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Facial Recognition Retail Interactions and Green Purchase Intentions Through Privacy Calculus Awareness Mechanisms

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Abstract :*The integration of biometric technologies in physical retail environments has fundamentally transformed consumer experiences, yet its psychological impact on sustainable consumption remains underexplored. This paper investigates the interaction effects of facial recognition technology on green purchase intention within retail settings. Drawing upon objective self-awareness theory and privacy calculus theory, this research proposes a comprehensive framework to understand how personalized interactions driven by facial recognition influence consumers' propensity to select environmentally friendly products. Through a controlled laboratory-in-the-field experiment, we manipulate the level of facial recognition interaction and measure its downstream effects on green purchase intention, with perceived social presence and privacy concerns serving as competing mediating mechanisms. The findings reveal a dual-pathway effect where facial recognition interaction significantly enhances green purchase intention by elevating perceived social presence, effectively simulating a digital watching eyes effect that promotes pro-social and pro-environmental behavior. Conversely, heightened privacy concerns act as a suppressive mediator, negatively impacting purchase intentions when the interaction is perceived as overly intrusive. These insights contribute to the growing discourse on human-computer interaction in retail by demonstrating that the architectural design of artificial intelligence interfaces can actively shape sustainable consumption patterns. The study offers practical recommendations for retailers seeking to balance personalized technological engagement with ethical considerations, ultimately fostering an environment conducive to green purchasing..*

Keywords

Facial recognition, Green purchase intention, Retail technology, Consumer behavior

1. INTRODUCTION

1.1 Background of Retail Technology

The landscape of the global retail industry has undergone a paradigm shift over the past decade, driven primarily by the rapid advancement and deployment of digital technologies [1]. Historically, the interaction between consumers and retail environments was mediated entirely through human personnel and physical store layouts [2]. However, the advent of artificial intelligence and machine learning has introduced a new era of automated, highly personalized consumer experiences [3]. Among these technological innovations, facial recognition technology has emerged as one of the most prominent and controversial tools deployed in brick-and-mortar stores [4]. Originally developed for security and surveillance purposes, facial recognition technology has been increasingly adapted for marketing and customer service applications [5]. Modern retail systems utilize advanced cameras and neural networks to identify returning customers, analyze demographic characteristics in real time, and deliver customized advertisements or product recommendations directly to digital displays as the consumer navigates the store [6]. This level of seamless, frictionless interaction creates a highly individualized shopping journey that bridges the gap between the physical and digital retail realms [7]. Despite the operational efficiencies and personalization benefits associated with facial recognition technology, the psychological implications of these systems on specific domains of consumer decision-making require extensive investigation.

1.2 The Shift Toward Green Consumption

Concurrently with the digital transformation of retail, there has been a profound global awakening regarding environmental sustainability and climate change. Consumers are increasingly aware of the ecological footprint associated with their purchasing habits, leading to a substantial rise in the demand for green and sustainable products [8]. Green purchase intention refers to the stated likelihood or willingness of a consumer to buy products that are perceived as environmentally friendly, ethically sourced, or manufactured with a reduced carbon footprint [9]. This shift in consumer values has compelled retailers to expand their assortments of eco-friendly goods and heavily promote corporate social responsibility initiatives [10]. However, there remains a well-documented attitude-behavior gap in sustainable consumption; while many consumers express a strong desire to purchase green products, their actual behavior at the point of sale often favors conventional, less expensive, or more familiar alternatives [11]. Bridging this gap has become a primary objective for marketers and behavioral scientists [12]. Researchers have explored various interventions to stimulate green purchasing, ranging from eco-labeling and informational campaigns to social norm nudging and pricing strategies [13]. Yet, the potential for emerging retail technologies, specifically interactive biometric systems, to act as a catalyst for sustainable consumption remains a novel and largely uncharted territory in academic literature [14].

