). AI marketing and AI-based promotions impact on consumer behavior and the avoidance of consumer autonomy threat. Journal of Consumer Behaviour, 23(3), 1053–1056.

34. Taddeo, M., & Floridi, L. (2018). The debate on the moral responsibilities of online service providers. Science and Engineering Ethics, 24(6), 1575–1603.

35. Turel, O., Brevers, D., & Bechara, A. (2020). Time distorted cognition in social media addiction. Journal of Psychiatric Research, 129, 89–96.

36. XP2. (2025). Shopping cart abandonment rate for eCommerce. https://xp2.com

37. Zhang, L., & Thompson, K. (2025). EU AI Act and global privacy laws: Implications for algorithmic accountability in digital marketing. Journal of Digital Governance, 8(1), 12–34.