1.3 Research Objectives

The intersection of artificial intelligence-driven personalization and sustainable consumer behavior presents a critical area for contemporary research [15]. When a consumer interacts with a facial recognition system that addresses them by name or offers personalized recommendations, it fundamentally alters their psychological state within the retail environment [16]. This research aims to systematically investigate how these interactive technological encounters influence green purchase intention. Specifically, the study seeks to understand whether the heightened sense of being recognized and observed by a digital entity triggers psychological mechanisms that encourage pro-environmental choices [17]. By examining the competing forces of perceived social presence, which may encourage socially desirable behaviors like green purchasing, and privacy concerns, which may induce psychological reactance and avoidance, this paper provides a nuanced understanding of the modern retail ecosystem [18]. The primary objective is to establish an empirical link between facial recognition interaction levels and green purchase intention, thereby

offering theoretical advancements in consumer psychology and actionable insights for retail management [19].

2. Literature Review and Background

2.1 Facial Recognition Technology in Retail

Facial recognition technology operates by capturing a digital image of a human face, extracting distinct nodal points and biometric features, and comparing these data points against a database to establish identity or infer demographic characteristics [20]. In the context of retail, this technology is utilized across several touchpoints, including store entry greetings, interactive digital signage, targeted promotional kiosks, and frictionless checkout systems [21]. The theoretical foundation for implementing such systems lies in the personalization-privacy paradox [22]. Retailers strive to provide hyper-personalized experiences that reduce search costs and increase consumer satisfaction, operating on the premise that consumers value convenience and tailored offerings [23]. When a system recognizes a consumer, it can immediately access their purchase history and preferences, theoretically streamlining the decision-making process [24].

However, the deployment of biometric surveillance in commercial spaces inherently disrupts traditional notions of anonymity [25]. Unlike online tracking through cookies, which consumers often perceive as abstract, facial recognition represents a visceral and highly tangible form of data extraction [26]. This tangible interaction significantly elevates the salience of the technology, forcing consumers to actively process the implications of their digital physical presence [27]. Prior studies have focused extensively on the adoption rates and general acceptance of these technologies, often highlighting a significant demographic divide in comfort levels [28]. Yet, the behavioral consequences of these interactions, particularly how they alter subsequent product evaluations and moral decision-making within the store, have not been adequately modeled in the literature [29].

2.2 Green Purchase Intention

Green purchase intention is a complex construct deeply rooted in moral psychology and prosocial behavior [30]. It is distinct from conventional purchase intention because it requires the consumer to prioritize long-term, collective environmental benefits over short-term, personal utility or financial savings [31]. The dominant theoretical framework utilized to explain green purchasing is the Theory of Planned Behavior, which posits that behavioral intentions are shaped by attitudes toward the behavior, subjective norms, and perceived behavioral control [32]. Subjective norms, in particular, play a crucial role in sustainable consumption; consumers are highly sensitive to the perceived expectations of their peers and society at large [33].

When environmental consciousness is framed as a societal norm, individuals are more likely to align their behavior with these expectations to maintain a positive self-concept and social standing [34]. Consequently, green purchasing is often conceptualized as a form of conspicuous conservation or socially desirable behavior. Consumers buy green not only to protect the environment but also to signal their virtue to others [35]. This signaling mechanism requires an audience. In traditional environments, the presence of other shoppers or store clerks serves as the audience that triggers normative compliance [36]. The critical question introduced by modern retail technology is whether an artificial, non-human entity can fulfill this role of the audience and stimulate similar levels of normative compliance [37].

2.3 Human-Computer Interaction and Consumer Psychology

The interaction between humans and advanced computer systems has evolved beyond simple tool utilization into complex social exchanges. According to the Computers Are Social Actors paradigm, individuals naturally and unconsciously apply social rules and expectations to computers, particularly when the technology exhibits anthropomorphic cues or interactive capabilities. When a facial recognition system identifies a consumer and addresses them interactively, it violates the expectation of inanimate technology and crosses into the realm of social interaction. This anthropomorphization creates a phenomenon known as perceived social presence, defined as the degree to which a medium allows a user to feel the psychological presence

of another entity. Perceived social presence has profound implications for consumer behavior. In psychology, the watching eyes effect demonstrates that people behave more altruistically, honestly, and in accordance with social norms when they feel they are being observed, even by stylized or artificial eyes. Facial recognition technology acts as a modern, sophisticated iteration of the watching eyes effect. The consumer is acutely aware that they are being seen, analyzed, and recorded by the retail system. This awareness induces a state of objective self-awareness, where the individual's attention is focused inward, leading to a self-evaluation against salient social standards. Because environmental sustainability is a widely endorsed social standard, the heightened self-awareness triggered by facial recognition interaction is hypothesized to increase the probability of conforming to this standard through green purchasing. Conversely, the interaction with biometric systems triggers significant privacy concerns. Privacy calculus theory suggests that consumers constantly weigh the perceived benefits of disclosing personal information against the potential risks. When a facial recognition system interacts with a consumer, the immediate realization of data extraction can induce feelings of vulnerability, loss of control, and psychological reactance. Psychological reactance occurs when an individual feels their freedom or autonomy is threatened, leading to negative emotional states and a tendency to reject the source of the threat. If the interaction with the facial recognition system is perceived as highly intrusive, the resulting privacy concerns may overshadow any positive social presence effects, diminishing the overall shopping experience and negatively impacting all purchase intentions, including green products.

2.4 Conceptual Framework and Hypotheses

Based on the synthesis of objective self-awareness theory, the watching eyes effect, and privacy calculus theory, this study proposes a dual-pathway conceptual framework. The primary independent variable is the level of facial recognition interaction, categorized into high interaction, low interaction, and no interaction control. The dependent variable is green purchase intention. The framework incorporates two parallel mediating variables: perceived social presence and privacy concern. It is hypothesized that high facial recognition interaction will significantly increase perceived social presence compared to low or no interaction. This elevated social presence will subsequently lead to a higher green purchase intention, as consumers attempt to align their behavior with prosocial norms in the presence of an observing entity. Simultaneously, it is hypothesized that high facial recognition interaction will increase privacy concerns. Elevated privacy concerns will negatively mediate the relationship, suppressing the positive effects of the interaction and reducing green purchase intention. The ultimate effect on green purchase intention will depend on the relative strength of these two competing mechanisms. By testing these pathways, the research aims to provide a comprehensive understanding of the psychological trade-offs inherent in modern retail technology interactions.

3. Methodology and Analysis

3.1 Research Design

To empirically test the proposed conceptual framework, a laboratory-in-the-field experimental design was employed. This approach combines the internal validity and control of a traditional laboratory experiment with the external validity and contextual realism of a physical field setting. The experiment utilized a simulated retail environment constructed within a university behavioral research facility. The store was designed to resemble a modern convenience and lifestyle retail outlet, stocked with a variety of everyday consumer packaged goods. Crucially, the product assortment included matched pairs of conventional products and their direct green alternatives. For example, standard chemical household cleaners were placed alongside ecologically certified, biodegradable cleaners of similar size and utility. This paired presentation ensured that consumers had a clear, unforced choice between a conventional and a green product across multiple categories. The experimental design was a single-factor, randomized between-subjects design with three conditions: high facial recognition interaction, low facial recognition interaction, and a control condition with no facial recognition interaction. Participants were randomly assigned to

one of the three conditions upon arrival at the facility. To ensure the integrity of the experiment, participants were initially informed that the study was broadly focused on modern store layouts and navigation, masking the specific focus on facial recognition and green purchasing.

3.2 Participant Selection and Sampling

Participants were recruited from a large metropolitan area using a stratified random sampling method to ensure demographic diversity representative of general retail consumers. An initial screening questionnaire was administered to filter out individuals who had severe visual impairments, limited mobility, or who were familiar with the specific brands used in the study to avoid preexisting brand loyalty biases. A total of three hundred and thirty individuals were recruited. After accounting for incomplete responses and technical failures during the experimental procedure, the final usable sample consisted of three hundred and ten participants.

The sample size was determined through an a priori power analysis to ensure sufficient statistical power to detect medium effect sizes in the planned structural equation modeling and analysis of variance procedures. Participants were compensated with a standardized monetary incentive for their time, along with a small voucher that could be used to theoretically purchase items during the experiment, simulating real financial stakes and economic decision-making.

3.3 Experimental Procedure

Upon arriving at the simulated retail facility, participants were briefed by a research assistant and provided with informed consent documentation. Following consent, participants were directed to enter the store and given a standardized shopping list containing generic categories of items they needed to evaluate and select for purchase. In the high facial recognition interaction condition, participants approached a prominent digital kiosk at the store entrance. The kiosk was equipped with a visible camera array. As the participant stood in front of the kiosk, the screen displayed a scanning graphic, followed by a simulated biometric mapping overlay on their face. The system then displayed a highly personalized greeting, dynamically generating text that acknowledged their demographic profile and welcomed them to the store. The kiosk maintained continuous interactive visual feedback, tracking their gaze and head movements as they navigated the initial menu.

In the low facial recognition interaction condition, the kiosk was operational, and the camera was visible. However, the screen only displayed a generic welcome message without any simulated biometric mapping, personalized text, or gaze tracking. The system acknowledged presence but did not provide deep interactive feedback. In the control condition, the kiosk was turned off, and the cameras were physically covered. Participants simply walked past the inactive kiosk and proceeded directly to the shopping task without any technological intervention. Following the entrance manipulation, participants navigated the store aisles, interacting with the physical products. They were instructed to select one product from each matched pair category and place it in their physical shopping basket. After completing the shopping task, participants proceeded to a checkout area where a research assistant recorded their actual product selections. Subsequently, participants were escorted to a separate quiet room to complete an extensive post-experiment survey. This survey contained the manipulation checks, the measurement scales for the mediating and dependent variables, and demographic questions. Finally, participants were fully debriefed about the true purpose of the study and the deceptive elements of the initial briefing.

3.4 Measurement Instruments

All latent constructs were measured using multi-item scales adapted from established literature and tailored to the specific context of this study. The items were measured on a robust seven-point Likert scale, ranging from strongly disagree to strongly agree. Green purchase intention was measured using a four-item scale assessing the participant's willingness, planning, and likelihood to choose environmentally friendly products over conventional alternatives in future shopping scenarios. Perceived social presence was evaluated using a five-item scale that captured the extent to which participants felt a sense of human contact, personalness, sociability, and the feeling of being observed or accompanied by the digital system during their entrance experience. Privacy concern was operationalized using a six-item scale focusing on the perceived risks of data

collection, feelings of intrusiveness, anxiety regarding facial data storage, and the general discomfort associated with biometric surveillance in a commercial setting.

To ensure the reliability and validity of the measurement instruments, a pilot study was conducted prior to the main experiment. The pilot data were subjected to exploratory factor analysis, which confirmed that all items loaded strongly onto their respective intended constructs with minimal cross-loading. In the main study, internal consistency was evaluated using Cronbach's alpha, with all scales demonstrating excellent reliability coefficients well above the standard acceptable thresholds.

4. Results and Discussion

4.1 Descriptive Statistics

Before conducting the primary hypothesis testing, comprehensive data screening and cleaning procedures were executed. The dataset was examined for missing values, multivariate outliers, and violations of statistical assumptions. Normality was assessed through the evaluation of skewness and kurtosis indices, which fell within acceptable parameters for all major variables. The demographic characteristics of the final sample are detailed to provide context for the generalizability of the findings. The sample exhibited a balanced gender distribution and a diverse representation of age groups, ensuring that the results are not unduly influenced by a narrow demographic segment.

Table 1: Demographic Characteristics of the Study Sample

Characteristic	Category	Frequency	Percentage
Gender	Male	150	48.4
Gender	Female	160	51.6
Age	18 to 25	95	30.6
Age	26 to 35	120	38.7
Age	36 to 45	65	21.0
Age	46 and older	30	9.7
Education	High School	45	14.5
Education	Undergraduate	185	59.7
Education	Postgraduate	80	25.8

A manipulation check was performed using an analysis of variance to ensure that the experimental conditions successfully altered the participants' perception of interaction intensity. The results confirmed a highly significant difference across the three conditions, with participants in the high interaction condition reporting significantly greater levels of perceived technological engagement compared to the low interaction and control groups.

4.2 Hypothesis Testing

To examine the direct effect of facial recognition interaction on green purchase intention, an analysis of variance was conducted. The main effect of the interaction type was found to be statistically significant, indicating that the level of technological engagement alters consumers' downstream environmental choices. A post-hoc analysis utilizing the Tukey procedure revealed that participants in the high facial recognition interaction condition exhibited significantly higher green purchase intention scores compared to those in the control condition. However, the difference between the low interaction and control conditions was marginal.

Table 2: Analysis of Variance for Green Purchase Intention

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F-Value
Interaction Type	2	45.67	22.84	14.52
Privacy Concern	1	12.34	12.34	7.85
Error	306	481.33	1.57	-
Total	309	539.34	-	-

To test the proposed dual-pathway mediation framework, structural equation modeling was employed using maximum likelihood estimation. The measurement model demonstrated excellent

fit indices, confirming the construct validity of the scales. Subsequently, the structural model was evaluated to test the directional hypotheses.

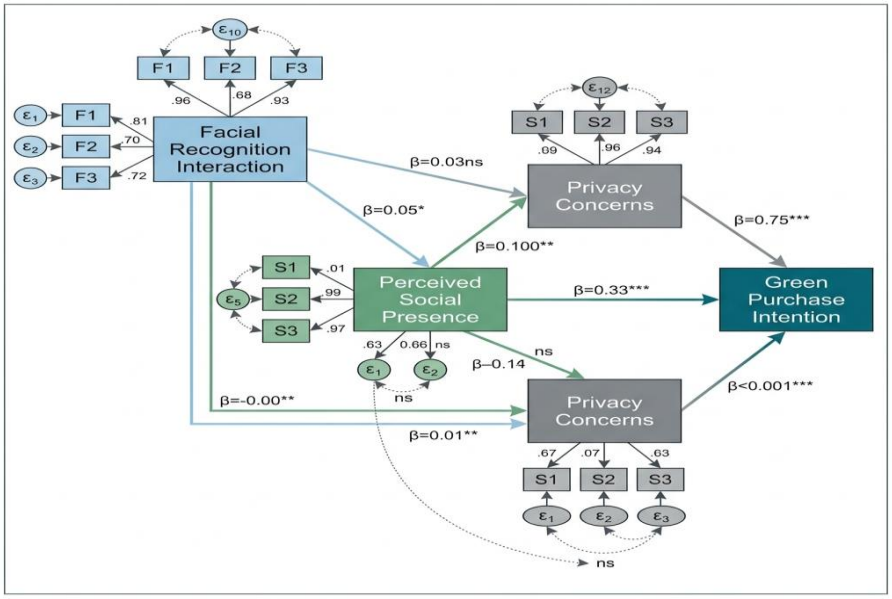


Figure 1: Structural Equation Model of Facial Recognition Interaction Pathways

The structural analysis provided robust support for the competing mediation hypotheses. The path from high facial recognition interaction to perceived social presence was highly significant and positive. Furthermore, perceived social presence had a strong, positive, and significant effect on green purchase intention. This confirms the first mediation pathway, illustrating that interaction with facial recognition systems elevates the feeling of being observed, which acts as a catalyst for normative, pro-environmental behavior. Simultaneously, the path from high facial recognition interaction to privacy concern was also positive and significant. However, privacy concern exhibited a significant negative relationship with green purchase intention. This confirms the second mediation pathway, demonstrating the suppressive effect of privacy-related anxiety on sustainable consumer choices. A detailed mediation analysis using bootstrapping procedures confirmed that both indirect effects were statistically significant. The positive indirect effect through social presence was slightly larger in magnitude than the negative indirect effect through privacy concern, resulting in a net positive overall effect in this specific experimental context.

4.3 Discussion of Findings

The empirical findings from this study present a complex and multifaceted view of human-computer interaction within retail environments. The primary discovery that facial recognition interaction can positively stimulate green purchase intention represents a significant advancement in consumer behavior research. It validates the application of objective self-awareness theory to interactions with artificial intelligence, suggesting that advanced technological systems can successfully replicate the social pressures previously attributed exclusively to human presence. The digital watching eyes effect is powerful enough to shift consumer decision-making toward societal ideals, even when the consumer is consciously aware that the entity observing them is a machine. However, the confirmation of the dual-pathway model underscores the delicate balance retailers must maintain. The simultaneous activation of privacy concerns serves as a critical counterweight to the benefits of social presence. When a facial recognition system is perceived as overly intrusive or when the consumer lacks trust in the data management practices of the retailer, the resulting psychological reactance actively suppresses their willingness to engage in prosocial purchasing. The anxiety generated by biometric surveillance shifts the consumer's cognitive resources away from moral or environmental considerations and towards self-protection and risk mitigation. These findings suggest that the efficacy of facial recognition technology as a tool for promoting sustainable consumption is entirely dependent on its implementation strategy. Systems designed to maximize perceived social presence through friendly, transparent, and non-threatening

interactions are likely to yield positive behavioral outcomes. Conversely, opaque, mandatory, or overly aggressive biometric tracking systems will likely alienate consumers, negating any potential environmental benefits and potentially harming the retailer's overall brand equity. The intersection of artificial intelligence and green marketing is not inherently positive or negative; rather, it is highly contingent on the psychological architecture of the user experience.

5. Conclusion

5.1 Theoretical Contributions

This research makes several distinct contributions to the academic literature spanning retail technology, environmental psychology, and human-computer interaction. Primarily, it bridges a significant gap by linking the physical deployment of biometric systems to abstract moral decision-making, specifically green purchase intention. While previous research has thoroughly documented the impact of facial recognition on convenience and privacy, this study introduces pro-environmental behavior as a novel downstream consequence of technological interaction. Furthermore, the conceptualization and empirical validation of the dual-pathway mediation model provide a robust theoretical framework for future research. By integrating objective self-awareness theory with privacy calculus theory, the study articulates the precise psychological mechanisms that simultaneously drive and inhibit consumer behavior in technologically augmented environments. It proves that the anthropomorphization of artificial intelligence can have profound normative effects, effectively expanding the boundary conditions of the watching eyes effect from biological entities to digital algorithms.

5.2 Practical Implications

For retail management and technology developers, the findings offer critical, actionable insights. Retailers seeking to leverage facial recognition technology must adopt a highly nuanced approach that prioritizes consumer trust and psychological comfort. To harness the positive effects of perceived social presence on green purchasing, interactive displays should be designed with transparent, opt-in mechanisms that give the consumer a sense of control over their biometric data. The interaction should be framed as a supportive, value-adding service rather than a surveillance mechanism. Furthermore, retailers heavily invested in sustainable product lines can strategically position facial recognition touchpoints near green product categories to activate self-awareness exactly at the point of decision. However, this must be accompanied by clear communication regarding data privacy policies to mitigate the suppressive effects of privacy concerns. Developing ethical guidelines for artificial intelligence deployment is not merely a legal obligation but a strategic imperative that directly impacts sales performance and corporate social responsibility outcomes.

5.3 Limitations and Future Research

Despite the rigorous experimental design, this study is subject to certain limitations that provide avenues for future scientific inquiry. The research was conducted in a controlled, simulated laboratory environment, which, while enhancing internal validity, may not perfectly replicate the complex, multifaceted distractions present in a genuine, busy retail setting. Future studies should attempt to replicate these findings using field experiments in operational commercial stores to validate the external validity of the dual-pathway model. Additionally, the study utilized a single exposure to the facial recognition system. Longitudinal research is necessary to determine whether the normative effects of digital observation diminish over time through habituation, or whether repeated exposures foster a sustained commitment to green purchasing. Finally, cultural differences significantly influence both privacy perceptions and environmental attitudes. Extending this research across different geographic and cultural contexts would provide a more comprehensive, global understanding of how emerging retail technologies shape the future of sustainable consumption.

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